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# Environmental Surveillance

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CHAPTER

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

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As part of SRS's radiological surveillance program, routine surveillance of all radiation exposure pathways is performed on all environmental media (air, rain, ambient gamma radiation, surface water, soil, sediment, vegetation, drinking water, food products, and wildlife) that could lead to a measurable annual dose above background at and beyond the site boundary.

Nonradioactive environmental surveillance at SRS involves the sampling and analysis of surface water, drinking water, 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 analysis results can be found in chapter 7, "Groundwater."

The Regulatory Integration & Environmental Services Department's Environmental Monitoring (EM) section performs surveillance activities for SRS. The Savannah River also is monitored by 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 (operating in Georgia), and the City of Savannah, Georgia.

A complete description of the EM surveillance program, including sample collection and analytical procedures, can be found in section 1105 of the *Savannah River Site Environmental Monitoring Program*, WSRC-3Q1-2, Volume 1, Revision 4 (SRS EM Program, 2002). Brief summaries of analytical results are presented in this chapter; complete data

sets can be found in tables on the CD accompanying this report.

## Radiological Surveillance

### Air

#### Description of Surveillance Program (Table)

EM maintains a network of 15 sampling stations in and around SRS to monitor the concentration of tritium and radioactive particulate matter in the air.

#### Surveillance Results Summary

Except for tritium, monitored radionuclides were not routinely detectable at the site perimeter. Both onsite and offsite radioactivity concentrations were similar to levels observed in previous years (see expanded discussion in paragraphs that follow).

Average gross alpha and gross beta results were slightly lower in 2008 than in 2007, and are consistent with historical results in demonstrating long-term variability.

No 2008 samples contained the detectable manmade gamma-emitting radionuclide cesium-137. Historically, only a small number of air samples have contained detectable cesium-137 activity.

During 2008, detectable levels of uranium-234 were observed in three air samples; however no detectable levels of uranium-238 were observed in any of

the 2008 samples. These results are similar to those observed in 2007. Uranium is naturally occurring in soil, and therefore expected to be present in low concentrations on some particulate filters. Aside from uranium, alpha-emitting radionuclide activity was observed in two samples from two locations—site perimeter and 25-mile. The site perimeter location revealed corresponding increases in plutonium-238, plutonium-239, and americium-241 for the same sampling date, which is consistent with the true presence of plutonium. Generally, these concentrations were consistent with historical results. For the remaining locations, all alpha-emitting isotopes were below detection levels. All 2008 strontium-89,90 results were below the minimum detectable concentration (MDC), whereas, two of the 2007 sample results were above the MDC. The dose consequences are explained in more detail in chapter 6 (“Potential Radiation Doses”).

Tritium-in-air results for 2008 were similar to—but generally higher than—those observed in 2007. However, the results are consistent with the long-term variability of historical results. The Burial Ground North (BGN) tritium-in-air results were slightly lower than those observed in 2007. As in previous years, the BGN location showed average and maximum concentrations significantly higher than those observed at other locations. BGN results are expected to be both higher and more variable because of the location’s proximity to both the tritium facilities and the phytoremediation project near the center of the site, and are influenced by operations at these facilities. Tritium was detected at every sampling location, although not every sample from a particular location had detectable tritium. As expected, tritium concentrations generally decreased with increasing distance from the tritium facilities.

## Rainwater

### Description of Surveillance Program

SRS maintains a network of 15 rainwater sampling sites as part of the air surveillance program. These stations are used to measure deposition of radioactive materials.

### Surveillance Results Summary (Tables A, B)

No detectable manmade gamma-emitting radionuclides were observed in rainwater samples in 2008.

Gross alpha and gross beta results from 2008 were consistent with those of 2007. In 2008, the average gross alpha results generally were slightly lower (four of seven locations showed a decrease) than those of 2007, while average gross beta results were slightly higher (four of seven locations showed an increase). 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 and uranium-238 were present in most samples. Uranium is naturally occurring in soil, and therefore expected to be present at low concentrations in some deposition samples. Elevated uranium-238 results again were observed at the D-Area and BGN locations. Increased airborne particulate matter (dust) is present at these locations as a result of one or both of the following: (1) D&D activities in the immediate vicinity, resulting in the movement of large amounts of soil, and (2) increased vehicle traffic on nearby dirt roads or fields. It is believed that this phenomenon is responsible for the observed increase. All locations showed detectable americium-241 (overall, 18 percent of the samples), with an average concentration of 1.60E-01 pCi/L—well below the drinking water standard. All other actinides, as well as strontium-89,90, either were below detection levels or were present in only a small number of samples in 2008.

