Environmental Surveillance and Oversight
1997-98 Environmental Data Report

Editors

Jim Brownlow
Kimberly Newell
Joy Powell

Prepared for South Carolina Department of Health and Environmental Control
and U.S. Department of Energy at Savannah River Site
Lower Savannah EQC
Aiken, SC 29801

Introduction

Since beginning operations, the Savannah River Site (SRS) has released radionuclides through routine operations and accidental releases. As reported in the Westinghouse Savannah River Company's (WSRC) Environmental Reports, the SRS has conducted surveillance and monitoring activities to determine the concentration and migration of radionuclides in the environment; detect and/or verify accidental releases; characterize concentration trends; and determine associated impacts on the environment and human health.

The primary function of the Environmental Surveillance and Oversight Program (ESOP) involves independent verification and evaluation of the SRS's non-regulatory environmental monitoring programs. The ESOP engages in a variety of activities including environmental monitoring on and around the SRS. These activities enable the ESOP to provide the public with an independent source of information on the effectiveness of the Site's monitoring activities.

The ESOP provides data quantifying levels of contaminants possibly released to the environment from SRS activities. This information is critical for maintaining the public's confidence that the Department of Energy's (DOE's) activities have not adversely impacted public health and the environment. Using this information, the ESOP helps support emergency response activities in the event of an unplanned release of radioactive materials; educates the public on monitoring activities around the SRS; and provides recommendations to the DOE for improving their environmental monitoring programs.

To accomplish this, the ESOP conducts technical reviews of the Westinghouse Savannah River Company-Environmental Monitoring Section's (WSRC-EMS) monitoring programs and collects data through an independent environmental monitoring network around the Site. The ESOP group examines all aspects of non-regulatory environmental monitoring programs conducted at the SRS through technical reviews of the Site's monitoring programs. Information gathered from these efforts aid in determining if the DOE activities are protective of the public health and environment.

There are ten media specific ESOP projects for monitoring the impacts on the environment and human health as related to releases by the SRS. These include:

a) Radiological Atmospheric Monitoring Project;
b) Ambient Groundwater Quality Adjacent to the SRS Project;
c) Radiological Surface Water and Sediment Surveillance Project;
d) Nonradiological Ambient Sediment and Surface Water Quality Monitoring Project;
e) Radiological Monitoring of Fish in the Savannah River Project;
f) Radiological Surveillance of Surface Soils On and Adjacent to the SRS Project
g) Terrestrial Vegetation Radiological Surveillance and Monitoring Project
h) Radiological Dairy Milk Monitoring Project;
i) Game Animal Monitoring Adjacent to the SRS Project

j) Federal Facilities Agreement (FFA) Site evaluation sites.

The implementation of radiological and nonradiological surveillance monitoring by the ESOP represents a significant increase in the South Carolina Department of Health and Environmental Control (SCDHEC) monitoring efforts at the SRS. The ESOP has identified additional field oversight projects to verify the validity and effectiveness of monitoring activities at Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites. Additional projects are being considered to fill data gaps and evaluate other SRS non-regulatory monitoring programs. This improvement in monitoring indicates a commitment by the SCDHEC to fulfill its mission to protect public health and the environment, and reinforces the DOE's commitment to improving open communication and cooperation with host states.

This 1997-98 ESOP Data Report provides a summary of the ESOP environmental monitoring results generated during the 1997-98 calendar years. The data and information presented are in accordance with the ESOP's Standard Operating Procedures and project monitoring plans. Complete data tables are located in the report appendices.

For further information on the ESOP program or individual monitoring projects, contact:

Kimberly Newell, Public Information Director
South Carolina Department of Health & Environmental Control
206 Beaufort St.
Aiken, SC 29801
(803) 641-7670
E-mail: newellkr@aiken30.dhec.state.sc.us

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The Radiological Atmospheric Monitoring Project 1997-98

The Radiological Atmospheric Monitoring Project provides independent monitoring of atmospheric media on a routine basis to detect and measure radionuclide concentrations in the atmosphere as associated with the SRS. Radiological atmospheric monitoring sites are located to provide spatial coverage of the project area where public exposure could occur.

Monitoring of ambient air for radionuclides was performed within a 30-mile perimeter of the SRS boundary, including the SRS boundary. The data generated provides the public with an independent source of information regarding radionuclides in the atmosphere on and around the SRS. Ambient air monitoring provides measurement of airborne concentrations of radionuclides in the atmosphere; allows determination of the relative level of radiological contaminants at the monitoring locations; verifies that the contributions of fugitive and diffuse sources are within acceptable concentration ranges; and serves as a check for dose-modeling calculation input.

Appendix A includes atmospheric moisture and rainwater tritium concentrations analyzed in 1997 and the ambient gamma concentration measured in 1997. **Appendix B** includes atmospheric moisture and rainwater tritium concentrations analyzed in 1998 and the ambient gamma concentration measured in 1998. **Map 1** contains the 1997-98 air sampling stations and **Map 2** contains the 1997 TLD locations.

1997 Methods and Results

The air monitoring capabilities in 1997 included air monitoring stations with capacity for sample collection of glass fiber filters, charcoal canisters, rain collectors, silica gel columns, and thermoluminescent dosimeters (TLDs) around the SRS perimeter. Rainwater, when present, was sampled and analyzed weekly for tritium. Silica gel distillates of atmospheric moisture were analyzed every other week for tritium. All tritium analyses were performed at SCDHEC Lower Savannah District Laboratory. TLDs were analyzed every three months for ambient beta-gamma levels.

