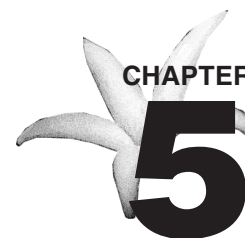


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# Environmental Surveillance

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**E**nvironmental surveillance at the Savannah River Site (SRS) is designed to survey and quantify any effects that routine and non-routine operations could have on the site, the surrounding area, and population. Site surveillance activities are divided into radiological and non-radiological programs.

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As part of the SRS radiological surveillance program, routine surveillance of all applicable radiation exposure pathways is performed on all environmental media (air, rain, surface water, soil, sediment, vegetation, drinking water, food products, wildlife, and aquatic wildlife) that could lead to a measurable annual dose above background at and beyond the SRS boundary. Radionuclides present in and around the SRS environment may be from a number of sources, including (1) natural background, (2) fallout from historical atmospheric testing of nuclear weapons, (3) nuclear power plant operations, and (4) SRS operations. Nonradioactive environmental surveillance at SRS involves the sampling and analysis of surface water, drinking water, air, sediment, groundwater, and fish. Results from the analyses of surface water, drinking water, sediment, and fish are discussed in this chapter. A description of the groundwater monitoring program and analysis results can be found in Chapter 7, “Groundwater.”

The Savannah River is monitored by SRS and other groups, including the South Carolina Department of Health and Environmental Control (SCDHEC), the Georgia Department of Natural Resources, Georgia Power Company’s Vogtle Electric Generating Plant (VEGP, operating in Georgia), and the city of Savannah, Georgia.

Brief summaries of analytical results are presented in this chapter; detailed data sets can be found in tables on the compact disk (CD) (see “Environmental Data/Maps - 2011”) inside the back cover of this report. Also on the CD are maps showing all applicable sampling locations. Tables on the CD are referred to in this chapter as “data table 5-X.” Tables in the chapter itself are referred to simply as “table 5-X.”

References to detectable amounts or levels of radioactivity within this chapter are synonymous with activity greater than the minimum detectable concentration (MDC) for a particular analytical method. The MDC is the smallest amount or concentration that can be distinguished in a sample by a given measurement system at a preselected counting time and at a given confidence level. Representative MDC values for radiological analyses can be found in Table 2 (“Representative Minimum Detectable Concentrations for Radiological Analyses”) in the “Sampling” section of the CD.

References to detectable amounts or levels of nonradioactivity within this chapter are synonymous with activity that is greater than either the method detection limit (MDL) or practical quantification limit (PQL) for a particular analytical method. The MDL is the lowest concentration that can be detected by an instrument with correction for the effects of sample matrix and method-specific parameters such as sample preparation. The PQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

## Radiological Surveillance

### Air

#### Description of Surveillance Program

SRS conducts atmospheric air monitoring both onsite and offsite to determine whether airborne radionuclides have reached the environment in measurable quantities of SRS releases and to verify and modify the models used to show compliance with the 10 mrem/year dose limit specified in United States Department of Energy (USDOE) Order 5400.5, “Radiation Protection of the Public and the Environment.” The atmospheric

surveillance program is divided into two primary areas, air and rainwater.

The SRS maintains a network of 15 atmospheric (ambient) surveillance sampling stations in and around SRS to monitor the concentration of tritium and radioactive particulate matter in the air. Tritium is the most abundant airborne radionuclide released as part of routine SRS operations, and becomes part of the natural environment. Monitoring ensures that it poses no health risk to the surrounding population. The tritium-in-air surveillance results are used to validate the dose models used for the airborne pathway to the nearby public.

The surveillance stations are placed at the center of the SRS, around the site perimeter, at a regional reference location (assumed to be unimpacted by SRS operations) nearly 25 miles from the SRS, and in population centers 25 and 100 miles from the SRS. Placement on the site boundary was designed to ensure that at least one monitoring station is in every 45-degree sector.

Each air surveillance sampling station consists of the following:

Media	Purpose	Sampling Frequency	Analysis Frequency	Analyses
Glass-Fiber Filter	Airborne Particulate Matter	Biweekly	Biweekly	Gamma-emitting radionuclides, gross alpha/beta emitting radionuclides
Glass-Fiber Filter	Airborne Particulate Matter	Biweekly	Annually	Total Strontium, Actinides (plutonium, americium, uranium, curium, and neptunium)
Charcoal Canister	Gaseous States of Radioiodine	Biweekly	Annually	Iodine-129, Iodine-131
Silica Gel	Tritiated Water Vapor	Biweekly	Biweekly	Tritium
Rainwater	Tritium in Rainwater	Monthly	Monthly	Tritium
Rain Ion Column	Wet/Dry Deposition	Monthly	Monthly	Gamma-emitting radionuclides, gross alpha/beta emitting radionuclides, total Strontium, Actinides (plutonium, americium, uranium, curium, and neptunium)

### Surveillance Results Summary

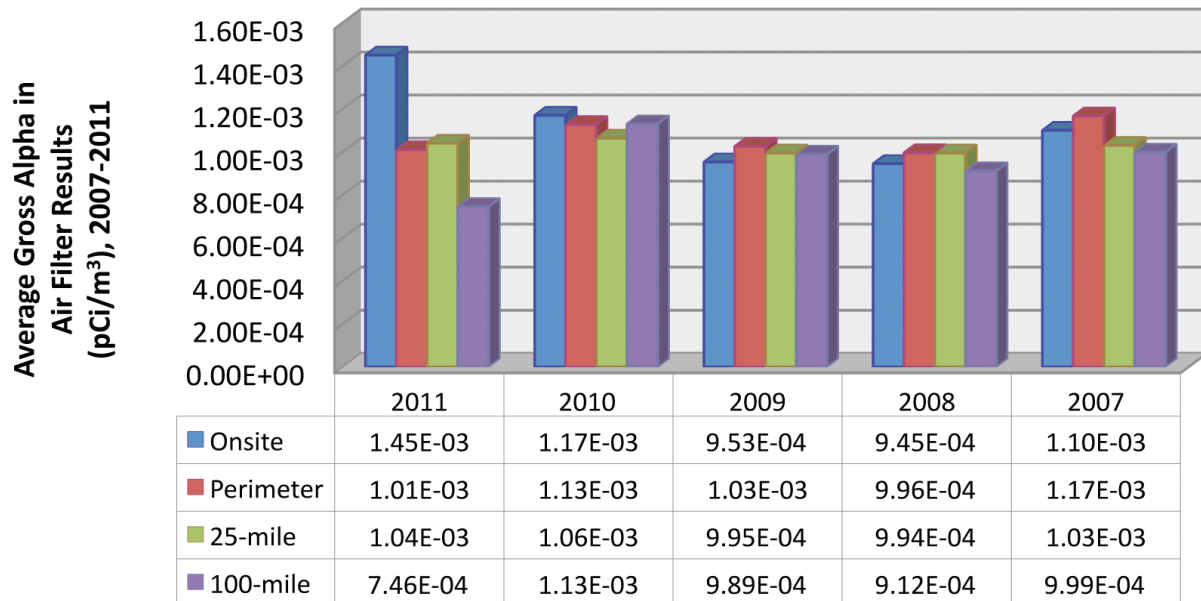
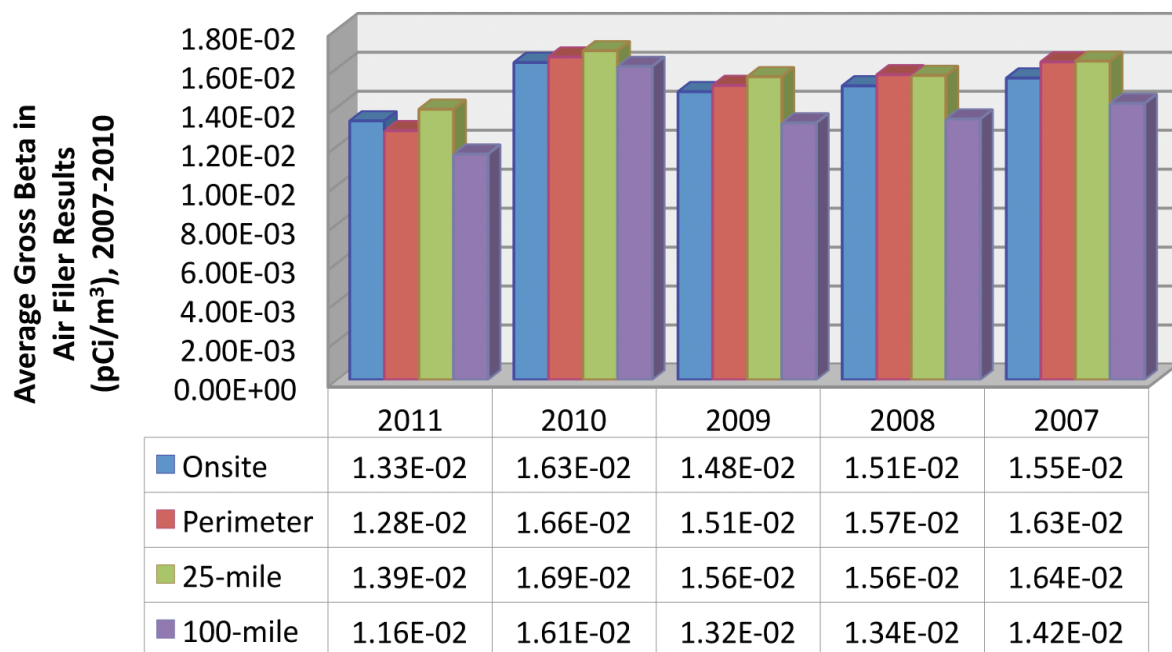
For the biweekly analyses at the site perimeter in 2011, only tritium was routinely detectable, greater than the MDC.

During March and April 2011, the Fukushima nuclear incident in Japan following the earthquake and tsunami led to airborne contamination released to the environment. The SRS surveillance program was impacted by this event in that detectable levels of contamination were measured during the routine surveillance. The details will be discussed in Post Fukushima Event Sampling section of Chapter 9.