As in previous years, tritium-in-rain values were highest near the center of the site—except for one value at the Augusta Lock and Dam that is considered an outlier. The tritium-in-rain result for August 2008 at the Augusta Lock and Dam is believed to be an outlier due to a lab error because (1) it is much higher than historical levels, (2) it is the only result for this location above the minimum detectable concentration for the entire year, (3) it is higher than locations located closer to the center of the site, and (4) the cycles immediately before and after the result in question were consistent with long-term levels. All 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 only seven samples representing six locations on the site perimeter. As with tritium in air, concentrations generally decreased as distance from the effluent release point increased.

## Gamma Radiation

### Description of Surveillance Program

Ambient dose rates from gamma radiation exposures in and around SRS are monitored by a system of thermoluminescent dosimeters (TLDs).

### Surveillance Results Summary (Table)

Ambient dose 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 2008, ambient dose rates varied between 67 and 115 mrem per year.

In general, the 2008 ambient gamma radiation monitoring results indicated gamma radiation dose rates slightly higher than those observed at the same locations in 2007. However, due to equipment malfunction, only partial results were available for the fourth quarter of 2008. In addition, results for the control samples from the third quarter were inadequate because of no exposure prior to field use; therefore, all sample results for this quarter were omitted. The averages were based only on the correct data results that were available. The average annual dose rate was 87 mrem in 2008, compared to 76 mrem in 2007; all locations showed higher average annual dose rates in 2008. However, these results generally are consistent 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 small amounts of radiation.

## Stormwater Basins

### Description of Surveillance Program

Stormwater accumulating in site stormwater basins is monitored because of potential contamination. In 2008, monitoring was conducted at six E-Area basins, as well as at the Z-Area Basin and F-Area Pond 400.

### Surveillance Results Summary (Table)

There are no active discharges to site stormwater basins. The primary contributor is rainwater runoff. Rain events did not supply enough water to the E-06 basin for sampling purposes in 2008. The highest stormwater basin mean tritium concentration was measured in the E-05 basin, and was consistent with historical results—although slightly higher than the highest stormwater basin concentration in 2007. Fission products were observed in the basins, with no iodine-129 in any basin and with cesium-137 appearing only in the Z-A Basin. Uranium-234, uranium-238, and plutonium-238 were the primary actinides detected in the basins. Gross alpha and gross beta were detected at all basins in concentrations generally consistent with those of previous years.