All of the ESOP data collected confirmed the SRS historically reported values for radionuclides in the ambient environment at the SRS boundary. The SRS reported average tritium oxide concentration in air for the site perimeter, measured at 14 locations in 1997, is 12 pCi/m^3. The ESOP average tritium oxide concentration for results above the ESOP Lower Limit of Detection (LLD) corresponded well with an average tritium oxide concentration in air for the Site perimeter of 9.7 pCi/m^3. Additionally, the ESOP 1997 gamma radiation surveillance program results indicated gamma exposure rates consistent with DOE reported values. The SRS TLD average for the site perimeter locations in the first and second quarter was 0.20 mR/day compared to the ESOP TLD average was 0.17 mR/day.

1998 Methods and Results

The 1998 air monitoring capabilities included air monitoring stations with capacity for sample collection of glass fiber filters, precipitation, and silica gel columns. The glass fiber filters were used to collect total airborne particulates. Particulates were screened weekly for gross beta, and gamma emitting radionuclides. Two batches of glass fiber filters were composited and analyzed for selected isotopic analyses. Rainwater, when present, was sampled and analyzed weekly for tritium. Silica gel distillates of atmospheric moisture were analyzed every other week for tritium. All tritium analyses were performed at the SCDHEC Lower Savannah District Laboratory. TLDs were collected every three months for ambient beta-gamma levels. Data is not reported for 1998 because of TLD equipment difficulty. All analyses performed that met quality assurance and quality control (QA/QC) requirements are provided in the appendices.

All precipitation, atmospheric moisture, and particulate isotopic analyses results were consistent with historically reported values, with the exception of gross alpha particulate analysis. The gross alpha levels were near an order of magnitude higher for four of 12 sample batches received. These increased alpha levels may be a result of the method used in the analysis since these samples consisted of several weeks of composited glass fiber filters. The gross alpha difference was observed at the air sampling control location in Allendale, SC (ALN) as well as the SRS perimeter locations.

All of the ESOP data collected confirmed historically reported values for radionuclides in the ambient environment at the SRS boundary. The SRS reported averages for tritium oxide concentration in air and rainwater for the SRS perimeter monitoring locations, measured at 14 locations, in 1998 were 11.3 pCi/m^3 for 300 air samples and 417.0 pCi/L for 293 rainwater samples. The ESOP results above the ESOP LLD corresponded with an average tritium oxide concentration in air for the site perimeter of 8.1 pCi/m^3 for 108 samples. The ESOP results above the ESOP LLD corresponded with an average tritium oxide concentration in air for the site perimeter of 603.0 pCi/L for 57 samples.

Ambient Groundwater Quality Adjacent to Savannah River Site, 1997-98

The Ambient Groundwater Monitoring Network (AGMN) is comprised of groundwater wells owned by various government agencies and members of the public. Ambient groundwater quality adjacent to the SRS is evaluated in an effort to develop background water quality information and determine if contaminant migration off-site exists.

The ESOP analyzed groundwater for basic water quality parameters, metals, volatile organic compounds, semi-volatile organic compounds, pesticides, polychlorinated biphenols, and tritium. Data from this project complements the SRS and other SCDHEC groundwater monitoring programs. The ESOP is also developing a Geographic Information Systems (GIS) database of water quality data and well information.

Appendix A includes the ambient groundwater quality monitoring results for 1997. **Appendix B** includes the ambient groundwater quality monitoring results for 1998. **Map 3** contains the ambient groundwater monitoring network locations for 1997-98.

1997 Methods and Results

The three objectives of the project were to locate wells identified through historical records and reconnaissance within ten miles of the SRS boundary; evaluate these wells for inclusion in the AGMN; and sample the network wells.

The ESOP used well construction information to determine the probable screened aquifer and hydrogeologic setting. Aquifers evaluated were Steed Pond, Upper Three Runs, Gordon, Crouch Branch, and McQueen Branch.

Hydrogeologic schematics and Stiff's diagrams were constructed summarizing mean concentrations of selected ions and water quality parameters by aquifer. Sodium and chloride increase in concentration from the Steed Pond to the Upper Three Runs. Sodium is highest in the Crouch Branch where chloride is lowest. Calcium and alkalinity are highest in the Gordon, and Upper Three Runs. Based on data from the few wells screened in the McQueen Branch, calcium and alkalinity concentrations are below or slightly above detectable levels. Like calcium, magnesium is highest in the Gordon and Upper Three Runs, and lowest in the McQueen Branch. Nitrates are elevated in Upper Three Runs and relatively low in the deeper Crouch Branch and McQueen Branch. Water quality parameters (i.e., pH, specific conductance, and total dissolved solids) increased in the Gordon and Upper Three Runs due to the increasing concentration of cations and anions, calcium and alkalinity in particular. Likewise, these parameters were low in the Steed Pond and McQueen Branch. Stiff's diagrams were constructed for selected cations and
anions for each well. Evaluation of these diagrams indicates that calcium and carbonates

increase southward and westward across the study area. Sodium and chlorides remain relatively stable with a slight elevation in the northern portion of the study area. This is consistent with the other analyses discussed previously.

After reviewing the analytical data, the ESOP determined potential anthropogenic and naturally occurring contaminants for each network well. Analytes above drinking water standards or maximum contamination level (MCL) were identified. Samples from the Town of Williston, Halford Street well; Town of Jackson well; Beech Island Water District well; and a private well at Windsome Plantation had detectable levels of lead (Pb). Williston and Jackson systems had historically been sited for lead and copper by the SCDHEC. However, since 1995 the lead has not been a problem within the distribution system. Beech Island has not historically had lead problems and there is no evidence that lead is detectable in the distribution system. Lead in the private well was below the drinking water action level of 15.0 μg/L. All of these wells were located in the northern portion of the study area. Endrin, a banned pesticide, was detected just above detection limits at Chappel's Labor Camp. The well, located in an agricultural area, will be resampled to confirm contamination. Manganese (Mn) and iron (Fe) have secondary MCLs and exceeded standards in one and five wells, respectively. The elevated iron was detected in deep wells and extremely shallow wells. Manganese was detected above MCLs in a shallow well.

