ESOP

Environmental Surveillance and Oversight Program

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

2011 DATA REPORT

CR-004111 3/13

South Carolina Department of Health and Environmental Control

Environmental Surveillance Oversight Program
Data Report for 2011

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Region 5
Environmental Quality Control
Serving: Aiken, Allendale, Bamberg, Barnwell, Calhoun, and Orangeburg Counties
Promoting Health, Protecting the Environment

Region 5 EQC
206 Beaufort Street NE,
Aiken, SC 29801
(803) 641-7670 Fax (803) 641-7675

Introduction

The South Carolina Department of Health and Environmental Control’s (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) supports and complements SCDHEC's comprehensive regulatory program at the Savannah River Site (SRS) by focusing on those activities not supported or covered through our normal regulatory framework. The primary function of the ESOP is to evaluate the effectiveness of SRS monitoring activities. To accomplish this function, the ESOP conducts non regulatory monitoring activities on and around the SRS, conducts evaluations of the SRS monitoring program and provides an independent source of information to the public pertaining to levels of contaminants in the environment from historical and current SRS operations.

This report includes a description of the ESOP's multi-media monitoring network and activities along with a summary of the findings of the ESOP from the 2011 calendar year monitoring period.

Table of Contents

Introduction

Section 1 2011 Air Monitoring

Chapter 1 Radiological Atmospheric Monitoring

Section 2 2011 Water Monitoring

Chapter 2 Ambient Groundwater Monitoring Adjacent to SRS

Chapter 3 Drinking Water Quality Monitoring

Chapter 4 Radiological Monitoring of Surface Water on and Adjacent to the SRS

Chapter 5 Nonradiological Monitoring of Surface Water

Chapter 6 Radiological and Nonradiological Monitoring of Sediments

Section 3 2011 Terrestrial Monitoring

Chapter 7 Surface Soil Monitoring Adjacent to SRS

Chapter 8 Radiological Vegetation Monitoring Associated with the Savannah River Site

Chapter 9 Radiological Monitoring of Edible Vegetation

Chapter 10 Radiological Monitoring of Dairy Milk

Section 4 2011 Biological Monitoring

Chapter 11 Radiological Monitoring of Fish Associated with the Savannah River Site

Chapter 12 Radiological Game Animal Monitoring Adjacent to SRS

Section 5 2011 Critical Pathway / Dose

Chapter 13 Critical Pathway / Dose Report

This Page Intentionally Left Blank

Section 1 2011 Air Monitoring

Chapter 1 **Radiological Atmospheric Monitoring**

2011 Radiological Atmospheric Monitoring on and Adjacent to the Savannah River Site

Environmental Surveillance and Oversight Program

97AA007
Adam R. Waller, Project Manager
January 1, 2011 – December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 2
TOTAL SUSPENDED PARTICULATES 2
AMBIENT BETA/GAMMA 2
TRITIUM 3

3.0 CONCLUSIONS/RECOMMENDATIONS 5

4.0 MAP 6

5.0 TABLES AND FIGURES 7

6.0 DATA TABLES 13

7.0 SUMMARY STATISTICS 24

LIST OF ACRONYMS AND UNITS OF MEASURE 28

REFERENCES 29

1.0 Project Summary

Atmospheric transport has a significant potential to impact the citizens of South Carolina from releases associated with activities at the Savannah River Site (SRS). This project provides independent quantitative monitoring of atmospheric radionuclide releases associated with the SRS. It also provides monitoring of atmospheric media on a routine basis to measure radionuclide concentrations in the surrounding environment and to identify trends that may require further investigation. Radiological atmospheric monitoring sites were established to provide spatial coverage of the project area.

The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) air monitoring capabilities in 2011 included eight air-monitoring stations with the capacity for sample collection using glass fiber filters, rain collection pans, silica gel columns, and 19 thermoluminescent dosimeters (TLDs). Five of the air-monitoring stations are on or within two miles of the SRS perimeter, New Ellenton (NEL), Jackson (JAK), Allendale Barricade (ABR), South Carolina Advanced Technology Park in Snelling (SCT), and Dark Horse at the Williston Barricade (DKH), one at the center of the site, Burial Grounds North (BGN), and two are within 25 miles of the site Aiken (AIK) and Allendale (ALN). Thirteen of the TLDs are on or near the site perimeter, one is in the center of the site, and five are within 25 miles of the site. Only perimeter air monitoring stations and TLDs are used for comparison. Refer to the map in Section 4.0 for specific monitoring locations.