## Streams

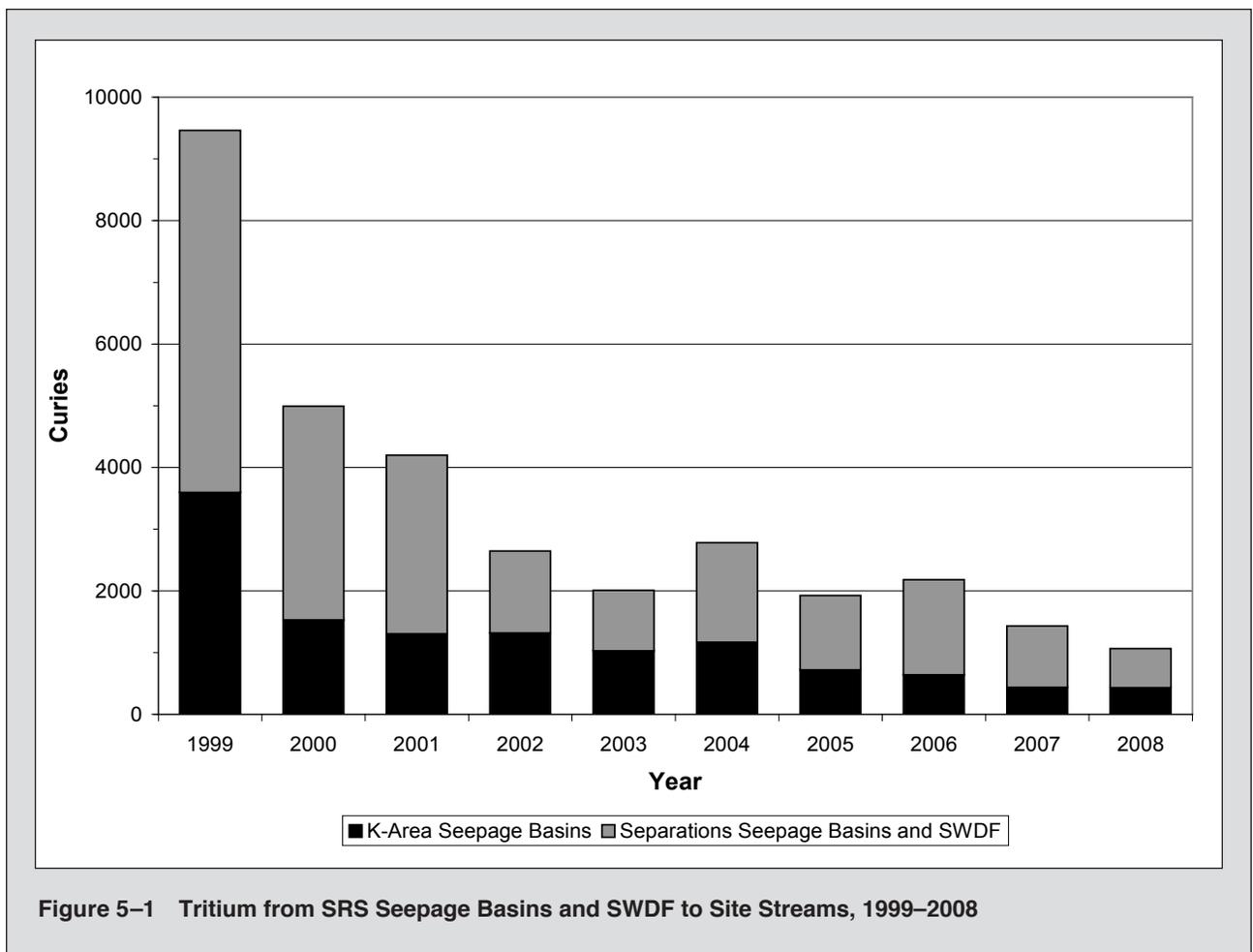
### Description of Surveillance Program

Continuous surveillance monitoring of SRS streams is utilized 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 (Table)

Detectable concentrations of tritium, the predominant radionuclide detected above background levels in SRS streams, were observed at least once at all stream locations in 2008. Tritium releases to site streams increased slightly during 2008 over 2007—primarily in direct releases to Upper Three Runs and in migration to Fourmile Branch. However, concentrations remain consistent with long-term tritium levels.

No detectable concentrations of cobalt-60 were observed in any of the five major SRS streams. Cesium-137 was detected in these streams, but none was detected at the final discharge measurement points of the streams. As expected, gross alpha and



gross beta were detected in all streams but concentrations were consistent with levels of recent years. Other radionuclides were observed at locations throughout the site, but were consistent with the source of the material, and exhibited variations similar to those of previous years. No significant trends were observed in 2008 when compared to recent years.

#### Seepage Basin and Solid Waste Disposal Facility Radionuclide Migration (Table)

To incorporate the migration of radioactivity to site streams into total radioactive release quantities, EM personnel continued to monitor and quantify the migration of radioactivity from site seepage basins and the Solid Waste Disposal Facility (SWDF) in 2008 as part of its stream surveillance program. Tritium, strontium-89,90, technetium-99, iodine-129 and cesium-137 were detected in migration releases.

Figure 5–1 is a graphical representation of releases of tritium via migration to site streams for the years 1999–2008. As can be 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. During 2008, the total quantity of tritium migrating from site seepage basins and SWDF was 1,215 Ci.

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. Because of their proximity, migration from the SWDF cannot be distinguished from migration from a part of H-Area Basin 4. Measured migration of tritium into Four-mile Branch in 2008 occurred as follows:

- from F-Area seepage basins, 71 Ci—a 54-percent decrease from the 2007 total of 154 Ci

- from SDWF and a part of H-Area seepage basin 4, 493 Ci—a 48-percent increase from the 2007 total of 333 Ci
- from H-Area seepage basins 1, 2, 3, and most of 4, 131 Ci—a 39-percent increase from the 2007 total of 94 Ci

The measured migration from the north side of SWDF and the General Separations Area (GSA) into Upper Three Runs in 2008 was 20 Ci, a 63-percent decrease from the 2007 total of 54 Ci. (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 2008 was estimated to be 25.4 mCi. Migration releases of strontium-89,90 vary from year to year but have remained below 100 mCi the past 7 years.

In 2008, 9.7 mCi of technetium-99, 19.9 mCi of iodine-129, and 153 mCi of cesium-137 were estimated to have migrated into Fourmile Branch.

**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 2008 migration total of 500 Ci represents a slight increase from the 431 Ci recorded in 2007.

**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).

### Transport of Actinides in Streams

Transport (flux) in site streams of the actinides uranium, plutonium, americium, and curium no longer is quantified because of the actinides’ histori-

cally low levels. 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. Values for 2008 were consistent with historical data.