In review of the results, water chemistry changes across the study area. Isopleth maps, hydrogeologic schematics, and Stiffs diagrams all generally indicate that total dissolved solids, conductivity, and pH increase to the east and south in the shallow aquifers (i.e., Steed Pond and Upper Three Runs) and the Crouch Branch. These changes are attributed to increasing calcium and bicarbonate, most likely due to a change in bulk chemistry of the formations and an increase in residence time of water. Sodium and chloride generally decrease to the east and south. Total dissolved solids and conductivity were relatively low in the McQueen Branch Aquifer. Contaminants, seemingly unrelated to activities at the SRS, are present in several wells. These wells will be re-evaluated after further sampling.

Due to resource limitations, analyses for dissolved cations and anions were not completed. This information would better characterize the water chemistry in the study area and correspond more closely with other studies being conducted in the area. Therefore, pending a review of the 1998 network data, the ESOP recommends that the AGMN organic sampling be reduced, so both total and dissolved cations and anions can be quantified.

The well network has minimal or no representation of some areas. These include the SRS property, Gordon Aquifer, and McQueen Branch Aquifer. This problem can be remedied by adding selected cluster wells (C-wells) to the network, and evaluating data from ambient and background wells located on the SRS.

Arithmetic means and standard deviations for each analyte were calculated and evaluated in their

entirety and in discrete data sets. Mean sodium and chloride are slightly elevated in northern portions of the study area. Calcium, alkalinity, magnesium, pH, specific conductance, and total dissolved solids generally increase in settings the south and east.

1998 Methods and Results

The objectives of the project were to evaluate groundwater quality adjacent to the SRS, compare results with the historical data, determine any off-site contaminant migration, expand current ambient water quality databases, and provide the public with independently generated groundwater quality information. The ESOP established a study area to the SRS and a ten-mile perimeter from the site boundary in South Carolina; evaluated four aquifer zones within the study area from the shallow water table to confined aquifers more than 1200 feet deep; and analyzed groundwater for basic water quality parameters, metals, volatile organic compounds, semi-volatile organic compounds, pesticides, polychlorinated biphenols, and tritium. Water was sampled in five distinct aquifers across the study area.

Based on a review of the analytical data, contaminants not typically associated with the SRS activities were present in several wells. MCLs for five constituents were exceeded in 12 wells. These exceedances included six wells with detectable concentrations of lead. Two wells had concentrations over the 15.0 μg/L action level. These levels are similar to the levels detected in 1997. The persistence of lead in these wells is likely due to well construction material or formation chemistry interacting with the low pH waters in the northern half of the study area. The SCDHEC samples for the drinking water system associated with these wells did not indicate lead contamination. These wells will be reevaluated during further sampling events and investigated by the SCDHEC's drinking water staff. Endrin, a banned pesticide, was detected in one deep well above the 2.0 μg/L MCL. Contamination of this deep aquifer by pesticides is unlikely. This result is possibly due to bottle contamination during field sampling, since several large cotton storage facilities are adjacent to the well. The laboratory also detected endrin and other pesticides in a rinsate blank collected in the area later in the sampling event. No evidence of pesticide contamination was noted in historic SCDHEC drinking water samples from the well.

Nitrate and nitrite contamination over the MCL was noted in two wells. Thallium was also detected at or slightly above the MCL of 2.0 μg/L in three monitoring wells.

Secondary MCLs for aluminum, iron, or manganese were exceeded in 25 wells. All impacted wells will be reevaluated during further sampling events and investigated by the SCDHEC drinking water staff. Sampling will continue by the ESOP.

The ESOP will compile these data with data collected in 1997 and subsequent years. The complete data set will be evaluated in its entirety to help assess groundwater quality in the area. Analysis of these data will provide the public with an independent source of regional groundwater information. The ESOP will also evaluate ambient data collected on the SRS for inclusion in this data set.

Nonradiological Surface Water and Sediment Project, 1997-98

The streams located on the SRS receive treated wastewater and non-point source runoff from on site facilities. Recent and historical data from the SRS Environmental Reports indicate that the SRS waters are within the Freshwater Standards according to the SCDHEC Water Classifications and Standards (Regulation 61-68), 1998.

The ESOP assessed the nonradiological sediment and surface water quality on the SRS. This was accomplished by sampling the onsite streams for inorganic and organic contaminants. Specific parameters were analyzed monthly, quarterly, and annually. Sample sites were strategically chosen to monitor ambient surface water conditions and detect any nonradiological impact from the SRS operations.

Appendix A includes the nonradiological surface water and sediment monitoring results for 1997. **Appendix B** includes the nonradiological surface water and sediment monitoring results for 1998. **Map 4** contains the nonradiological surface water and sediment sampling locations for 1997-98.

1997 Methods and Results

The overall nonradiological water quality in 1997 on the SRS compares favorably with the Freshwater Standard for South Carolina streams. However, nitrate and nitrite concentrations from sample location Four Mile Creek (SV-326) were significantly higher than the other locations. These higher concentrations possibly result from groundwater outcropping from F-Area and H-Area seepage basins upstream from this location. All surface water data from this study parallels the SRS's data with the exception of dissolved oxygen and zinc. Sediment data from this study, as well as, the SRS's 1997 sediment data indicates no impacts from the SRS operations. No gross impacts of the Site's streams were detected.