With the exception of the post-Fukushima incident monitoring results, onsite and offsite radionuclide concentrations were similar to levels observed in previous years (see expanded discussion in paragraphs that follow).

**Glass-Fiber Airborne Particulates Results**—(data table 5-1) Average gross alpha results for 2011 compared to 2010 were generally higher at the onsite Burial Ground North (BGN) location and were generally lower at the site perimeter and beyond the site (figure 5-1). Average gross beta results were generally lower than those of 2010 for all locations (figure 5-2). Gross alpha and beta results were consistent with historical results in demonstrating long-term variability.



Figure 5–1 Five Year Trendchart of Average Gross Alpha in Air Filter Results (pCi/m<sup>3</sup>), 2007-2011Figure 5–2 Five Year Trendchart of Average Gross Beta in Air Filter Results (pCi/m<sup>3</sup>), 2007-2011



**External Configuration of Air Surveillance Sampling Station**

As part of SRS routine operations, cesium-137 is released into the atmosphere at quantities well below the Derived Concentration Guide (DCG). One out of 402 filter samples for 2011 contained detectable amounts of the man-made gamma-emitting radionuclide cesium-137, consistent with the historical results.

During 2011, detectable levels of uranium-234 were observed in 14 of 24 air samples, and detectable levels of uranium-238 were observed in 16 of 24 air samples; however, no detectable levels of uranium-235 were observed in any of the 2011 samples. These results are similar to those observed in 2010 and previous years. Uranium is naturally occurring in soil, and therefore expected to be present in low concentrations on some particulate filters. Aside from uranium, the only alpha-emitting radionuclide observed was americium-241 in three of 24 air samples. Generally, these concentrations were consistent with historical results. All other alpha-emitting isotopes were below detection levels.



**Field Sampling Technician Changes Air Filter Media**

**Charcoal Canister Results**—(data table 5-2) Due to the Fukushima nuclear incident in early 2011, additional charcoal samples were taken during March and April 2011. Of the gamma-emitting radionuclides, cesium-137 was detectable in two of 138 samples during 2011. Radioiodine-129 was detected in 21 of 138 charcoal samples and iodine-131 in 29 of 138 samples. These were all around the post Fukushima timeframe and were consistent with other published results around the United States. More details will be provided in Chapter 9.

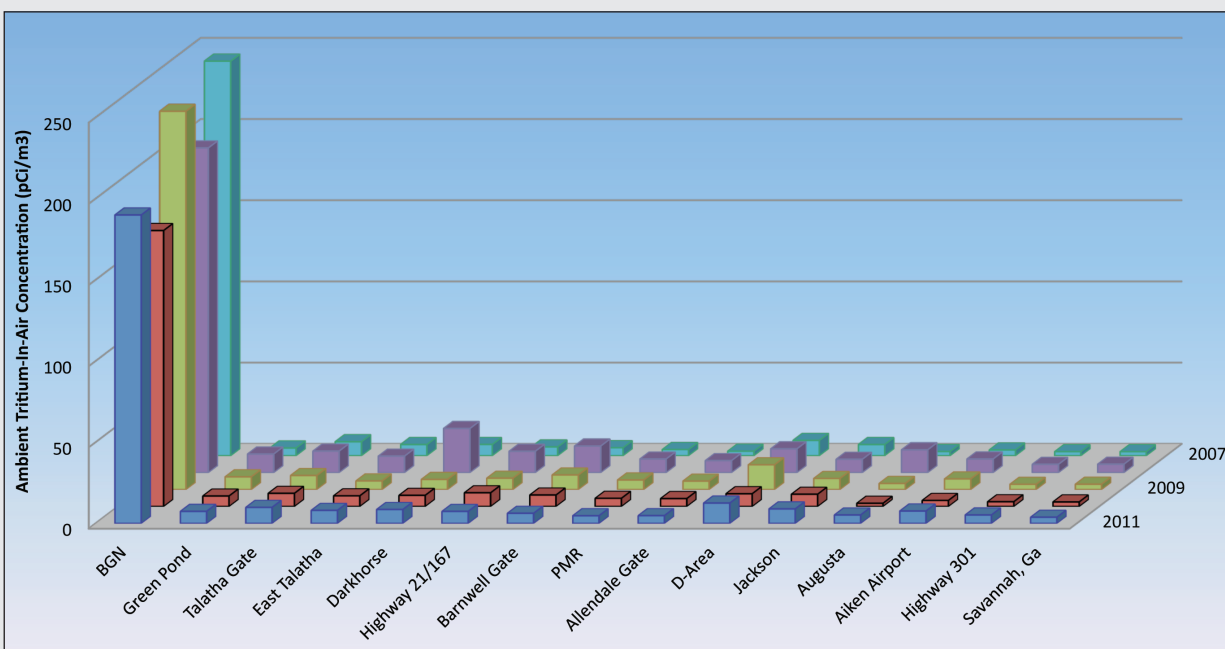
**Silica Gel Tritium-In-Air Results**—(data table 5-3) Tritium-in-air results for 2011 were greater than those observed in 2010 but were consistent with the long-term variability of historical results (table 5-1). Tritium-in-air results showed detectable levels in 149 (38%) of the 388 silica gel samples for 2011. As in previous years, the Burial Ground North (BGN) location showed average and maximum concentrations significantly higher than those observed at other locations. BGN concentrations are expected to be higher and more variable because of

the location's proximity to both the Tritium Facilities and to the phytoremediation project near the center of the SRS; the concentrations are influenced by operations at these facilities. All (100 percent) of the silica gel samples from the center of the site contained detectable

levels of tritium. Beyond the center of the SRS, tritium-in-air was detected in 34-percent of the samples. As expected, tritium concentrations generally decreased with increasing distance from the Tritium Facilities (figure 5-3 and table 5-1).

**Table 5-1 2011 Average Tritium-in-Air Results (pCi/m<sup>3</sup>), 2007 – 2011**

Location	2011	2010	2009	2008	2007
Burial Ground North	190 (+/-1.42)	170	233	200	243
Green Pond	7.49(+/-0.673)	6.49	7.90	11.5	4.78
Talatha Gate	9.93 (+/-0.682)	8.15	8.71	13.3	8.64
East Talatha	8.09 (+/-0.683)	6.61	5.36	10.2	6.92
Darkhorse	8.63 (+/-0.701)	6.91	6.30	27.2	6.94
Highway 21/167	7.47 (+/-0.705)	8.48	7.03	13.2	5.43
Barnwell Gate	6.30 (+/-0.671)	7.11	9.04	16.4	4.93
PMR	4.81 (+/-0.694)	5.09	5.97	8.43	3.82
Allendale Gate	4.86 (+/-0.666)	4.93	5.26	7.45	2.79
D-Area	12.6 (+/-0.739)	7.91	15.3	14.7	9.44
Jackson	9.01 (+/-0.749)	7.59	6.88	8.26	6.92
Augusta	5.27 (+/-0.707)	2.03	3.83	14.1	2.60
Aiken Airport	7.71 (+/-0.800)	3.77	6.60	8.44	3.57
Highway 301	5.28 (+/-0.735)	2.99	3.29	5.18	2.54
Savannah, GA	3.86 (+/-0.703)	2.86	3.34	5.24	2.51



**Figure 5-3 Ambient/Atmospheric Tritium-In-Air Concentrations (pCi/m<sup>3</sup>), 2007 - 2011**

\* The tritium-in-air results are well below the concentration equivalent to 1 mrem from inhalation. The NESHAPS limit for airborne pathway is 10 mrem.

## Rainwater

### Description of Surveillance Program

The atmospheric surveillance program also includes rainwater surveillance, divided into two parts, sampling for tritium in rainwater and sampling for nontritium radionuclides in wet/dry deposition. Rainwater sampling is performed at all 15 locations, while seven of these locations are sampled for wet/dry deposition. The placement of locations for deposition was selected to provide a uniform distribution around the SRS.

### Surveillance Results Summary

Other than iodine-131, no other detectable man-made gamma-emitting radionuclides were observed in rainwater samples during 2011 (data table 5-4).

Gross alpha and gross beta results from 2011 were consistent with those of 2010. In 2011, the average gross alpha and gross beta results generally were slightly lower than in 2010. Annual average gross alpha and gross beta concentrations, as well as individual sample results, are consistent with historical results, which demonstrate long-term variability.

Detectable levels of uranium-234 were present in 20 of 99 samples. Detectable levels of uranium-238 were present in 22 of 99 samples. No detectable levels of uranium-235 were in any of the 99 samples. Uranium is naturally occurring in soil and is therefore expected to be present at low concentrations in some deposition samples. Both uranium-234 and uranium-238 results were higher at the D-Area perimeter location than at the other site perimeter locations; they also were higher at the BGN (onsite) location. This is likely attributable to the increased airborne particulate matter (dust) present at these locations because of vehicle traffic on nearby dirt roads and fields. Neither plutonium-238 nor plutonium-239 was observed in any of the 99 samples. Americium-241 was observed in 13 samples (three from the BGN location and 10 at the site perimeter). The average concentration of americium-241 was well below the drinking water standard. Eight strontium-89,90 results were above the MDC (seven at the center of the SRS and one at the D-Area perimeter location). The strontium concentration levels were below regulatory limits.

Tritium in rainwater results showed detectable levels in 31 (16 percent) of the 195 rainwater samples for 2011 (data table 5-5). As in previous years, tritium-in-rain values were highest near the center of the SRS. All rainwater samples from the center of the site contained detectable tritium. This is consistent with the H-Area

effluent release points that routinely release tritium. Beyond the center of the site, tritium was detected in 9.89 percent of the rainwater samples. As with tritium-in-air (figure 5-3), concentrations generally decreased as distance from the effluent release points increased.

## Gamma Radiation

### Description of Surveillance Program

Ambient gamma exposure rates in and around SRS are monitored by an extensive network of dosimeters. SRS uses the thermoluminescent dosimeter (TLD) to quantify integrated gamma exposure on a quarterly basis. The TLD performs this function accurately, reliably, and relatively inexpensively.