## Savannah River

### Description of Surveillance Program

Continuous surveillance is performed along the Savannah River at locations above and below SRS, including a location at which liquid discharges from Georgia Power Company’s Vogtle Electric Generating Plant (VEGP) enter the river.

### Surveillance Results Summary (Table)

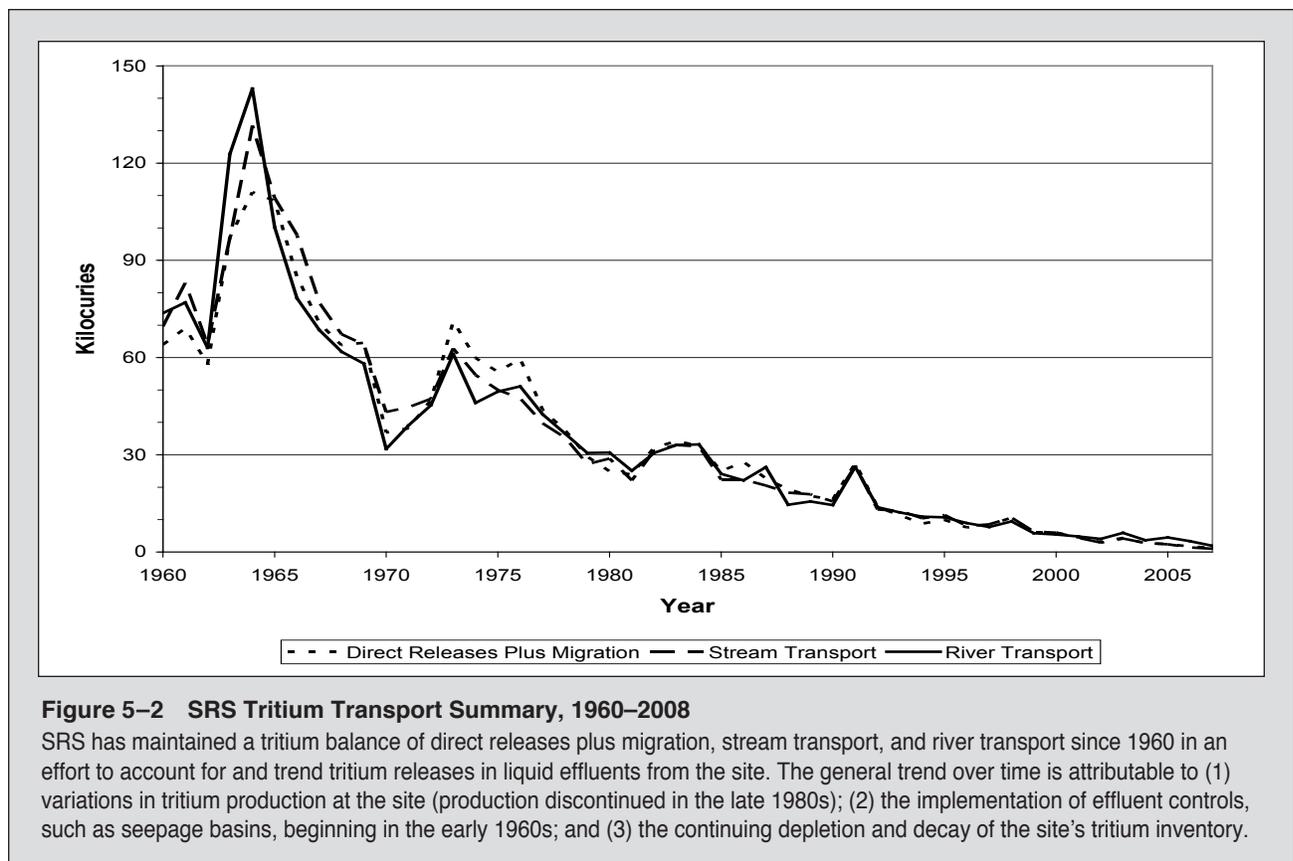
Based on curies released, tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS and VEGP tritium releases (weekly composites) at River Mile (RM) 118.8 increased in 2008, but levels were well below the drinking water standard. Except for cesium-137 recorded at one location during a one-week period, no gamma emitters were detected. Detectable gross alpha and gross beta activity was observed at all river sampling locations, and was consistent with long-term gross alpha and gross beta levels in the river.

In addition to the weekly composite samples referred to above, SRS collects annual grab samples to provide a more comprehensive suite of radionuclides. Uranium-234 and uranium-238 were quantified in all these grab samples in 2008. Annual sampling also detected the manmade radionuclides americium-241 and technetium-99. Americium-241 has been detected previously in the river, but technetium-99 has not.