1998 Methods and Results

The overall nonradiological water quality in 1998 on the SRS meets the Freshwaters Standard for South Carolina streams for pH, dissolved oxygen and fecal coliform. All but one of the surface water and sediment parameters were within expected ranges for South Carolina streams (SCDHEC, Summary of Selected Water Quality Parameter Concentrations in South Carolina Waters and Sediments, Technical Report No. 004-98). Surface water nitrate concentrations from Four Mile Creek were higher than comparable South Carolina streams. These higher surface water nitrate concentrations possibly result from groundwater outcropping from F-Area and H-Area seepage basins upstream from this location. Data from ESOP nonradiological surface water and sediment locations were compared to the WSRC-EMS data where sample points were co-

located. The data from these four co-located stations were similar for the parameters that were analyzed by both the ESOP and the WSRC-EMS. Sediment data from this study, as well as 1998 WSRC-EMS sediment data, indicate no measurable impacts from SRS operations.

Radiological Surface Water and Sediment Surveillance Project, 1997-98

The objectives of the Radiological Surface Water and Sediment Surveillance Project were to detect and/or verify the concentration of radionuclides in surface water and sediments associated with the SRS; detect and/or verify any routine or accidental radionuclide releases; validate the results of the WSRC-EMS Radiological Surveillance and Monitoring Program; and characterize trends of radionuclides in streams and sediments associated with the SRS. Project activities focused on surface water and sediments primarily in the SRS streams and the Savannah River.

A monitoring strategy was developed and implemented based upon historical monitoring data for radionuclides in surface water and sediment on and adjacent to the SRS. When possible, existing WSRC-EMS locations were used to provide a means of historical data comparison. Surface water samples were collected by the grab method and automatic samplers programmed to collect roughly 30 milliliters of water every thirty minutes. Sediments were collected utilizing stainless steel spoons or a ponar dredge sampler, and placed into 400cc containers. Surface water samples were collected and analyzed for tritium at least once per week at predetermined locations and sediment samples were collect in April and August, 1997; and August, 1998. Results for many of the gross alpha, gross beta and gross gamma analyses were not released because the results did not meet ESOP's quality assurance criteria. However, a few sediment samples collected in August were reanalyzed for gamma emitting radionuclides.

An emergency protocol was developed for providing timely information to those customers downstream that utilize water from the Savannah River for drinking purposes. For this protocol, samples collected from the three public access locations were immediately analyzed to determine if tritium concentrations were near the 20,000 pCi/L Environmental Protection Agency (EPA) MCL. This sampling was performed on a weekly basis. If tritium concentrations exceeded 20,000 pCi/L, the affected Bureaus of the SCDHEC and the SRS would be notified immediately.

Appendix A includes the radiological surface water and sediment monitoring results for 1997.
Appendix B includes the radiological surface water and sediment monitoring results for 1998.
Map 5 contains the nonradiological surface water and sediment sampling locations for 1997-98.

1997 Methods and Results

Analytical results indicate that the SRS contributes tritium to the Savannah River. The results also indicated that tritium can be detected in all streams on the SRS. Samples were collected from several locations downstream from all SRS facilities. The mean concentrations were detected at the following sampling locations downstream from all SRS facilities: Upper Three Runs (SV-325) 3475.21 pCi/L; Four Mile Creek (SV-2043) 262578.41 pCi/L; Four Mile Creek (SV-2039) 214753.60 pCi/L; Four Mile Creek (SV-2045) 385634.90 pCi/L; Pen Branch (SV-2048) 142187.38 pCi/L; Steel Creek (SV-327) 6341.07 pCi/L; and Lower Three Runs (SV-2053)

937.22 pCi/L. Of the five surface water locations that were co-located with WSRC-EMS two did not have consistent concentrations of tritium. Sample collection methods might explain the differences in tritium concentrations.

Results from the gamma analysis performed on the sediment samples indicated levels of Cesium (Cs-137) at Upper Three Runs, Four Mile Creek (SV-2043), Steel Creek, Lower Three Runs, Beaver Dam Creek, Steel Creek Boat Landing, and Highway 301 locations on and adjacent to the SRS. Results for sediment samples co-located with WSRC-EMS did not show any significant differences in results. Cobalt-60 was not detected at any location.

Because of the high flow stages of the Savannah River during periods of high rainfall, it is recommended that WSRC-EMS monitor the combination of Four Mile Creek, Pen Branch, and Steel Creek discharges as it crosses the Steel Creek boat landing. This flooding event generally occurs when the Savannah River reaches a flow rate of approximately 18,000 cubic feet per second. This event causes these three streams to flow off the SRS and across Creek Plantation where it eventually discharges into the Savannah River at Little Hell Landing. This may also warrant additional dose assessment studies for individuals living on Creek Plantation as well as public citizens that frequent the Steel Creek Boat Landing during these high river stage events.

1998 Methods and Results

Surface water and sediment samples were collected and analyzed for tritium, gross alpha, gross beta, Strontium-90 (Sr-90) and gamma emitting radionuclides. Surface water samples were collected and analyzed for tritium at least once per week at predetermined locations and sediment samples were collected in August, 1998.