SRS has been monitoring ambient environmental gamma exposure rates with TLDs since 1965. The information provided by this program is used primarily to determine the impact (if any) of site operations on the gamma exposure in the environment and to evaluate trends in environmental exposure levels. Other potential uses include support of routine and emergency response dose calculation models.

The SRS ambient gamma radiation monitoring program is divided into four subprograms: site perimeter stations, population centers, air surveillance stations, and Vogtle (stations that monitor potential exposures from Georgia Power's VEGP). All TLDs are exchanged quarterly. Most gamma exposure monitoring is conducted onsite and at the SRS perimeter. Monitoring continues to be conducted in population centers within nearly 15 kilometer (km) (9 mile (mi)) of the site boundary, but only limited monitoring is conducted beyond this distance and at the 40- to 160-km (25- to 100-mi) air surveillance stations.

### Surveillance Results Summary

Ambient gamma exposure rates at all TLD monitoring locations show some variation based on normal site-to-site and year-to-year differences in the components of natural ambient gamma radiation exposure levels. In 2011, ambient gamma exposure rates varied between 56.5 and 125 millirem (mrem)/year (yr) (data table 5-6).

In general, the 2011 ambient gamma radiation monitoring results indicated dose rates very close to those observed at the same locations in 2010. The average annual exposure rate was 82.5 mrem in 2011, compared to 82 mrem in 2010. The total ambient exposure results for the BGN (onsite) location was lower for 2011 (125 mrem/yr) than for 2010 (129 mrem/yr). However, these results generally are consistent





**Thermoluminescent Dosimeters Placed in the Field for Ambient Gamma Exposure Monitoring**

with previously published historical results and indicate that no significant difference in average annual dose rates is observed between monitoring networks except in the case of population centers. Ambient dose rates in population centers are slightly elevated compared to the other monitoring networks, as expected, because of factors such as buildings and roadways, which emit low levels of radiation.

## Stormwater Basins

### Description of Surveillance Program

Stormwater accumulating in site stormwater basins is monitored monthly for gross alpha, gross beta, tritium, strontium, gamma-emitting radionuclides, and actinides.

Analyses for specific radionuclides are determined by the makeup of the previous releases to the basins.

In 2011, monitoring was conducted at five E-Area basins as well as at the Z-Area Basin and F-Area Pond 400.

### Surveillance Results Summary

No active discharges to SRS stormwater basins are present. The primary contributor is rainwater runoff. Cesium-137 and gross beta concentration levels in the Z-Area Basin were measured during 2011 and are

attributed to storm water runoff from near Saltstone Disposal Facility (SDF) Vault 4 operations. Cesium-137 was greater than the MDC level in 11 of the 12 Z-Area Basin samples during 2011 at an average of 220 (+/-3.57) pCi/L and a maximum of 803 (+/-27.3) pCi/L. These levels are higher than those of 2010 and the historical trend, but below the USDOE DCG of 3,000 pCi/L for cesium-137. The Z-Area basin does not discharge to the environment. SDF management has implemented steps (i.e., installation of weather enclosures, enhanced facility operations, and installation of storm water management controls) for radioactive contamination control. SDF operations and radiological areas are maintained in accordance with SRS radiological practices. SCDHEC performs routine inspections of the SDF. The highest mean tritium concentration in all the basin samples was measured in the E-005 Basin, at 17,400 (+/-124) pCi/L, which was 33% lower than the mean tritium concentration at the same location in 2010. This is consistent with the previous five years of historical results. Cobalt-60 was less than the MDC in all of the basin samples. Other than the Z-Area Basin, cesium-137 was not greater than the MDC in any of the other basin samples. Curium-244 was detected in one basin sample from the Basin North (E-002) but was well within the historical trend for this location. Technetium-99 was detected in 11 of the 12 samples from Z-Area Basin at an average level of 10.0 (+/-0.349) pCi/L, and 10 of the other basin locations, averaging 1.15 pCi/L. Fission products, as well as some actinides, were observed in the basins measuring a mean average of less than 1.00 pCi/L. Gross alpha and gross beta activity were detected in all the basins, and, other than the Z-Area Basin, the concentrations were comparable to those of the previous five years to identify any trends (data table 5-7).

## Streams

### Description of Surveillance Program

Continuous surveillance monitoring of SRS streams is performed downstream of several process areas to detect and quantify levels of radioactivity in effluents transported to the Savannah River. The five primary streams are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs. The frequency and types of analyses performed on each sample are based on potential quantity and types of radionuclides likely to be present at the sampling location.

### Surveillance Results Summary

The average 2011 concentrations of gross alpha, gross beta, and tritium in SRS streams are presented in table 5-2. Detectable concentrations of tritium, the predominant radionuclide detected above background





**SRS and SCDHEC  
Side-by-Side Automated Samplers**



**Liquid Surveillance  
Stream Sampling Location Fourmile-A7**

levels in SRS streams, were observed at least once at all stream locations in 2011. When comparing stream tritium averages for 2011 and 2010, some were slightly higher and others were slightly lower; however, no statistically significant differences occurred between the averages of the two years. The ten-year trend chart for the average tritium levels in the streams shows a decreasing trend over time (figures 5-4 and 5-5), which is due to a combination of decreases in site releases

and the natural decay of tritium over time. Overall, tritium concentrations in SRS streams during 2011 were consistent with long-term tritium levels.

Cesium-137 was detected in 16 of 272 stream samples (less than 6%) for 2011 from the Upper Three Runs, Fourmile Branch, and Lower Three Runs locations. Gross alpha and gross beta activity was detected in all the streams, but overall average concentrations were

**Table 5-2 Average 2011 Concentrations of Radioactivity in SRS Streams**

Location	Gross Alpha (pCi/L)	Standard Deviation	Gross Beta (pCi/L)	Standard Deviation	Tritium (pCi/L)	Standard Deviation
<b>Onsite Downstream Locations</b>						
Tims Branch (TB-5)	10.7	0.304	3.50	0.171	409	50.0
Lower Three Runs (L3R-3)	5.61	0.349	3.07	0.231	781	51.1
Steel Creek (SC-4)	3.72	0.196	3.37	0.138	2,900	62.3
Pen Branch (PB-3)	1.57	0.169	1.85	0.182	3,080	160
Fourmile Branch (FM-6)	3.19	0.135	10.4	0.188	3,950	180
Upper Three Runs (U3R-4)	35.8	0.773	12.5	0.420	937	53.7
<b>Onsite Control Location (for comparison purposes)</b>						
Upper Three Runs (U3R-1A)	6.26	0.213	2.20	0.155	261	29.6



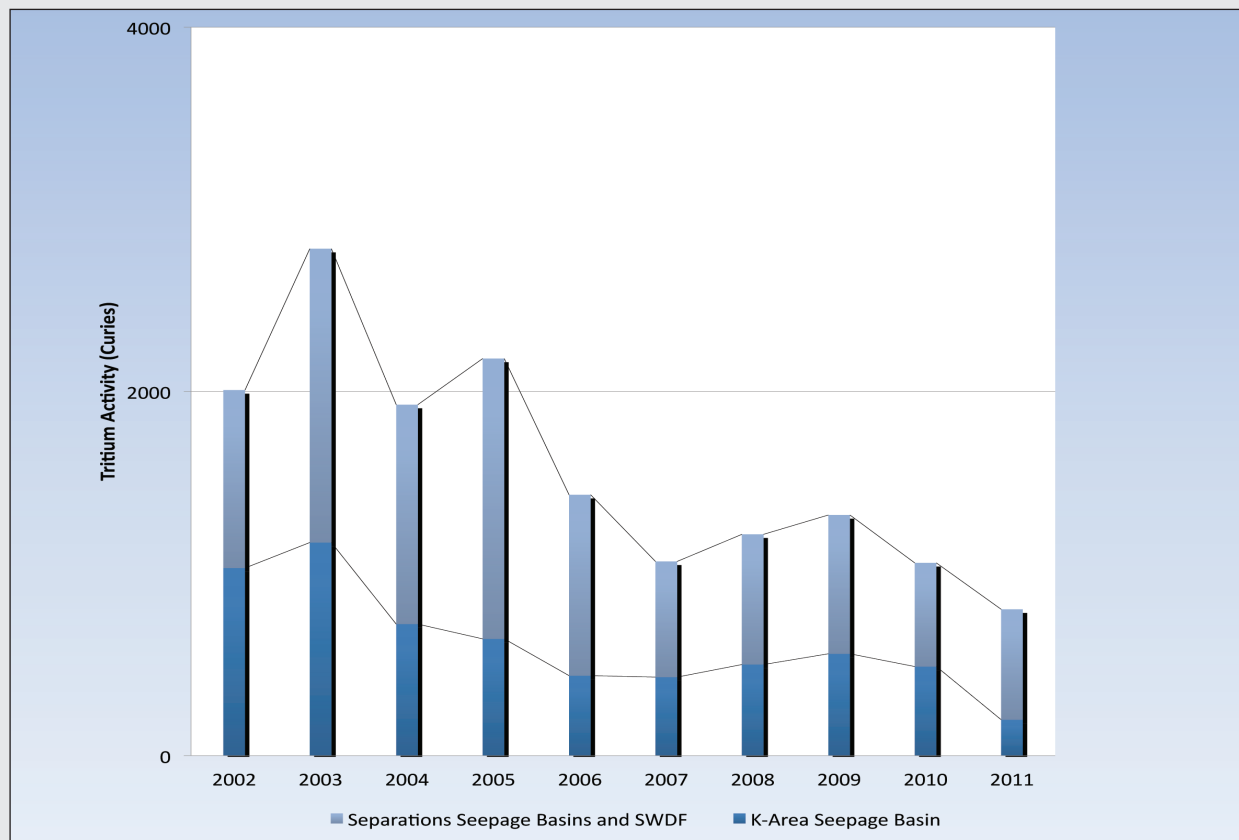
**Figure 5-4 Ten-Year Trend of Average Tritium Concentration in Lower Three Runs, Steel Creek, and Upper Three Runs (pCi/L)**



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

consistent with levels of recent years. Gross alpha levels were higher for the Lower Three Runs-2 and Upper Three Runs-4 locations during the late summer of 2011 due to sedimentation in the samples. The samples were reanalyzed several times to filter out the sedimentation. Isotopic analyses revealed the source to be natural uranium. The levels were accounted for in

the radioactivity transport calculations. Strontium-89,90 was detected in all samples from the Fourmile Branch location with an average of 3.74 (+/-0.143) pCi/L, below the Minimum Control Level of 8.00 pCi/L. Other radionuclides were observed at locations throughout the SRS but were consistent with the source of the material and exhibited variations similar to those of previous



Year	K-Area Seepage Basin Curies	Separations Seepage Basins and SWDF Curies	Total Curies
2002	1030	977	2007
2003	1170	1613	2783
2004	722	1205	1927
2005	641	1539	2180
2006	439	993	1432
2007	431	635	1066
2008	500	715	1215
2009	559	762	1321
2010	489	569	1058
2011	197	606	803

**Figure 5-6 Estimated Tritium Migration from SRS Seepage Basins and SWDF to Site Streams, 2002-2011**

years. No significant trends were observed in 2011 when compared with recent years (data table 5-8), and, in most cases, averages were less than one pCi/L.