### Tritium Transport in Streams (Table)

Tritium is introduced into SRS streams and the Savannah River from former production areas on site. Because of the mobility of tritium in water and the quantities of the radionuclide released during the years of SRS operations, a tritium balance has been performed annually since 1960. The balance is evaluated among the following alternative methods of calculation:

- tritium releases from effluent release points and calculated seepage basin and SWDF migration



(direct releases)

- tritium transport in SRS streams and the last sampling point before entry into the Savannah River (stream transport)
- tritium transport in the Savannah River down-river of SRS after subtraction of any measured contribution above the site (river transport)

Combined tritium releases in 2008 (direct discharges and migration from seepage basins and SWDF) totaled 1,535 Ci, compared to 1,317 Ci in 2007.

The total tritium transported to the Savannah River from SRS streams increased from 1,025 Ci in 2007 to 1,185 Ci in 2008.

The total tritium released to the Savannah River in 2008 was 2,659 Ci, compared with the previous year's 1,938 Ci. Both VEGP and SRS contributed to these release values. SRS's calculated releases of tritium to the river in 2008 totaled 1,364 Ci.

SRS [tritium transport data](#) for 1960–2008 are

depicted in figure 5–2, which shows the history of direct releases, stream transport, and river transport, as determined by EM.

EM personnel continued to assess the tritium flux in the Lower Three Runs system in 2008. A more extensive tritium flux assessment initially was conducted in 2004—and described in the *SRS Environmental Report for 2004*. As it has during the past several years, a small but measurable amount of tritium from earlier EnergySolutions LLC (formerly Chem-Nuclear Systems) low-level radioactive waste disposal facility operations entered the stream system in 2008. The facility is privately owned and located 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. EM and EnergySolutions will maintain a monitoring program for Lower Three Runs to evaluate this tritium migration.

## Domestic Water

### Description of Surveillance Program

EM collected domestic water samples in 2008 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 EPA 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 (Table)

All domestic water samples collected by EM in 2008 were screened for gross alpha and gross beta concentrations to determine if activity levels warrant further analysis. No domestic water exceeded EPA's 15-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 EPA tritium limit or the 8-pCi/L strontium-89,90 MDC.

No cobalt-60, cesium-137, uranium-235, plutonium-239, or curium-244 was detected in any domestic water samples in 2008. On site, americium-241 was detected at four locations, uranium-234 at five locations, uranium-235 at one location, and uranium-238 at six locations.

## 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). These foods include milk, meat (beef), fruit, and green vegetables (collards). 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 (beef), fruit (melons or peaches), and a green vegetable (collards)—are collected from one location within each of four SRS quadrants and from a control 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 seven dairies within a 25-mile radius of the site. Four of the seven dairies were open during only two quarters in 2008. The food product surveillance program was expanded in 2005 to include secondary crops on a rotating schedule. Pecans and peanuts were sampled in 2008 as part of this program.

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, and gross beta.

### Surveillance Results Summary (Tables A, B)

The only gamma-emitting radionuclide detected in food products in 2008 was cesium-137, which was found in collards at two locations and pecans and peanuts at one location. Strontium-89,90 was detected in collards at all locations and in beef at one location. Uranium-234 was detected in three collard and three beef samples, while uranium-238 was detected in four beef samples and two collard samples. Plutonium-238 was detected in four beef samples. Americium-241 was detected in one collard, one peanut, and two pecan samples. Gross beta was detected in all food products and gross alpha was detected in one collard sample. The 2008 results appeared to be randomly distributed among the monitoring locations, and no underlying spatial distribution was observed.

Tritium in food products is attributed primarily to releases from SRS; however, tritium was detected only in beef (northeast quadrant, 1.14E-01 pCi/g) and in milk (Girard, 6.00E+02 pCi/L). These results are similar to those of previous years.

## Aquatic Food Products

### Description of Surveillance Program

The aquatic food product surveillance program includes fish (freshwater and saltwater) and shellfish. To determine the potential dose and risk to the public from consumption, both types are sampled.

Nine surveillance points for the collection of freshwater fish are located on the Savannah River—from above SRS at Augusta, Georgia, to the coast at Savannah, Georgia. Composite samples—comprised of three to five fish of a given species—are prepared for each species from each location. Analyses for technetium-99; iodine-129; and the actinide series (uranium-234, uranium-235, and uranium-238, plutonium-238 and plutonium-239, americium-241, and curium-244) were added to all samples in 2006.