The results indicated that tritium can be detected in all streams on the SRS. Analytical results also indicated that the SRS contributes tritium to the Savannah River. Four Mile Creek and Pen Branch have consistent tritium concentrations above the EPA MCL for drinking water of 20,000 pCi/L. This is most likely due to the baseflow contribution of contaminated groundwater from various waste sites into these two streams. Composite samples from the last six months in 1998 were analyzed for gross alpha, gross beta, Sr-90 and gamma emitting radionuclides. Higher concentrations of gross alpha were found in Upper Three Runs than any other stream that was sampled. This is most likely the result of the Effluent Treatment Facility (ETF) located in H-Area. ETF treats low-level radioactive wastewater. Elevated levels of gross beta, Sr-90 and gamma emitting radionuclides were detected in Four Mile Creek. These elevated levels are primarily due to groundwater contamination coming from the Old Rad Waste Burial Grounds, and the former Seepage Basins in F-Area and H-Area.

Overall, tritium data from both the ESOP and WSRC-EMS was very compatible at similar locations. Gross alpha, gross beta, Sr-90 and Cs-137 were also compared between the two organizations when collected from the same locations. The data was relatively similar at all locations. Sediment data was also similar from co-located stations, with the exception of Steel

Creek. There is no obvious reason why there is a difference between these two samples.

Laboratory results detected levels of Cs-137 in sediment samples from Upper Three Runs, Four Mile Creek, Steel Creek, Lower Three Runs, and Highway 301. The highest levels were at Four Mile Creek (SV-2045 & SV-2039).

Special Study: Sediment Monitoring on Creek Plantation, August 1998

As a result of high rainfall periods around the Savannah River Basin, the Savannah River increases in stage height forcing Four Mile Creek, Pen Branch and Steel Creek to flow alongside the South Carolina bank, parallel to the Savannah River. These creeks flow off the Savannah River Site (SRS), through Creek Plantation, and finally discharge into the Savannah River at Little Hell Landing. Creek Plantation is a privately owned cattle and horse farm located south of the SRS.

The ESOP staff collected sediment samples from Creek Plantation along a transect perpendicular to the flow of the Savannah River. Cs-137 was detected in all sediment samples collected. This Cs-137 activity could be contributed to historical releases by the SRS into Four Mile Creek, Pen Branch and Steel Creek during high water stages of the Savannah River. Based on these findings, as well as historical WSRC-EMS data, further analyses samples collected on Creek Plantation will be considered in the future. **Appendix B** includes the sediment monitoring on Creek Plantation results. **Map 6** contains the sediment sampling locations for Creek Plantation.

Savannah River Radiological Fish Monitoring, 1997-98

As a significant pathway for exposure to humans from consumption of fish, public concerns are being addressed through independent monitoring of radionuclide concentrations in fish to determine the magnitude, extent, and trends of radionuclide contamination. The WSRC-EMS conducts fish monitoring to assess the effects of routine and accidental releases of radionuclides and other contaminants. In October of 1990, the Georgia Department of Natural Resources discovered higher radionuclide concentrations in Savannah River fish than had previously been reported. In 1996, the ESOP implemented an independent fish monitoring program. Published documents concerning radionuclide concentrations in fish were reviewed and the data generated was used to evaluate the WSRC-EMS Radiological Fish Monitoring Program. Largemouth bass and channel catfish were used as the target species. Both species are known to be consumed in the study area and dominant in the catch of local anglers. Sampling studies have shown that these species bioaccumulate measurable amounts of radionuclides.

Project information will be available for the affected SCDHEC Bureau's to further evaluate potential human health risk associated with the consumption of Savannah River fish. The information provided will also help in advising, informing, and protecting the people at risk, and comparing current and historical data.

Appendix A includes the radiological fish monitoring results for 1997. **Appendix B** includes the radiological fish monitoring results for 1998. **Map 7** contains the fish sampling locations for 1997-98.

1997 Methods and Results

Samples of five fish from each species (bass or catfish) were collected from nine sample locations on a random basis using boat mounted electrofishing equipment. Samples were collected at five stations where creeks from SRS meet the Savannah River. In addition, samples were collected at two stations above and two stations below the SRS. All fish were composited, by species and sample location, and separated into edible and non-edible homogeneous portions. Composites were analyzed for gamma-emitting radionuclides, tritium, Sr-90, and plutonium isotopes.

Results were obtained for 59 composites prepared during the 1997 collection season. Laboratory results indicated the highest levels of Cs-137 were at the Steel Creek location. The highest levels of tritium and Sr-90 were reported at the Four Mile Creek location. Eighteen samples were analyzed for plutonium isotopes, all plutonium samples were reported at less than the MDA. Data summaries for this project were compared with the WSRC-EMS's reported values. Tritium values between the two agencies could not be compared. Cs-137 and Sr-90 values were found to be comparable with the exception of Cs-137 values for Beaver Dam Creek and Steel Creek. This discrepancy in results could be attributed to sample or methodology differences.

1998 Methods and Results

Samples of five fish for each species (bass or catfish) were collected from 12 sample locations using boat mounted electrofishing equipment. Samples were collected at five stations where creeks from SRS meet the Savannah River. In addition, samples were collected at one station above, three stations below the SRS, and three background locations. All fish were composited, by species and sample location, and separated into edible and non-edible homogeneous portions. Composites were analyzed for gamma-emitting radionuclides, tritium, Sr-90, and plutonium isotopes.

Gamma results indicated the highest levels of Cs-137 were from the Steel Creek location. The highest levels of tritium and Sr-90 were reported from the Four Mile Creek location. Isotopic plutonium results were reported for ten composites. Four composites indicated less than the MDA, where the remaining six composites reported a value less than 0.07 pCi/g. Consistent with 1997 result data, higher concentrations of gamma-emitting radionuclides and tritium were reported at the locations adjacent to the SRS. The low levels of isotopic plutonium data are also consistent with the 1997 result data. Additional Sr-90 data is needed before any conclusions can be drawn.