The glass fiber filters were used to collect total suspended particulates (TSP). Particulates were screened weekly for gross alpha and gross beta-emitting activity. Precipitation, when present, was sampled and analyzed monthly for tritium. Silica gel distillates of atmospheric moisture were analyzed monthly for tritium. TLDs were collected and analyzed every quarter for ambient beta/gamma levels. SCDHEC emphasizes monitoring for radionuclides in atmospheric media around the SRS at potential public exposure locations.

SCDHEC data substantiated historically reported Department of Energy-Savannah River (DOE-SR) values for radionuclides in the ambient environment at or near the SRS boundary. Average DOE-SR atmospheric radiological monitoring results for gross alpha/beta in air, ambient beta/gamma, and tritium in precipitation at the SRS boundary were within two standard deviations of the SCDHEC reported average values. Variations in atmospheric radiological monitoring results between SCDHEC and DOE-SR are likely a result of differences in monitoring locations, local meteorological conditions, frequency of sampling, and number of locations. Reported differences are at regional background levels and present no difference with regard to the impact on public health.

In summary, no United States Environmental Protection Agency (USEPA) air standards were exceeded at the monitored locations and there were no elevations of radiological pollutant concentrations associated with SRS operations. Sampling results by SCDHEC indicate that SRS activities had a measurable but negligible impact on local air quality.

2.0 RESULTS AND DISCUSSION

Total Suspended Particulates

Gross Alpha

During the 2011 sampling period, gross alpha activity ranged from <LLD (Less than Lower Limit of Detection) to 0.0081 picoCuries per cubic meter (pCi/m^3) at the site perimeter (NEL, JAK, ABR, SCT, and DKH). The maximum gross alpha detection was collected on July 5 at the JAK air station. Values in this range are typically associated with naturally occurring alpha-emitting radionuclides, primarily as decay products of radon, and are considered normal (Kathren 1984). According to the USEPA, (Rhonda Sears telephone conversation, September 17, 2005) if gross alpha counts are above 0.7 pCi/m^3, the filters are analyzed for specific radioisotopes. The SCDHEC average gross alpha radionuclide concentration in 2011 was 0.0018 (± 0.0010) pCi/m^3. The DOE-SR gross alpha average of 0.0011 (± 0.0007) pCi/m^3 is within one standard deviation of the SCDHEC gross alpha activity average (SRNS 2012). Section 5.0, Figure 1 shows average gross alpha activity for SRS perimeter locations and illustrates trending of gross alpha values for SCDHEC and DOE-SR.

Gross Beta

During the 2011 sampling period, the site perimeter (NEL, JAK, ABR, SCT, and DKH) gross beta concentrations ranged from 0.0066 to 0.0408 pCi/m^3. The maximum gross beta detection was collected on June 7 at the DKH air station. The average gross beta concentration reported by SCDHEC in 2011 was 0.0216 (±0.0051) pCi/m^3. Section 5.0, Figures 6-11 show SCDHEC trending for 2011 for both gross alpha and gross beta. Values in this range are typically associated with naturally occurring beta-emitting radionuclides, primarily as decay products of radon (Kathren 1984). Small seasonal variations at each monitoring location have been consistent with historically reported SCDHEC values (SCDHEC 2007). The USEPA Office of Radiation and Indoor Air uses gross beta counts as an indicator to determine if additional analyses will be performed. A gamma scan is conducted if the gross beta activity exceeds 1 pCi/m^3. This tiering of definitive analyses is used for all total suspended particulate sampling associated with RadNet. RadNet is comprised of a nationwide network of sampling stations that identify trends in the accumulation of long-lived radionuclides in the environment (USEPA 2005). The DOE-SR gross beta average of 0.0128 (± 0.0039) pCi/m^3 is within two standard deviations of the SCDHEC gross beta activity average (SRNS 2012). Over the past several years, SCDHEC has seen a slight decrease in gross beta while DOE-SR results have remained stable. Section 5.0, Figure 2 shows average gross beta activity for the SRS perimeter locations and illustrates trending of gross beta values for SCDHEC and DOE-SR.

Radiochemical Particulate Data

First quarter glass fiber filters were composited and analyzed for plutonium 238 and 239/240. One location had a detection of Pu-238, SCT, which was 1.38E-05 (± 1.19E-05) pCi/m^3. All other locations were below the minimum detectable activity (MDA). Data is shown in Section 6.