### Surveillance Results Summary

Cesium-137 and iodine-129 were the only manmade gamma-emitting radionuclides found in Savannah River edible fish composites during 2008. Strontium-89,90, uranium-234, uranium-238, plutonium-238, and tritium were detected at most of the [river locations for freshwater fish](#). Concentrations were similar to those of previous years. Neptunium-237 was found slightly above the MDC in one composite sample of catfish from Beaver Dam Creek Mouth and one composite from the Highway 301 Bridge vicinity.

Tritium, uranium-234, uranium-235, uranium-238, plutonium-238 and strontium-89,90 were detected in [saltwater fish](#); americium-241, uranium-234, uranium-235, uranium-238, and strontium 89,90 were detected in [shellfish](#). Concentrations were similar to those of previous years.

## Deer and Hogs

### Description of Surveillance Program

Annual hunts, open to members of the general public, are conducted at SRS to control the site's deer and feral hog populations and to reduce animal-vehicle accidents. Before any animal is released to a hunter, EM personnel use portable sodium iodide detectors to perform field analyses for cesium-137. Media samples (muscle and/or bone) are collected

periodically for laboratory analysis based on a set frequency, on cesium-137 levels, and/or on exposure limit considerations. SRS established an administrative dose limit of 30 mrem per year for the consumption of game animals in 2006. This limit, which ensures that no single pathway contributes more than 30 percent to the all-pathway dose limit of 100 mrem, is consistent with DOE guidance. The doses from deer and hog consumption are quantified and reported in chapter 6.

### Surveillance Results Summary

A total of 432 deer and 110 feral hogs were taken during the 2008 site hunts. As observed during previous hunts, cesium-137 was the only manmade gamma-emitting radionuclide detected during laboratory analysis. Generally, the cesium-137 concentrations measured by the field and lab methods were comparable. Field measurements from all animals ranged from 1 pCi/g to 12.65 pCi/g, while lab measurements ranged from 1 pCi/g to 8.53 pCi/g. The average field cesium-137 concentration was 2.40 pCi/g in deer (with a maximum of 12.65 pCi/g) and 2.91 pCi/g in hogs (with a maximum of 8.53 pCi/g). This range of concentrations is normal for the site's deer and hog populations.

The muscle and bone samples from a subset of the animals returned to the lab for cesium-137 analysis also are analyzed for strontium-89,90. Typically, muscle and bone samples are collected for analysis from the same animals checked for cesium-137, and the samples are analyzed for strontium-89,90. Strontium was detected in muscle tissue in 2008, with highs of 4.35 pCi/g in deer and 0.016 pCi/g in hogs. Lab measurements of strontium-89,90 in bone ranged from a high of 16.70 pCi/g to below detection in deer and from a high of 5.97 pCi/g to below detection in hogs. These results are similar to those of previous years.

## Turkeys/Beavers

### Description of Surveillance Programs

Prior to 2003, wild turkeys were trapped on site by the South Carolina Department of Natural Resources and used to repopulate game areas in South Carolina and other states. Since that time, the program has remained inactive because of reduced needs.

During April 2008, a special hunt for the mobility impaired was held that resulted in the harvest of 17 turkeys. The average cesium-137 concentration measured in the field was 1.30 pCi/g.

The U.S. Department of Agriculture Forest Service—Savannah River harvests beavers in selected areas within the SRS perimeter to reduce the population and thereby minimize dam-building activities that can result in flood damage to timber stands, to primary and secondary roads, and to railroad beds. This activity resumed during 2006. Although population control activities continued in 2008, no beavers were removed from their habitat for disposal.

## 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

The 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. Two locations (West Jackson and Windsor Road) were added to the program in 2007. Because of this program's design, a direct comparison of data from year to year is not appropriate. However, the data may be evaluated over a period of years to determine long-term trends.

### Surveillance Results Summary (Table)

In 2008, radionuclides were detected in soil samples from all 23 locations, as follows:

- cesium-137 at 17 locations (three onsite, all 12 perimeter, and two offsite)
- uranium-234 at all locations
- uranium-235 at all locations

- uranium-238 at all locations
- plutonium-238 at nine locations (four onsite, three perimeter, and two offsite)
- plutonium-239 at 13 locations (three onsite, eight perimeter, and two offsite)
- americium-241 at nine locations (three onsite, three perimeter, and three offsite)
- curium-244 at three locations (two onsite and one perimeter)

The concentrations at these locations are consistent with historical results. 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.

DOE 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.