Data reported for this project was compared to WSRC-EMS reported information. Data could not be compared for several locations for tritium, Cs-137, and Sr-90. Discrepancies in these results could be attributed to identical samples not being analyzed by each program. Samples have been collected and split between the SCDHEC and the WSRC-EMS in past meetings of the Central Savannah River Area Radiological Environmental Monitoring Program (CSRA-REMP) and have shown no discrepancies in data results. This would potentially rule out methodology differences and conclude that the discrepancy is with different samples being analyzed between the two programs.

Radiological Surveillance of Surface Soils On and Adjacent to the Savannah River Site, 1998

The ESOP has evaluated surface soil radionuclide concentrations on and around the SRS. This project provides independent radiological monitoring of soil media on a routine basis to detect and measure radionuclide concentrations in the soil as associated with the SRS. The WSRC-EMS's soil monitoring was reduced from 24 sample locations in 1995 to six sample locations currently. The ESOP's surface soil monitoring has been configured to provide thorough perimeter coverage of SRS. The SCDHEC Radiological Environmental Monitoring Division (REMD) analyzed all samples for gamma-emitting radionuclides.

The ESOP conducted soils monitoring in 1998 at 16 locations around the perimeter of the SRS. Three locations were 25 miles from the center of SRS (former WSRC-EMS locations) and three locations were chosen at random from within a 50-mile radius of SRS and a background location approximately 100 miles from the SRS. Samples were collected from the surface to a six-inch depth during December 1998 and January 1999. **Appendix B** includes the radiological surface soil monitoring results for 1998. **Map 8** contains the radiological surface soil sampling locations for 1998.

Laboratory results indicate the presence of low levels of Cs-137 in all samples. Levels of Cs-137 along the perimeter appear to be consistent with background locations. Reported levels were slightly higher than the MDA. Slightly elevated Cs-137 levels were found northeast of A-Area and M-Area along the site perimeter. Although actinium-228 should not have been observed due to its short half-life, it was reported as an indicator of the thorium Natural Radioactive Series. This indicated the presence of thorium-232 and radium-228, at levels slightly above the MDA. Results are consistent with background levels.

Historical WSRC-EMS Cs-137 data from 1991-1998 was evaluated with 1998 ESOP data. The ESOP statistical analysis consisted of computed means and standard deviations. Corresponding quadrants of SRS soils data were compared with ESOP data. Radionuclide levels were very similar; results were within an order of magnitude. The ESOP data corresponds favorably with historic WSRC-EMS data.

The ESOP recommends that annual soil monitoring at perimeter locations be reduced. Future soil analysis may include plutonium, strontium and other isotopes.

Terrestrial Vegetation Radiological Surveillance and Monitoring Project, 1997-98

The SRS has historically collected and analyzed terrestrial vegetation, primarily Bermuda grass, to determine concentrations of radionuclides. Sampling was discontinued at four 25-mile and three of four 100-mile stations in mid-1995. In 1996, the sampling frequency at locations outside burial grounds and the 14 SRS perimeter stations was reduced from quarterly to annually. In 1998, the number of onsite and perimeter stations was reduced from 100 to five.

Appendix A includes the terrestrial vegetation monitoring results for 1997. **Appendix B** includes the terrestrial vegetation monitoring results for 1998. **Map 9** contains the vegetation sampling locations for 1997-98.

1997 Methods and Results

The ESOP conducted independent vegetation monitoring in 1997 at 16 locations around the perimeter of the SRS; three locations 25 miles from the center of SRS that are no longer part of the SRS environmental monitoring program; two locations selected at random from within a 50 mile radius of SRS; and a background station approximately 110 miles from SRS. Personnel collected leaves from broad-leafed evergreen plants in June, September, and October 1997. The samples were analyzed for tritium activity, gamma-emitting isotopes, and gross alpha and beta levels.

Tritium was detected in vegetation at 11 of the 22 sites sampled in 1997, including one 25-mile station. The stations with detectable activity were generally located on the western half of the SRS. Seven of the stations produced tritium levels greater than the LLD in both June and September-October. Activity levels were highest in vegetation collected near D-Area, possibly due to ongoing heavy water reprocessing and historical operations at that facility. Tritium was not detected at either of the random 50-mile radius stations, nor the 100-mile background station.

Seventeen samples were analyzed for gamma-emitting radionuclides. Gamma emitting radionuclides were detected in all samples analyzed, most activity levels being near the MDA except for naturally occurring potassium-40. Eighteen samples were analyzed for gross alpha and gross beta activity. Activity levels for 16 of the alpha analyses were below the MDA. Beta activity was evident above the MDA in 16 samples. However, natural beta emitters such as potassium-40 (K-40) could account for this.

Comparison of the ESOP data and the WSRC-EMS data was not conducted due to differences in vegetation sampled and analysis methods. ESOP recommends that the WSRC-EMS report tritium activity in a more relevant manner, such as picocuries/milliliter, or picocuries/gram of fresh vegetation, to reflect the tritium activity in the water extracted from the sample.

1998 Methods and Results

The ESOP conducted independent vegetation monitoring in 1998 at 16 locations around the perimeter of the SRS; three former SRS monitoring locations 25 miles from the center of the SRS; eight locations selected at random from within a 50 mile radius of the SRS; and a background station approximately 110 miles from the SRS. Sampling was performed in March, June, September, and December 1998.