## Seepage Basin and Solid Waste Disposal Facility Radionuclide Migration

### Description of Surveillance Program

To incorporate the migration of radioactivity to site streams into total radioactive release quantities, SRS

personnel continued to monitor and quantify the migration of radioactivity from SRS seepage basins and the SWDF in 2011 as part of its stream surveillance program.

### Surveillance Results Summary

Tritium, strontium-89,90, technetium-99, iodine-129, and cesium-137 were detected in migration releases (data table 5-9).

Figure 5-6 is a graphical representation of releases of tritium via migration to site streams for 2011. As seen in the figure, migration releases of tritium generally have declined the past 10 years, with year-to-year variability caused mainly by the amount of annual rainfall.

Accordingly, during 2011, the total quantity of tritium migrating from SRS seepage basins and SWDF was 803 Ci compared to 1,058 Ci in 2010, a 24% decrease.

Radioactivity previously deposited in the F-Area and H-Area Seepage Basins and SWDF continues to migrate through the groundwater and to outcrop into Fourmile Branch and Upper Three Runs. Groundwater migration from the F-Area Seepage Basins enters Fourmile Branch among locations FM-3A, FM-2B, and FM-A7. Because of their proximity, migration from the SWDF cannot be distinguished from migration from a part of H-Area Basin 4. Estimated migration of tritium into Fourmile Branch in 2011 occurred as follows:

- From F-Area Seepage Basins, 13 Ci, a 62% decrease from the 2010 total of 34 Ci
- From SWDF and a part of H-Area Seepage Basin 4, 457 Ci, a 20% increase from the 2010 total of 381 Ci
- From H-Area Seepage Basins 1, 2, 3, and most of 4, 68 Ci, a 20% decrease from the 2010 total of 85 Ci

The estimated tritium migration from the north side of SWDF and the General Separations Area (GSA) into Upper Three Runs in 2011 was 68.3 Ci, compared with the 2010 total of 69 Ci, a fluctuation consistent with historical results. (The GSA is in the central part of SRS and contains all waste disposal facilities, chemical separations facilities, and associated high-level waste storage facilities along with numerous other sources of radioactive material.)

The total amount of strontium-89,90 entering Fourmile Branch from the GSA seepage basins and SWDF during 2011 was estimated to be 15.2 mCi (table 5-3). Migration releases of strontium-89,90 vary from year to year but have remained below 100 mCi the past nine years. In 2011, 10.6 mCi of technetium-99, 14.8 mCi of iodine-129, and 19.5 mCi of cesium-137 were estimated to have migrated into Fourmile Branch (table 5-3).

**Table 5-3 Strontium-89,90, Technetium-99, Iodine-129, and Cesium-137 Migration Estimates**

Radionuclide	Total Activity (millicuries [mCi])
Strontium-89,90	15.2
Technetium-99	10.6
Iodine-129	14.8
Cesium-137	19.5

**K-Area Drain Field and Seepage Basin** Liquid purges from the K-Area Disassembly Basin were released to the K-Area Seepage Basin in 1959 and 1960. From 1960 until 1992, purges from the K-Area Disassembly Basin were discharged to a percolation field below the K-Area Retention Basin. Tritium migration from the seepage basin and the percolation field is measured annually in Pen Branch. The 2011 estimated migration total of 197 Ci represents a 60% decrease from the 489 Ci recorded in 2010.

**C-Area, L-Area, and P-Area Seepage Basins** Liquid purges from the C-Area, L-Area, and P-Area Disassembly Basins were released periodically to their respective seepage basins from the 1950s until 1970. Migration releases from these basins are accounted for in the stream transport totals (see “Tritium Transport in Streams” section of this chapter).

## Migration of Actinides in Streams

Migration of the actinides (uranium, plutonium, americium, and curium) into site streams no longer is quantified because of the historically low levels of these actinides. However, the streams are sampled and analyzed annually for the presence of these actinides. The resulting concentrations are compared to those of previous years to identify any trends. Overall, values for 2011 were consistent with historical data and generally remained at or below the analytical MDC.

## The Savannah River

### Description of Surveillance Program

Continuous surveillance is performed along the Savannah River at locations above and below SRS tributaries, including a location at which liquid discharges from VEGP enter the river.



### Surveillance Results Summary

Five locations along the river continued to serve as environmental surveillance points in 2011. Composite samples are collected weekly at these five river locations and analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides (data table 5-10). The average 2011 concentrations of gross alpha, gross beta, and tritium at river locations are presented in table 5-4. The tritium concentration levels are well below the USEPA drinking water standard of 20,000 pCi/L. Detectable levels of gross alpha and gross beta activity were observed at all river sampling locations and were consistent with the averages of the previous five years. Cesium-137 was detected in one out of the 265 weekly composite river samples for 2011.

Based on curies (of activity) released, tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS and VEGP tritium estimates based on concentration results and average flowrates at Savannah River Mile (RM) 118.8 were 2,090 Ci in 2011 compared to 2,058 Ci in 2010, well within the statistical overlap. In addition to the weekly composite samples referenced above, SRS collects annual grab samples to provide a more comprehensive suite of radionuclides (strontium-89,90, technetium-99 and actinides). Uranium-234, uranium-238 and americium-241 were quantified in all these grab samples from RM 118.8 and several other locations in 2011. Results were consistent with the averages of the previous five years.



River Surveillance Sample Collection from Automated Samper at River Mile 160

Table 5-4 Average 2011 Concentrations of Radioactivity in the Savannah River

Location	Gross Alpha (pCi/L)	Standard Deviation	Gross Beta (pCi/L)	Standard Deviation	Tritium (pCi/L)	Standard Deviation
RM-160	0.346	0.046	2.57	0.094	164	7.13
RM-150.4	0.556	0.056	2.66	0.096	1,480	8.79
RM-150	0.317	0.045	2.53	0.094	402	7.46
RM-141.5	0.487	0.052	2.32	0.092	621	7.78
RM-118.8	0.431	0.050	2.37	0.093	599	7.75