Low total suspended solids (TSS) levels result in a small amount of settleable solids, so an accurate measurement of radioactivity levels in settleable solids is impossible. Based on this, an interpretation of the radioactivity-levels-in-settleable-solids requirement was provided to SRS by DOE in 1995. The interpretation indicated that TSS levels below 40 parts per million (ppm) were considered to be in de-facto compliance with the DOE limits.

To determine compliance with these limits, EM 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. If an outfall shows that TSS levels regularly are greater than 30 ppm, a radioactivity-levels-in-settleable-solids program and an increase in sediment monitoring will be implemented.

## Surveillance Results Summary

In 2008, only two NPDES TSS samples exceeded 30 ppm. Both samples were collected in March from sanitary waste facility outfall K-12, with results of 80 and 51 ppm. These results were attributed to a plant upset resulting from a combination of factors, including infiltration of solids from nearby construction activities, a possible cement-like material being poured into the collection system, and inadequate aeration basin dissolved oxygen and mixing due in part to a faulty air diffuser head. Despite the two exceptions, the 2008 NPDES TSS results indicate that overall, 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 variation in sampling locations—but the data obtained can be used to observe long-term environmental trends.

Sediment samples were collected at eight Savannah River and 13 site stream locations in 2008.

### Surveillance Results Summary (Table)

Cesium-137 was the only manmade gamma-emitting radionuclide observed in river and stream sediments in 2008. The highest cesium-137 concentration in streams,  $3.41E+01$  pCi/g, was detected in sediment from R-Canal; the lowest levels were below detection at four locations. The highest level found on the river,  $1.40E+00$  pCi/g, was at River Mile 150.2; 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 site. Most radionuclides settle out and deposit on the stream beds or at the streams' entrances to swamp areas along the river.

Strontium-89,90 was above the MDC in sediment

at four stream locations in 2008. The maximum detected value was  $2.06E-01$  pCi/g at the Four Mile Creek at Road A-7A location.

Plutonium-238 was detected in sediment during 2008 at eight stream locations and five river locations. The results ranged from a maximum of  $8.32E-02$  pCi/g at FM-2A at Road 4 to below detection at several locations. Plutonium-239 was detected in sediment at 10 stream and three river locations. The maximum value was  $2.55E-02$  pCi/g—at FM-A7A. Uranium-234, uranium-235, and uranium-238 were detected at most locations.

The distribution and concentration of radionuclides in river sediment during 2008 were similar to those of previous years.

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 resuspension 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 the soil and sediment samples in order to determine the environmental accumulation of radionuclides and to help validate the dose models used by SRS. 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

## Surveillance Results Summary (Table)

Radionuclides in the grassy vegetation samples collected in 2008 were detected as follows:

- tritium at four locations (one onsite, three perimeter)
- cesium-137 at four locations (perimeter)
- strontium-89,90 at eight locations (one onsite, six perimeter, 100-mile-radius)
- uranium-234 at one location (100-mile-radius)
- uranium-238 at one location (100-mile-radius)
- plutonium-239 at one location (perimeter)
- americium-241 at three locations (perimeter)
- gross beta at all 17 locations
- gross alpha at four locations (three perimeter, one 25-mile-radius)

Overall results show a slight decline in radionuclide concentrations during the past several years.

## Savannah River Swamp Surveys

### Description of Surveillance Program

The Creek Plantation, a privately owned land area located along the Savannah River, borders part of the southern boundary of SRS. In the 1960s, an area of the Savannah River Swamp on Creek Plantation—specifically, the area between Steel Creek Landing and Little Hell Landing—was contaminated by SRS operations. During high river levels, water from Steel Creek flowed along the lowlands comprising the swamp, resulting in the deposition of radioactive material. SRS studies estimated that a total of approximately 25 Ci of cesium-137 and 1 Ci of cobalt-60 were deposited in the swamp.

Comprehensive and cursory surveys of the swamp have been conducted periodically since 1974. These surveys measure radioactivity levels to determine changes in the amount and/or distribution of radioactivity in the swamp. A series of 10 sampling trails—ranging from 240 to 3,200 feet in length—was es-

tablished through the swamp. Fifty-four monitoring locations were designated on the trails to allow for continued monitoring at a consistent set of locations. [Fledderman, 2007]

The 2008 survey was designated as a cursory survey, requiring limited media sampling and analysis. Cursory surveys provide assurance that conditions observed during the more detailed comprehensive surveys have not changed significantly. A comprehensive survey requiring extensive media sampling and analyses was conducted in 2007.