Samples were analyzed for tritium activity, gamma-emitting isotopes, and gross alpha and beta activity. Tritium was detected in vegetation at 19 of the 28 sites sampled in 1998, including all perimeter stations and one 25-mile station. Eight of the perimeter stations produced tritium levels greater than the LLD in all four sampling months. The stations with the highest detectable activity were generally located on the western and northern sides of the SRS, including vegetation collected near D-Area, possibly due to ongoing heavy water reprocessing and historical operations at that facility. Tritium was detected at two of the random 50-mile radius stations, but not the 100-mile background station.

Gamma-emitting radionuclides were detected in all samples. Cs-137 was detected at higher levels and more frequently than in 1997, especially in clusters of stations near D-Area and on the northern side of the SRS. Sixteen samples were analyzed for gross alpha and beta activity. Activity levels for nine of the alpha analyses were above the MDA. Beta activity was evident above the MDA in all samples.

The ESOP data confirms the WSRC-EMS conclusion that elevated tritium levels at the site perimeter are due to atmospheric releases from the SRS. Despite differences in sampling and analysis methods between the two programs, tritium results from similar sampling locations were within the same order of magnitude, and the one co-location produced nearly identical results. However, the ESOP recommends that the WSRC-EMS modify its reporting format for tritium, either to picocuries/milliliter, or as picocuries/gram of fresh vegetation. Results for the one co-location were similar for Cs-137 and gross beta analyses, but not for the gross alpha analysis. A full list of gamma-emitting radionuclides detected in the SRS analyses may be warranted in the annual SRS Environmental Data report.

Dairy Milk Radiological Monitoring Project, 1997-98

The SRS personnel have historically conducted monitoring around the SRS to determine concentrations of certain radionuclides in dairy milk. Due to a change in scope of environmental monitoring at SRS, only five of the seventeen initial sampling locations remain active. The ESOP personnel performed independent dairy milk sampling within a 50-mile radius of the site.

Consumption of milk and other food products containing radioactive materials can be a significant source of human exposure to radioactivity. Dairy milk becomes contaminated when cows ingest atmospheric deposition of radioactive particles on grass and plants and released in milk. The pathway via milk is of particular importance in the case of infants and children, because not only are they more likely to drink large quantities of milk, but they are also actively developing bones and teeth. Strontium, a calcium analogue, can accumulate in bone and teeth displacing the calcium. Because this is an important pathway for human exposure to radioactivity, milk samples from dairies around SRS were routinely analyzed to determine if they contained levels of radioactivity that could be detrimental to human health. **Map 10** contains the dairy milk sampling locations for 1997-98.

1997 Methods and Results

Milk samples were collected on a monthly basis from five dairies around the SRS beginning in June 1997. The samples were analyzed for tritium and gamma emitting radionuclides. Quality Assurance and Quality Control measures were performed in accordance with established standard operating procedures concerning the collection and evaluation of milk.

The analytical results for tritium samples are in **Appendix A**. There were 35 samples acquired during 1997. Only three of the samples were above the MDA.

1998 Methods and Results

Milk samples were collected on a monthly basis in 1998. The samples were analyzed for tritium and gamma emitting radionuclides. **Appendix B** includes the dairy milk monitoring results for 1998. Overall, the analytical results between the ESOP and the SRS are comparable with no anomalies noted. Quality Assurance and Quality Control measures were performed in accordance with established standard operating procedures concerning the collection and evaluation of milk.

Game Animal Monitoring Adjacent to the Savannah River Site Project

Through it's operations the SRS has introduced radionuclides to the environment through routine and accidental releases to streams, atmosphere, and other media. These releases have the potential to directly affect game animal populations and their food sources. Due to the mobility of game animals, they have the potential to encounter impacted habitat prior to being harvested for consumption. Because consumption of game animals is an important pathway for human exposure, collection and analysis of deer and hog tissue samples is routinely used to assist in evaluating potential radiation doses received by the off-site population. WSRC-EMS has monitored deer and hogs harvested as part of population control hunts since 1965. In 1998, the ESOP began analyzing flesh and bone samples from game animals for radionuclides within the study area by utilizing samples harvested by local hunters. An independent data set of the results on radionuclides obtained from harvested game has been established and the results have been summarized. **Appendix B** includes the game animal monitoring results for 1998. **Map 11** contains the game animal surveillance locations for 1998.

A total of nine samples were collected in 1998. These samples consisted of three white-tailed deer, one hog, four waterfowl, and one dove sample. Cesium-137 for white-tailed deer data ranged from below MDA to 3.725 pCi/g. Cs-137 was detected in one waterfowl sample at 0.312 pCi/L. In 1998, WSRC-EMS reported Cs-137 values ranging from 1.0 pCi/g to 77.0 pCi/g in harvested white-tailed deer.

Federal Facilities Agreement (FFA) Site Evaluation Sites, 1997

The Site Evaluation program evaluates areas with potential or known releases of hazardous substances unidentified before the effective date of the Federal Facility Agreement, August 16, 1993. The primary objective of the FFA Program Support Projects was to evaluate the potential impact of facility operations on the soil. Other objectives established were to conduct document review; establish contacts concerning each activity; acquire, validate, and report discrepancies in raw data; provide oversight of sampling activities; conduct split sampling; and implement independent sampling programs.

A total of five sites were evaluated. Data for the GIS database was collected at all five sites. At two sites, the evaluation consisted of only oversight of sampling activities for adherence to established sampling protocol. The remaining three sites included oversight of field activities and the acquisition of split samples from selected locations. Soil samples were collected from the Sandblast Area, CMN-002 on August 28, 1997; and the Gunsite 012, Rubble Pile Site on April 2, 1997. These split samples were shipped to the SCDHEC Analytical Services Laboratory for analysis of metals, volatiles, pesticides, herbicides and other constituents.