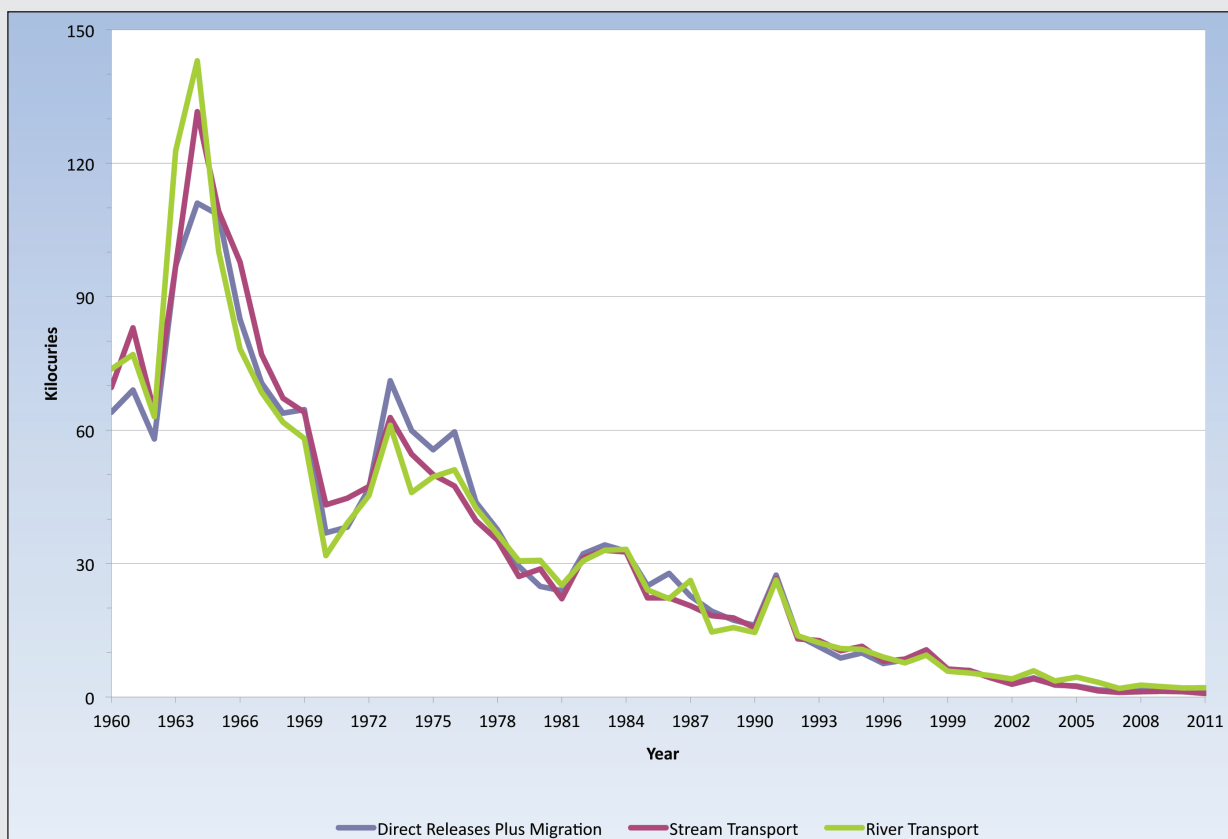
## Tritium Transport in Streams

### Description of Surveillance Program

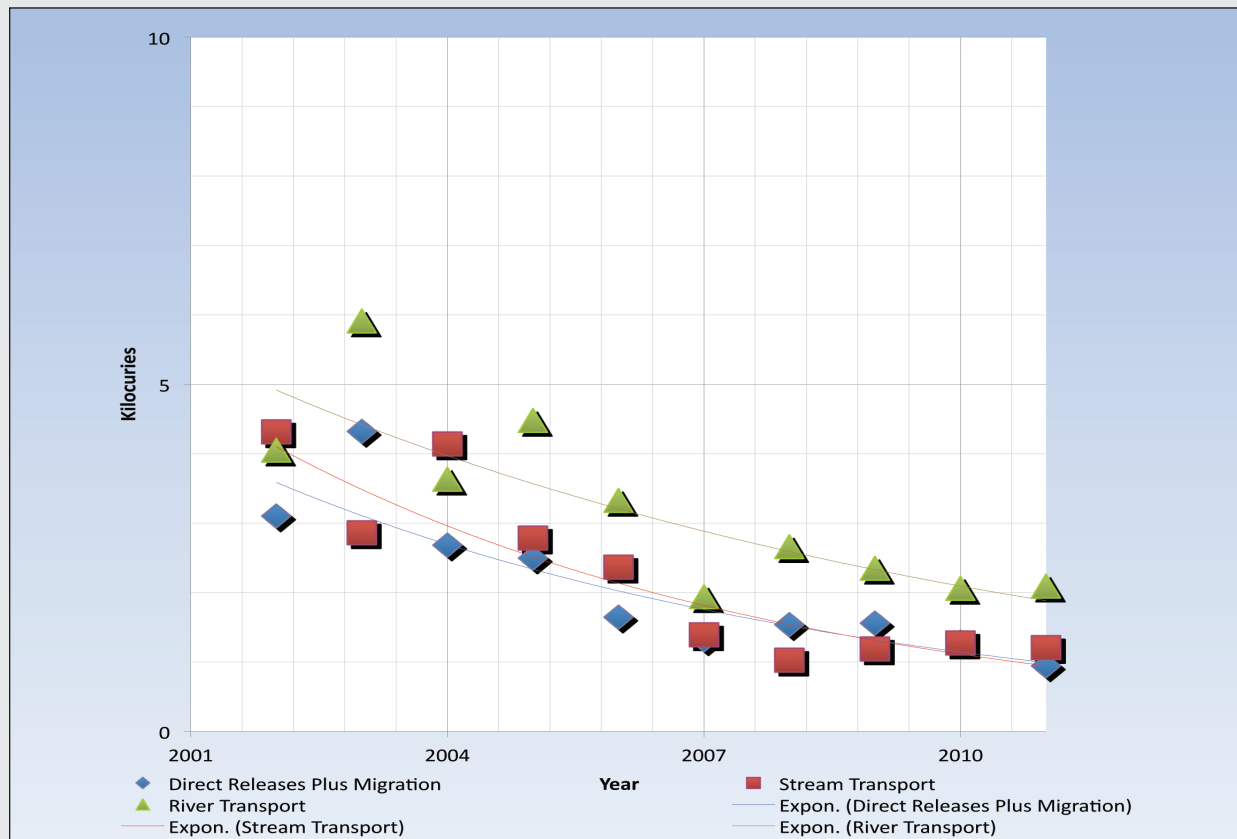
Tritium is introduced into SRS streams and the Savannah River from former production areas onsite. Because of the mobility of tritium in water and the quantities of the radionuclide released during the years of SRS operations, a tritium balance comparison at various site stream and Savannah River monitoring locations has been performed annually since 1960. SRS tritium transport data for 1960-2011 are depicted in figure 5-7, which shows the history of direct releases, stream transport, and river transport, as determined by SRS personnel. The history of tritium transport at SRS is documented in data table 5-11. The ten-year trend analysis shows a decreasing trend for the past ten years (figure 5-8). The tritium balance is compared among the following alternative methods of calculation:

- Total direct tritium releases, including releases from (1) facility effluent discharges and (2) measured shallow groundwater migration of tritium from SRS seepage basins and SWDF (direct releases)
- Tritium transport in SRS streams, measured at the last sampling point before entry into the Savannah River (stream transport)
- Tritium transport in the Savannah River, measured downriver of SRS (near RM 118.8) after subtraction of any measured contribution above the SRS (river transport)

The general trend over time is attributable to (1) variations in tritium production and processing at the SRS; (2) the implementation of effluent controls, such as seepage basins, beginning in the early 1960s; and (3) the continuing depletion and decay of the SRS's tritium inventory.



**Figure 5-7 SRS Tritium Transport Summary, 1960–2011**



**Figure 5-8 Ten-Year Trend of SRS Tritium Transport, 2002-2011**

### Surveillance Results Summary

The *direct releases* of tritium in 2011 decreased by almost 27% (from 1,285 Ci in 2010 to 942 Ci in 2011).

The *stream transport* of tritium in 2011 decreased by almost 36% (from 1,205 Ci in 2010 to 776 Ci in 2011).

The *river transport* of tritium estimated in the Savannah River in 2011 was 2,090 Ci, compared with 2,058 Ci from the previous year. Both VEGP and SRS contributed to these values. For the 2011 dose calculations, the highest value between the SRS *direct releases* and *stream transport* measurements (which was 942 Ci) is added to the VEGP reported tritium release total of 1,370 Ci to obtain an overall tritium total of 2,312 Ci (see chapter 6).

A small but measurable amount of tritium from earlier EnergySolutions LLC low level waste (LLW) radioactive waste disposal facility operations continued entering the stream system in 2011 as in the past few years. The facility is privately owned and adjacent to SRS. The amount of tritium entering the system is expected to

continue a gradual decline over time. EnergySolutions LLC began a program of capping the tritium sources in 1991, thereby reducing the amount of tritium entering the groundwater. The tritium currently in groundwater will continue to decay and dilute as it moves from the source toward Lower Three Runs. Environmental Monitoring and EnergySolutions LLC will maintain a monitoring program for Lower Three Runs to evaluate this tritium migration.

## Domestic Water

### Description of Surveillance Program

SRS personnel collected domestic water samples in 2011 from locations at SRS and at water treatment facilities that use Savannah River water. Potable water was analyzed at offsite treatment facilities to ensure that SRS operations did not adversely affect the water supply and to provide voluntary assurance that drinking water did not exceed USEPA drinking water standards for radionuclides.

Onsite domestic water sampling consisted of quarterly grab samples at large treatment plants in A-Area,

D-Area, and K-Area and annual grab samples at wells and small systems. Composite samples were collected monthly off site from

- The Beaufort-Jasper Water and Sewer Authority's Chelsea and Purrysburg Water Treatment Plants
- The city of Savannah Industrial and Domestic Water Supply Plant
- The North Augusta (South Carolina) Water Treatment Plant

### Surveillance Results Summary

All onsite and offsite domestic water samples in 2011 were screened for gross alpha and gross beta concentrations to determine if regulatory limits were exceeded. No domestic water exceeded USEPA's 15 picocuries per liter (pCi/L) alpha activity limit or 50 pCi/L beta activity limit. Also, no onsite or offsite domestic water samples exceeded the 20,000 pCi/L USEPA tritium limit or the 8 pCi/L strontium-89,90 MDC.

No cesium-137, strontium-89,90, uranium-235, plutonium-238, plutonium-239, or curium-244 was detected in any domestic water samples in 2011. For the 14 onsite samples, detectable levels greater than the MDC were observed for americium-241 in one sample, uranium-234 in four samples, and uranium-238 in four samples (data table 5-12). The levels were well below the USDOE DCG.

### Terrestrial Food Products

#### Description of Surveillance Program

The terrestrial food products surveillance program consists of radiological analyses of food product samples typically found in the Central Savannah River Area (CSRA). The purpose of the foodstuff monitoring program is to determine whether SRS operations are affecting human health through the food chain. Agricultural products, livestock and game animals for human consumption may contain radionuclides. SRS samples foods including milk, meat, fruit, nuts, and green vegetables because of the potential to transport radionuclides to people via the food chain. Data from the food product surveillance program are not used to show direct compliance with any dose standard; however, the data can be used as required to validate dose models and determine environmental trends.

Samples of food, including meat, fruit, and a green vegetable, are collected from one location within each of four SRS quadrants and from a location within an extended (to 25 miles beyond the perimeter) southeast

quadrant. All food samples are collected annually except milk, which is collected quarterly from four dairies within a 25-mile radius of the SRS. In general, as part of the foodstuffs surveillance, sampling of meat, fruit, and green vegetables is conducted on a three-year rotating schedule. Beef, collards, peanuts, pecans, and watermelon were sampled in 2011 as part of this program. Additionally, strawberries were collected and analyzed to evaluate elevated iodine-131 levels associated with the Fukushima Daichii Plant nuclear incident in Japan (Chapter 9). Food samples typically are analyzed for the presence of gamma-emitting radionuclides, tritium, strontium-89,90, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, americium-241, curium-244, gross alpha activity, and gross beta activity. Technetium-99 was added to the analytical suite in 2009 and neptunium in 2010.

### Surveillance Results Summary

Terrestrial food product results for collards, peanuts, pecans, fruit, and beef appear in data table 5-13; results for milk appear in data table 5-14.

Tritium in food products is attributed primarily to releases from SRS. Tritium in peanuts was not analyzed due to inadequate moisture content. Tritium was detected during 2011 as follows:

- Fruit at all four quadrants (0-10 miles from the SRS) at a maximum of  $9.70\text{E-}02$  ( $\pm 2.25\text{E-}02$ ) pCi/g
- Beef at the northeast and southeast quadrants (0-10 miles from the SRS) at a maximum of  $1.42\text{E-}01$  ( $\pm 3.93\text{E-}02$ ) pCi/g
- Pecans at the southwest quadrant (0-10 miles from the SRS) at a concentration of  $6.24\text{E-}02$  ( $\pm 2.18\text{E-}02$ ) pCi/g
- Milk in 5 out of 24 dairy samples at a maximum concentration of  $4.38\text{E+}02$  ( $\pm 8.38\text{E+}01$ ) pCi/L

The detectable levels of tritium in milk were confirmed with reprocessing of the samples.