### Surveillance Results Summary (Table)

As anticipated, based on source term information and historical survey results, cesium-137 was the primary manmade radionuclide detected in the 2008 survey. Cesium-137 was detected in all soil samples while cobalt-60 was detected in one soil sample. Cesium-137 concentrations varied from a low of 0.20 pCi/g to a high of 47.50 pCi/g. These levels are comparable with results of previous surveys. Examination of the 10 shallow core samples showed that in general, higher concentrations of cesium-137 were observed in the shallow depths. Increased activity was observed as far away as trail 10, while higher concentrations were present on trails 1 and 4.

Cesium-137 was detected in all 10 vegetation samples. Concentrations varied from a minimum of 0.29 pCi/g to a maximum of 7.30 pCi/g. These levels are comparable with results of previous surveys. Higher concentrations generally were observed on trails 4, 5, and 8. No relationship was observed between soil and vegetation samples; however, the samples were collected at different times of the year. There was no detectable strontium-90 or cobalt-60 in the vegetation samples.

## Nonradiological Surveillance

### Air

SRS does not conduct onsite surveillance for non-radiological ambient air quality. However, to ensure compliance with SCDHEC air quality regulations and standards, SRNL most recently conducted air dispersion modeling for all site sources of criteria pollutants and toxic air pollutants in 2001. This 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 site with current applicable regulations and standards. The states of South Carolina and Georgia continue to monitor ambient air quality near the site as part of a network associated with the federal Clean Air Act.

## Surface Water

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 and 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 guidelines used in water quality surveillance, but because some of these guidelines are not quantifiable, they are not tracked at SRS.

### Surveillance Results Summary (Table)

Most water quality parameters and metals were detected in at least one sample at every location. Four samples (two from an onsite stream and two from the Savannah River) had detectable pesticides/herbicides in 2008. These results continue to indicate that SRS discharges are not significantly affecting the water quality of onsite streams or the river.

## Drinking Water

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 site also has 14 small drinking water facilities, each of which serves populations of fewer than 25 persons.

## Surveillance Results Summary

All samples collected from SRS drinking water systems during 2008 were in compliance with SCDHEC and EPA water quality standards. Additional information is provided in the Safe Drinking Water Act section of chapter 3, “Environmental Compliance.”

## Sediment

The nonradiological sediment surveillance program provides a method to determine the deposition, movement, and accumulation of nonradiological contaminants in stream systems. Sample preparation prior to analysis was changed in 2007 from an extraction (toxicity characteristic leaching procedure, or TCLP) to a total sample digestion.

### Surveillance Results Summary (Table)

In 2008, as in the previous 5 years, no pesticides or herbicides were found to be above the quantitation limits in sediment samples. Metals analyses results for 2008 also were comparable to those of the previous 5 years.

## Fish

EM personnel analyze the flesh of fish caught from the Savannah and Edisto Rivers to determine concentrations of [mercury in the fish](#). In 2008, the addition of metals (arsenic, cadmium, manganese, and antimony) to the analytical suite was completed. The fish analyzed represent the most common edible species of fish in the CSRA (freshwater) and at the mouth of the Savannah River (saltwater).

### Surveillance Results Summary (Table)

In 2008, mercury analyses were performed on 336 fish from the Savannah River and 15 from the Edisto River at West Bank Landing. Concentrations of mercury generally were slightly lower than those observed in 2007. The highest concentrations were found in the Savannah River—in bass at the Highway 301 Bridge Area (1.205 µg/g), in catfish at Stokes Bluff (0.871 µg/g), and in bream at the

Highway 301 Bridge Area (0.853 µg/g). The highest concentrations found at West Bank Landing were 1.037 µg/g in bass, 0.940 µg/g in bream, and 0.536 µg/g in catfish.

Arsenic was detected in sixteen samples, with the highest concentration in spottail bass (1.46 µg/g) at RM-08 of the Savannah River. Cadmium was below detection in all samples. Manganese was detected at all locations, with the highest concentration in bream (5.13 µg/g) at the mouth of Lower Three Runs. Antimony was detected in 63 samples, with the highest concentration in bream (1.09 µg/g) at the mouth of Steel Creek.

## River Water Quality Surveys

### Description of Surveys

Academy of Natural Sciences (ANS) personnel conducted biological and water quality surveys of the Savannah River from 1951 through 2003, when EM assumed this responsibility. The surveys were designed to assess potential effects of SRS contaminants and warm-water 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 site
- patterns of change over seasons or years that indicate improving or deteriorating conditions

EM conducted macroinvertebrate sampling during the spring and fall of 2008, and diatom sampling was conducted monthly. The diatom slides were sent to ANS for archiving. No adverse biological impacts have been identified in the Savannah River diatom communities.

Macroinvertebrates collected from river traps during 2007 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. Collections from 2008 will be sorted and archived during 2009.