The ESOP provided oversight and participated in the pre-characterization soil sampling activities at all of these sites. Oversight activities included the observation of sampling; splitting of soil samples; acquisition of GIS data points; contractor adherence to the SRS's sampling protocol; and the acquisition of photographs for documentation and visual representation. **Appendix A** includes the FFA monitoring results for 1997.

Sandblast Area, CMN-002

This area was used for sandblasting activities for the removal of rust and paint from ferrous equipment. Sandblasting activities were performed around the outside of the building. The metals of concern resulting from these activities were lead and chromium. A review of the Sandblast Area's history was conducted to help determine the best locations of sampling for the constituents of concern. Split samples were collected from those locations with the highest probability for detecting the constituents of concern. Samples were collected as composites from depths 0-1 foot and 1-4 feet within the unit confines.

The observation of sampling activities at the sandblast area was limited to four locations, designated as CMN-002-3B, CMN-002-6B, CMN-002-8B, and CMN-002-11B. The SRS personnel performed sampling in accordance with established SRS protocols and procedures utilizing hand-auguring technology. ESOP personnel did not perform any sampling at the sandblast area, but acquired split samples from these locations.

All Target Analyte List results were below their respective residential Risk Based Concentrations (RBCs). The only exception noted was arsenic. Arsenic was detected by the SRS in all samples

above its RBC. The SCDHEC laboratory could not verify the arsenic values due to the MDA for arsenic being greater than the RBC.

The SRS personnel performed the Sandblast Area, CMN-002, site assessment in accordance with established protocol and procedures. The analytical results released by both laboratories are comparable. There are no noted discrepancies that would warrant further evaluation.

Gunsite 012, Rubble Pile Site

Gunsite 012 consisted of anti-aircraft gun emplacements manned by military personnel from 1955 to 1957. The gunsites were dismantled and/or abandoned in 1961. Support facilities at the gunsite included barracks, mess halls, administrative buildings, underground fuel storage tanks, and septic tanks. All buildings had been removed and there were no records of hazardous waste or constituents having been disposed at the gunsite.

The observation of sampling activities at the gunsite was limited to five locations, designated as GS12-61, GS12-63, GS12-65, GS12-67, and GS12-BK4. All samples were obtained from the interval of 0-1 foot. Samples were acquired through the use of direct push technology. The sampling performed by Microseeps personnel, under the direction of the SRS personnel, was done in accordance with established SRS protocols and procedures. ESOP personnel did not perform any sampling at the Gunsite 012 Rubble Pile Site, but acquired split samples from these locations.

All target analyte list results were below their respective RBCs. The only exception noted was arsenic. Arsenic was detected by the SCDHEC in all samples above its RBC. The SRS contract laboratory reported arsenic values greater than its RBC in three of the five split soil samples. The SRS personnel performed the Gunsite 012, Rubble Pile Site, site assessment in accordance with established protocol and procedures. The analytical results released by both laboratories are comparable, except for arsenic. This discrepancy warrants further evaluation.

Combined Spills at 674-T

Soil samples from this site were collected as composites from depths 0-1 foot and 1-4 feet within the perimeter of the fenced unit. The site consisted of a drum and equipment storage area along with a graveled laydown yard. Drum contents included feedstocks for the TNX Area, process materials, and waste materials awaiting disposal. A majority of the drums, stored on wooden pallets, contained or were suspected of containing hazardous chemicals. After 1994, all drums containing hazardous materials were relocated to diked storage buildings. Since 1983, this area was also used for equipment storage for an unspecified period of time.

The observation of sampling activities at the Combined Spills at 674-T was limited to three

locations, designated as 674T-8, 674T-10, and 674T-11. Soil Samples were acquired using hand auguring technology. The sampling was performed by SRS personnel and executed in accordance with established SRS protocols and procedures. ESOP personnel did not perform any sampling at the combined spills area.

Acronyms

AGMN – Ambient Groundwater Monitoring Network

C-well – Cluster Well

CERCLA – Comprehensive Environmental Response, Compensation and Liability Act

CSRA – Central Savannah River Area

DOE – US Department of Energy

EMS – Environmental Monitoring Section of the Environmental Protection Department (of Westinghouse Savannah River Company)

EPA – US Environmental Protection Agency

ESOP – Environmental Surveillance and Oversight Program (of the South Carolina Department of Health and Environmental Control)

ETF – Effluent Treatment Facility

FFA – Federal Facilities Agreement

GIS – Geographic Information System

LLD – Lower Limit of Detection

MCL – Maximum Contamination Level

MDA – Minimum Detectable Activity

pH – Measure of the hydrogen ion concentration in an aqueous solution (acidic solutions, pH from 0-6; basic solutions, pH>7; and neutral solutions, pH=7)

QA/QC – Quality assurance/quality control

RBC – Risk Based Concentrations

REMD – Radiological Environmental Monitoring Division (of the South Carolina Department of Health and Environmental Control)

REMP – Radiological Environmental Monitoring Program

SCDHEC – South Carolina Department of Health and Environmental Control

SRS – Savannah River Site

TLD – Thermoluminescent Dosimeter

WSRC – Westinghouse Savannah River Company

Units of Measurement

Curie	Ci	cubic meter	m^3
picocurie	pCi	microgram	μg
microcurie	μCi	cubic centimeters	cc
Liter	L	milliroentgen	mR
cubic meter	m^3		

Appendix A
1997 Data Tables

Appendix B
1998 Data Tables

Maps