The only gamma-emitting radionuclide detected in food products in 2011 was cesium-137 as follows:

- Collards from the northeast and southeast quadrants (0-10 miles from the SRS) at a maximum of  $4.32\text{E-}02$  ( $\pm 1.21\text{E-}02$ ) pCi/g
- Peanuts from the northwest and southeast quadrants (0-10 miles from the SRS) at a maximum of  $1.10\text{E-}02$  ( $\pm 3.01\text{E-}03$ ) pCi/g

- Pecans from the northeast quadrant (0-10 miles from the SRS) at a concentration of  $1.34\text{E}-02$  ( $\pm 3.81\text{E}-03$ ) pCi/g
- One milk sample at concentration of  $3.49\text{E}+00$  ( $\pm 8.67\text{E}-01$ ) pCi/L

Strontium-89,90 was detected in beef in the southwest quadrant (0-10 miles from the SRS) at  $2.21\text{E}-03$  ( $\pm 7.34\text{E}-04$ ) pCi/g, in collards at all five locations at a maximum of  $1.89\text{E}-01$  ( $\pm 2.55\text{E}-02$ ) pCi/g, and in five milk samples out of 24 milk samples at a maximum of  $2.27\text{E}+00$  ( $\pm 4.08\text{E}-01$ ) pCi/L. Uranium-234 and uranium-238 were detected above the MDC for beef and collards at levels within the historical trend. Americium-241 was detected in collards at the northwest quadrant (0-10 miles from the SRS). Technetium-99 was detected in collards at all locations, in beef at the southeast and northwest quadrants 0-10 miles from the SRS, and in peanuts southeast and northeast quadrants 0-10 miles from the SRS. Detectable levels of gross beta activity were observed in all food products, while no detectable levels of gross alpha were observed in any of the food products. The 2011 results appeared to be randomly distributed among the monitoring locations, and no underlying spatial distribution was observed.

All radiological results on terrestrial food products were consistent with those of previous years.

### Aquatic Food Products

#### Description of Surveillance Program

The aquatic food product surveillance program includes fish (freshwater and saltwater) and shellfish. SRS maintains an ongoing program for collecting and analyzing fish from the Savannah River and surrounding freshwater bodies. Various species of fish were also collected off site from streams and tributaries to determine the potential dose and risk to the public from consumption. Because of a die-off attributed to cold weather in December 2010 and January 2011, no spotted sea trout could be collected. Nine surveillance points for the collection of freshwater fish are on the Savannah River from above SRS at Augusta, Georgia, to the coast at Savannah. Composite samples composed of three to five fish of a given species are prepared for each species from each location. Freshwater fish are grouped into one of three categories: bass, panfish (bream), or catfish. Saltwater fish include composites of sea trout, red drum (spottail bass), and mullet. The fish are selected for sampling because they are the most sought-after fish in the Savannah River. Composites are divided into edible (meat and skin only) and nonedible (scales, head, fins, viscera, bone) portions; however, catfish are skinned,



**Field Sampling Technicians Collect Fish at Steel Creek River Mouth**



**Striped Bass Collected at Steel Creek River Mouth**

and the skin becomes part of the nonedible composite. Analyses conducted on edible and nonedible composites include tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, technetium-99, iodine-129, and the actinide series.

#### Surveillance Results Summary

Aquatic food product results for saltwater fish are in data table 5-15; for freshwater fish, data table 5-16; and for shellfish, data table 5-17.



Gross alpha results were below the MDC for all edible and nonedible fish composites of saltwater and freshwater fish. Gross beta activity was detectable in all edible saltwater and freshwater fish composites at maximum concentrations of 3.14 (+/-0.362) pCi/g and 5.27 (+/-0.451) pCi/g, respectively, and was also detected in some of the nonedible saltwater and freshwater fish composites at all locations. This is most likely attributed to the naturally occurring radionuclide potassium-40. Iodine-129 was greater than the MDC in one freshwater fish composite from West Bank Landing at 2.27E-02 (+/-8.11E-03) pCi/g and not detected (or less than the MDC) in saltwater and shellfish composites. Cesium-137 was detectable in 33% of the freshwater edible fish composites at a maximum of 1.40E-01 (+/-1.88E-02) pCi/g, and 17% of the freshwater nonedible fish composites at a maximum of 1.25E-01 (+/-2.34E-02) pCi/g. No man-made gamma-emitting radionuclides were found in Savannah River edible and nonedible fish composites during 2011.

Strontium-89,90 was greater than the MDC in 39% of the nonedible freshwater fish composites at a maximum of 9.65E-03 (+/-1.80E-03) pCi/g and 99% of the nonedible fish composites at a maximum of 4.38E-01 (+/-2.89E-02) pCi/g. Uranium-234, uranium-238, and tritium were detected in freshwater and saltwater fish composites at concentrations similar to those of previous years. For the edible and nonedible saltwater fish composites, technetium-99 was below the MDC. For the freshwater fish composites, 29% of the edible composites contained detectable levels of technetium-99 at a maximum of 1.05E-01 (+/-2.64E-02) pCi/g. No Plutonium-239 or plutonium-238 was detectable in any of the edible freshwater and saltwater fish composites. Uranium-234 and uranium-238 were detected in saltwater and freshwater fish at levels consistent with the historical trends.

Gross alpha and gross beta were detected in shellfish at an average concentration of 6.41E-01 (+/-2.31E-01) pCi/g and 1.17 (+/-0.267) pCi/g, respectively. These levels were within the historical statistical trends. Strontium-89,90, uranium-234, uranium-235, and uranium-238 were detected in shellfish at levels similar to those of previous years. No detectable levels of iodine-129, plutonium-238, plutonium-239, americium-241, and curium-244 greater than the MDC were present in shellfish.

Calculations of risk from the consumption of fish from the Savannah River can be found in Chapter 6 ("Potential Radiation Doses").

## Wildlife Monitoring of Deer, Hogs, and Coyote

### Description of Surveillance Program

Annual game animal hunts, open to members of the general public, are conducted at SRS to control the SRS's deer and feral hog populations and to reduce animal-vehicle accidents. Prior to releasing any animal to a hunter, SRS personnel use portable sodium iodide detectors to perform field analyses for cesium-137. In 2011, Cs-137 concentrations in deer (muscle and bone) samples were periodically collected for laboratory analysis based on (1) a set frequency, (2) the cesium-137 levels, or (3) exposure limit considerations. Cesium-137 is chemically analogous to potassium in the environment and behaves similarly. It has a half-life of about 30 years and tends to persist in soil, and, if in soluble form, can readily enter the food chain through plants. It is widely distributed throughout the world from historic nuclear weapons detonations from 1945 to 1980 and has been detected in all environmental media.

SRS established an administrative dose limit of 30 mrem per year in 2006 for the consumption of game animals. This limit, which ensures that no single pathway contributes more than 30 % to the all-pathway dose limit of 100 mrem, is consistent with USDOE guidance. The doses from deer and hog consumption are quantified and reported in Chapter 6.

### Surveillance Results Summary

A total of 564 deer, 156 feral hogs, and 30 coyote were harvested and released during the 2011 SRS hunts. As observed during previous hunts, cesium-137 was the only man-made gamma-emitting radionuclide detected in animal flesh during laboratory analysis. Generally, cesium-137 concentrations measured by field detectors and laboratory methods were comparable. Field measurements for cesium-137 from all released animals ranged from the lowest default value of 1.00 pCi/g to 11.5 pCi/g while laboratory measurements ranged from below the MDC to 7.38 (+/-0.495) pCi/g. One hog was disposed of from hunt compartment number 48 with a cesium-137 concentration of 27.8 pCi/g, (equivalent to a dose of 19.4 mrem). This dose did not exceed the release limit of 30 mrem, but the hunter voluntarily decided to dispose of the animal onsite.

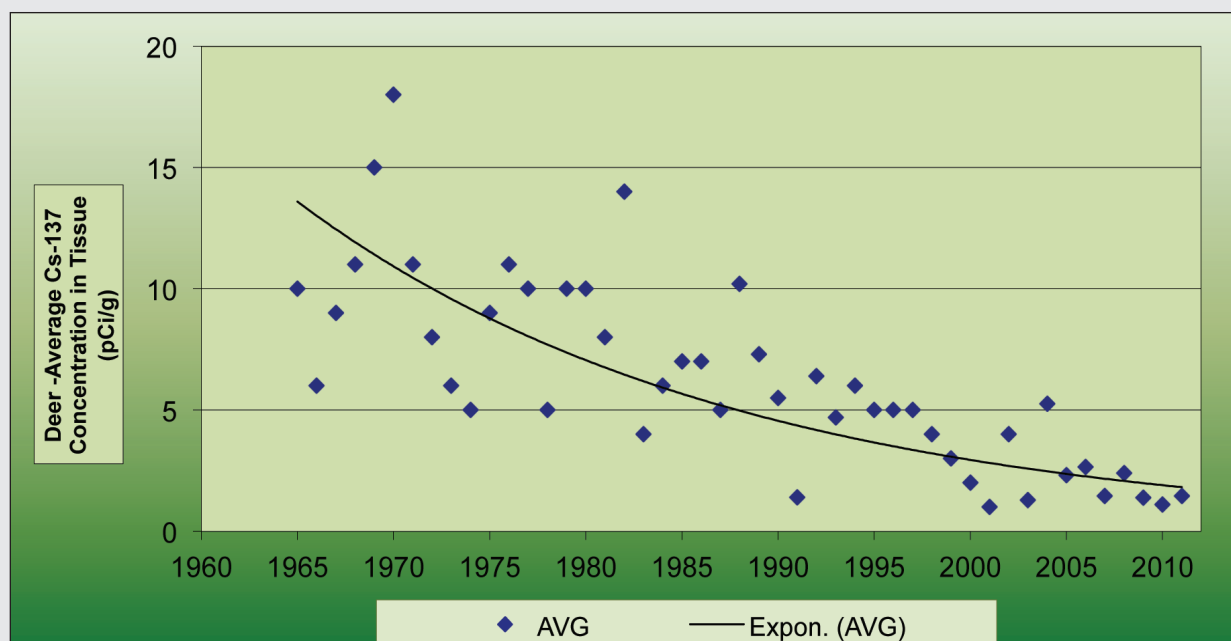
Laboratory measurement results are summarized in data tables 5-18 and 5-19 for deer tissue and bone, and in data tables 5-20 and 5-21 for hog tissue and bone. Results of field and laboratory measurements are summarized in table 5-5. The dose impacts to hunters are discussed in Chapter 6.



**Table 5-5 2011 Cesium-137 Results for Laboratory and Field Measurements**

2011	Number Animals	Field Gross Average Cs-137 (pCi/g)	Field Maximum Cs-137 (pCi/g)	Lab Average Cs-137 (pCi/g)	Standard Deviation
Deer	564	1.46	10.5	2.12	0.018
Hog	156	1.75	11.5*	2.22	0.011
Coyote	30	1.45	5.13	-----	-----

\* One hog measured 27.8 pCi/g but was not released

**Figure 5-9 Historical Trend of Cesium-137 Concentrations in Deer (pCi/g), 1965-2011**

Average cesium-137 concentrations in deer have indicated an overall decreasing trend for the past ten years. The historical trend analysis is in figure 5-9.

The muscle and bone samples from a subset of the animals returned to the laboratory for cesium-137 analysis also are analyzed for strontium-89,90. Because of its chemistry, strontium is more readily measured in bone than in muscle tissue.

In 2011, all 69 deer bone samples had detectable levels of strontium-89,90 greater than the MDC with an average of 4.14 (+/-0.038) pCi/g and a maximum of 9.03 (+/-0.564) pCi/g. For the deer muscle tissue samples, 20 out of the 97 muscle tissue samples had detectable levels greater than the MDC for strontium-89,90 with a maximum of 8.08E-03 (+/-1.28E-03). Strontium-89,90

was also greater than the MDC in the two hog bone samples at a maximum of 3.89 (+/-0.282) pCi/g and below the MDC for the hog muscle tissue samples. These results are similar to those of previous years.

## Turkeys

### Description of Surveillance Programs

SRS hosted a special turkey hunt during April 2011 for hunters with mobility impairments. Twenty-eight turkeys were harvested and released.

### Surveillance Results Summary

All field measurement results for the 28 turkey harvested had Cs-137 levels at or below the lowest default value of 1.00 pCi/g, which is comparable with the results from previous special hunts.

## Beavers

### Description of Surveillance Programs

The U.S. Department of Agriculture Forest Service-Savannah River (USFS-SR) harvests beavers in selected areas within the SRS perimeter to reduce the population and thereby minimize dam-building activities that can result in food damage to timber stands, to primary and secondary roads, and to railroad beds.

### Surveillance Results Summary

USFS-SR harvested 20 beavers in 2011 from six locations. Because none of these animals were taken from suspect radiological areas, no monitoring was performed, and they were disposed of in an onsite landfill.

## Soil

### Description of Surveillance Program

The SRS soil monitoring program provides

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

Concentrations of radionuclides in soil vary greatly among locations because of differences in rainfall patterns and in the mechanics of retention and transport in different types of soils. Therefore, a direct comparison of data from year to year is not appropriate. However, the data are available in previous environmental reports and can be evaluated over a period of years to determine and analyze long-term trends.

Hand augers or other similar devices are used in soil sample collection to a depth of three inches. The samples are analyzed for gamma-emitting radionuclides, strontium-89,90, and the actinides.

### Surveillance Results Summary

In 2011, radionuclides were detected in soil samples from all 21 sampling locations (five onsite, 12 at the perimeter, and four offsite), as follows:

- Cesium-137 at all locations with the exception of one of the onsite locations near the burial ground
- Uranium-234 at all 21 locations
- Uranium-235 at all 21 locations
- Uranium-238 at all 21 locations
- Plutonium-238 at one location (F-Area location)

- Plutonium-239 at 15 locations (four onsite, nine perimeter, two offsite)
- Strontium-89,90 at two locations onsite
- Americium-241 at seven locations (two onsite, four perimeter, one offsite)
- Curium-244 at four locations (one onsite, three perimeter)

The concentrations at these locations are consistent with historical results (data table 5-22). Uranium is naturally occurring in soil and therefore expected to be present in soil samples.

## Settleable Solids

### Description of Surveillance Program

Settleable-solids monitoring in effluent water is required to determine, in conjunction with routine sediment monitoring, whether a long-term buildup of radioactive materials occurs in stream systems.

USDOE limits on 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.

Accurate measurement of radioactivity levels in settleable solids is impractical in small amounts of settleable solids with low Total Suspended Solids (TSS). TSS levels below 40 parts per million (ppm) comply with DOE limits. To determine compliance with these limits, SRS uses TSS results gathered as part of the routine National Pollutant Discharge Elimination System (NPDES) monitoring program from outfalls co-located at or near radiological effluent points.

### Surveillance Results Summary

In 2011, there were no NPDES TSS sample results which exceeded 40 ppm. The 2011 NPDES TSS results indicate that SRS remains in compliance with the DOE radioactivity-levels-in-settleable-solids requirement.

## Sediment

### Description of Surveillance Program

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in stream beds and in the Savannah River bed. Significant year-to-year differences may be evident because of the continuous deposition and remobilization occurring in the stream and river beds (or because of slight variations in sampling locations) but the data obtained can be used to observe long-term environmental trends.



**Field Sampling Technician collects sediment at River Mile 151.**

Sediment samples were collected at eight Savannah River and 21 onsite stream and basin locations during 2011.

### Surveillance Results Summary

Cesium-137 was the only man-made gamma-emitting radionuclide observed in river and stream sediments during 2011. The highest cesium-137 concentration in streams, 64.1 (+/-2.60) pCi/g, was detected in sediment from R-Canal (100-R Location); the lowest levels were below the minimum detectable concentration level at eight locations. The highest level from the river, 9.89E-01 (+/-5.89E-02) pCi/g, was at RM 129; the lowest levels were below detection at three locations. Generally, cesium-137 concentrations were higher in stream sediments than in river sediments. This is to be expected because the streams receive radionuclide-containing liquid effluents from the SRS. Most radionuclides settle out and deposit on the stream beds or at stream entrances to swamp areas along the river. Strontium-89,90 was above the MDC in sediment at 12 stream locations in 2011. The maximum detected value was 6.14E-01 (+/-6.94E-02) pCi/g at the Fourmile A-7A (Beaver Pond) location.

Plutonium-238 was detected in sediment during 2011 at ten stream locations and two river locations. The results ranged from below the MDC to a maximum of 3.03 (+/-0.281) pCi/g at FM-2 at Road 4. Plutonium-239 was detected in sediment at 14 stream locations and one river location. The maximum value was 7.24E-01 (+/-7.35E-02) pCi/g at Pond 400. Uranium-234, uranium-235, and uranium-238 were detected at all locations at levels similar to previous years.

The distribution and concentration of radionuclides in river sediment during 2011 were similar to those of previous years (data table 5-23).

Concentrations of all isotopes generally were higher in streams than in the river. As indicated in the earlier discussion of cesium-137, this is to be expected.

Differences observed when these data are compared to those of previous years probably are attributable to the effects of re-suspension and deposition, which occur constantly in sediment media.

## Grassy Vegetation

### Description of Surveillance Program

The radiological program for grassy vegetation is designed to collect and analyze samples from onsite and offsite locations to determine radionuclide concentrations. Vegetation samples are obtained to complement soil and sediment samples to determine the environmental accumulation of radionuclides and to help validate SRS dose models. Vegetation can be contaminated externally by the deposition of airborne radioactive contaminants and internally by uptake from soil or water by the roots. Bermuda grass is preferred because of its importance as a pasture grass for dairy herds.

Vegetation samples are obtained from

- Locations containing soil radionuclide concentrations that are expected to be higher than normal background levels
- Locations receiving water that may have been contaminated
- All air sampling locations

Vegetation samples are analyzed for tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, and the actinides.

## Surveillance Results Summary

All vegetation surveillance samples are based on dry weight. Radionuclides in the grassy vegetation samples collected during 2011 were detected in all 17 locations (one onsite, 12 at the perimeter, and four offsite), as follows:

- Tritium at six locations (one onsite, four perimeter, and one offsite)
- Cesium-137 at six locations (five perimeter and one offsite)
- Strontium-89,90 at 13 locations (one onsite, eight perimeter, four offsite)
- Uranium-234 at eight locations (one onsite, five perimeter and two offsite)
- Uranium-238 at eight locations (one onsite, five perimeter and two offsite)
- Technetium-99 at all 17 locations
- Gross beta at all 17 locations
- Gross alpha at three SRS perimeter locations

No levels were above the MDC for neptunium-237, plutonium-238, plutonium-239, americium-241, or uranium-235. Average tritium results show a 16% increase from 2010 to 2011 with levels ranging from below the MDC to 1.18 (+/-0.03) pCi/g at the BGN location. Results for the other radionuclides show a slight decrease in concentrations from the past several years but remain consistent with historical results (data table 5-24).

## Nonradiological Surveillance

### Air Quality

#### Description of Surveillance Program

SRS does not conduct onsite surveillance for nonradiological ambient air quality. However, to ensure compliance with SCDHEC air quality regulations and standards, SRNL conducted air dispersion modeling for all SRS sources of criteria pollutants and toxic air pollutants in 2011.

#### Surveillance Results Summary

Air dispersion modeling indicated that all SRS sources were in compliance with air quality regulations and standards. Since that time, additional modeling conducted for new sources of criteria pollutants and toxic air pollutants has demonstrated continued compliance by the SRS with current applicable regulations and standards. The states of South Carolina and Georgia continue to monitor ambient air quality near the SRS as part of a network associated with the Clean Air Act.

## Mercury in Rainwater and Wet/Dry Deposition

### Description of Surveillance Program

SRNL sponsors a monitoring and collection station in support of the National Mercury Deposition Network of the National Atmospheric Deposition Program (NADP). This network provides data on the geographic distributions and trends of mercury in precipitation. It is the only network providing a long-term record of mercury concentrations in North American precipitation. All monitoring sites follow standard procedures and have uniform precipitation collectors and gauges. In the fall of 2010 the mercury collector at the SRNL monitoring station (SC03) was upgraded to a modern precipitation collector that satisfies network collection requirements. In 2011, SRNL installed an electronic rain gage that completed equipment modernization of this station.

#### Surveillance Results Summary

During calendar year 2010 (the last year for which data is available) the average (volume weighted) concentration of total mercury in precipitation was 10.9 ng/L and the wet deposition rate was 6.5  $\mu\text{g}/\text{m}^2$ . Data from 2011 will not be available until the fall of 2012. Additional information on this network is accessible via the following link: <http://nadp.sws.uiuc.edu/mdn/>.

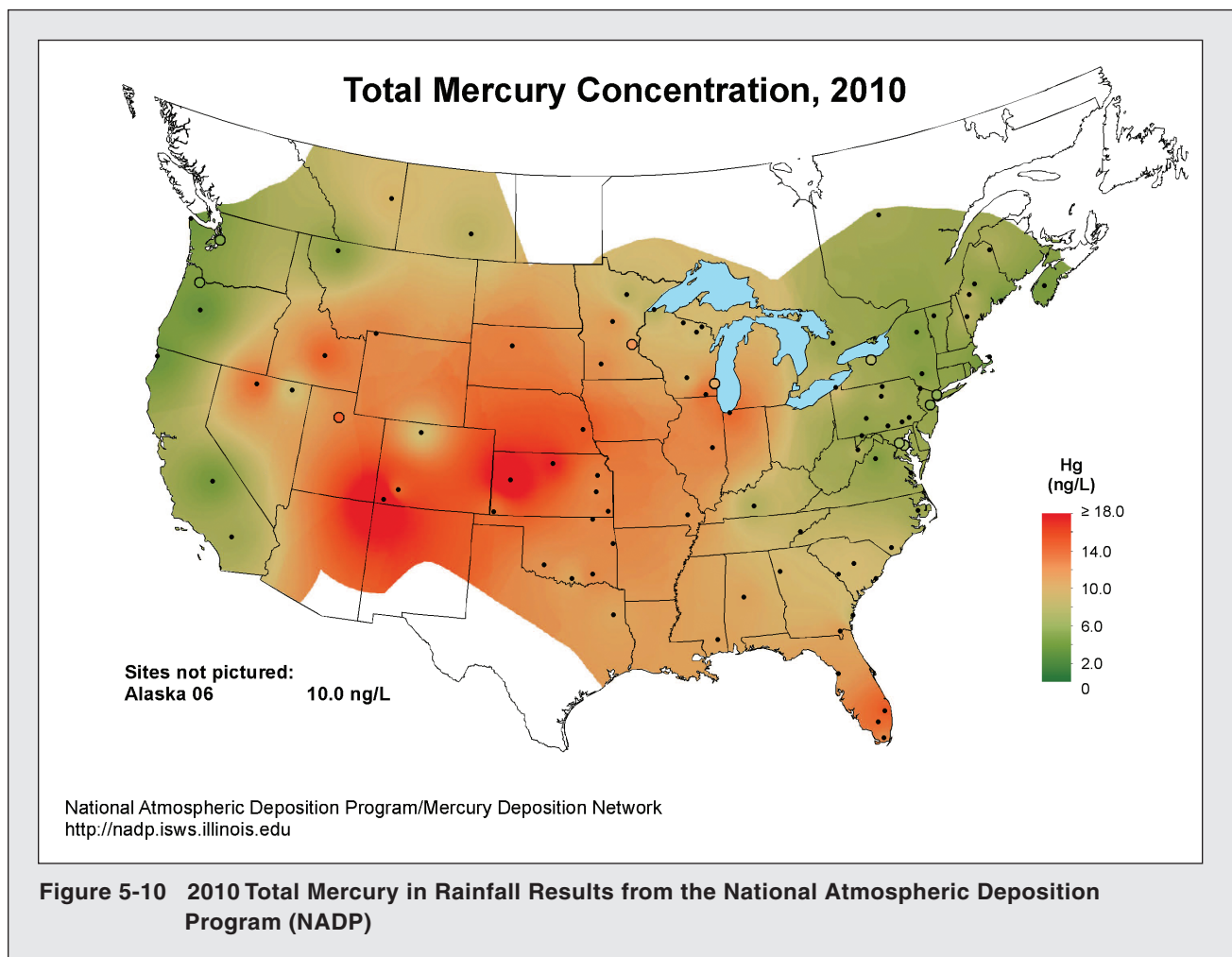


**Weekly Precipitation Sampling in Support of the National Atmospheric Deposition Program**

### Mercury Deposition Network

The NADP provides a long-term record of wet deposition of mercury from precipitation. SRNL sponsors and operates Station SC03 at SRS.





## Surface Water

### Description of Surveillance Program

SRS streams and the Savannah River are classified by SCDHEC as “Freshwaters,” which are defined as surface water suitable for

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

Appendix A (“Applicable Guidelines, Standards, and Regulations”) of this report provides some of the specific standards used in water quality surveillance, but, because not all the standards are quantifiable, they are not tracked at SRS.

## Surveillance Results Summary

Water quality parameters were measured at all 16 sampling locations in SRS streams and along the Savannah River during 2011 and metals were detected in at least one sample at each location. With the exception of Endosulfan II detected at SC-4 during July 2011, no samples had detectable pesticides/herbicides. These results continue to indicate that SRS discharges are not significantly affecting the water quality of onsite streams or the river (data table 5-25).

## Drinking Water

### Description of Surveillance Program

Most of the drinking water at SRS is supplied by three systems that have treatment plants in A-Area, D-Area, and K-Area. The SRS also has 14 small drinking water facilities, each of which serves populations of fewer than 25 persons.





**Water Quality Parameters are Measured in Samples from the Savannah River (pictured)**

### Surveillance Results Summary

All samples collected from SRS drinking water systems during 2011 were in compliance with SCDHEC and USEPA water quality standards. Additional information is provided in the Safe Drinking Water Act section of Chapter 3, "Environmental Compliance."

### Sediment

#### Description of Surveillance Program

The SRS's nonradiological sediment surveillance program provides a method to determine the deposition and accumulation of nonradiological contaminants in stream systems.

The nonradiological sediment program consists of the collection of sediment samples at eight onsite stream locations and three Savannah River locations. Collection is made by either a Ponar sediment sampler or an Emery pipe dredge sampler. The samples are analyzed for various inorganic contaminants (metals) and pesticides/herbicides by the Toxicity Characteristic Leaching Procedure (TCLP). This method analyzes for the soluble constituents in sediment. The program is designed to check for the existence and possible buildup of the inorganic contaminants as well as for pesticides/herbicides.

### Surveillance Results Summary

In 2011, as in the previous five years, no pesticides or herbicides were above the quantitation limits in sediment samples. No mercury was detected at any of the locations during 2011 as in previous years. Metals analysis showed some metals with levels greater than the Practical Quantitation Limit for 2011 but were consistent with those seen in soil samples and comparable to those of the previous five years (data table 5-26).



**Striped Bass Collected at Steel Creek River Mouth**

### Fish

#### Description of Surveillance Program

SRS personnel collected and analyzed the flesh of fish caught from the Savannah and Edisto Rivers to determine concentrations of mercury, arsenic, cadmium, manganese, and antimony in the fish.

### Surveillance Results Summary

Mercury analyses were performed in 2011 on 468 fish at 11 locations including site streams, the Savannah River and the Edisto River at West Bank Landing. Concentrations of mercury generally were slightly lower than those observed in 2010 (data table 5-27). The MDL for the mercury in fish analyses was 0.02 µg/g. The highest concentrations were in the Savannah River in bass at the Lower Three Runs Creek Mouth (1.30 µg/g), in catfish at West Bank Landing (0.673 µg/g), in bream at the Augusta Lock and Dam (0.978 µg/g), in red drum at RM 0-8 (0.304 µg/g), and in mullet at RM 0-8 (0.022 µg/g). Review of the surveillance results concluded

- Cadmium levels were below minimum detection limits in all 468 fish samples collected during 2011.

- Arsenic was detected in four fish samples with the highest concentration in bass (0.691 µg/g) from the Stokes Bluff Landing sampling location.
- Antimony also was detected in 22 fish samples, with the highest concentration in catfish (0.458µg/g) at the Upper Three Runs Creek River Mouth. Metal results are lower than those of 2010 and are consistent with the previous 5 years (data table 5-28).
- Manganese was detected at all 11 fish sampling locations, with the highest concentration in bream (3.03 µg/g) at Beaver Dam Creek River Mouth.

## River Water Quality Surveys

### Description of Surveys

Biological and water quality surveys are conducted to assess the potential effects of SRS contaminants and warm-water discharges on the general health of the river and its tributaries. The surveys were designed to assess potential effects of SRS contaminants and warmwater discharges on the general health of the river and its tributaries. This is accomplished by looking for

- Patterns of biological disturbance geographically associated with the SRS
- Patterns of change over seasons or years that indicate improving or deteriorating conditions

### Survey Results Summary

In 2011, SRS conducted macroinvertebrate sampling during the spring and fall and diatom sampling monthly. The diatom slides were sent to the Academy for Natural Sciences (ANS) for archiving. No adverse biological impacts have been identified in the Savannah River diatom communities.

Macroinvertebrates collected from river traps during 2011 were similar in species diversity to those documented in surveys during the 1990s. An overall decrease in total populations was observed that likely is associated with low flow in the river and incipient drought conditions. No evidence of adverse biological impacts was found in the observed macroinvertebrate communities.