Ambient Beta/Gamma

SCDHEC conducts ambient beta/gamma monitoring through the deployment of Thermoluminescent Dosimeters (TLDs) around the perimeter of the SRS. Ambient beta/gamma levels measured with TLDs are provided for all quarters of 2011. It should be noted that 4 millirem (mrem) are subtracted from the reported result for each TLD to account for the transcontinental flight from South Carolina to California and back (Walter 1995). During the 2011 sampling period total combined quarterly ambient beta/gamma ranged from 59 to 101 mrem, at the site perimeter. The maximum ambient beta/gamma detection was collected at the US 278 at Upper Three Runs Creek location. The SCDHEC average ambient beta/gamma activity for perimeter TLDs in 2011 was 78 (±10.88) mrem. The DOE-SR average ambient beta/gamma activity was 79.99 (± 10.78) mrem for 2011 (SRNS 2012). The DOE-SR ambient/beta gamma average was within one standard deviation of the SCDHEC average. During the sampling period, SCDHEC external radiation levels at monitored locations were slightly lower than levels reported by DOE-SR. Over the past six years, there have been no major increases or decreases in the average ambient beta/gamma activity reported by DOE-SR or SCDHEC. Section 5.0, Figure 3 shows trends at the SRS perimeter for averaged ambient beta/gamma values for DOE-SR and SCDHEC.

Tritium

Tritium continues to be the predominant radionuclide detected in the perimeter samples. During 2011, DOE-SR released approximately 28,100 Ci of tritium from SRS (SRNS 2012). Most of the tritium detected in SCDHEC perimeter samples may be attributed to the release of tritium from tritium facilities, separation areas, and from diffuse and fugitive sources (SRNS 2012).

<u>Tritium In Air</u>

Tritium in air values reported by SCDHEC are the result of using the historical means of calculating an air concentration of tritium based on the upper limit value of absolute humidity (11.5 grams of atmospheric moisture per cubic meter) in the geographic region (NCRP 1984). SCDHEC tritium results greater than the lower limit of detection (LLD) are then converted from picocuries per liter (pCi/L) to pCi/m^3 using the formula:

$$\frac{\text{pCi/L}}{1000} = \text{pCi/ml}(11.5) = \text{pCi/m}^3$$

During the 2011 sampling period tritium in air ranged from <LLD to 12.10 pCi/m^3. The maximum tritium in air activity was collected at the JAK air station, for the month of April 2011. The SCDHEC average measured activity for tritium in air was 4.98 (±2.23) pCi/m^3. The SCDHEC average for tritium activity was well below the USEPA equivalent yearly average standard of 21,000 pCi/m^3 for airborne tritium activity (ANL 2007). The DOE-SR average measured value for tritium activity in air at the SRS perimeter was 13.41(± 6.92) pCi/m^3 (SRNS 2012). DOE-SR average measured values for tritium in atmospheric moisture were higher than SCDHEC averaged measured values for the SRS perimeter (SRNS 2012). The DOE-SR average measured activity for tritium was within two standard deviations of the SCDHEC measured average. This difference may be attributed to a dilution that occurs when desiccants are used for collecting atmospheric moisture for tritium analysis. Prior to deployment in the field, silica-gel desiccant is dried to remove any moisture. However, a small percentage of water remains in the

desiccant. This results in a slight dilution of the collected sample, which is reflected in the distillate. Another factor that may contribute to the lower SCDHEC air tritium values is that only two of the monitoring stations are exactly on the SRS perimeter (property line), while the other three points used for this comparison are located in population centers approximately two miles from the SRS property line.

Average DOE-SR tritium in air activity was higher than the SCDHEC measured activity but well within the same order-of-magnitude. These variations could be caused by different sampling locations, number of locations, or sample frequency.

Average tritium in air activity at the SRS perimeter reported by SCDHEC for 2011 was lower than reported in 2010 and has fluctuated over the last six years. DOE-SR also reported a slight increase from 2010 to 2011 and also has fluctuated over the past six years. Section 5.0, Figure 4 illustrates trending of atmospheric tritium activity for SCDHEC and DOE-SR as measured and calculated at the SRS perimeter. Section 5.0, Figures 12-14 show trending for 2011 for SCDHEC.

Tritium In Precipitation

During the 2011 sampling period tritium in precipitation ranged from <LLD to 889.23 pCi/l. The maximum reported value for SCDHEC perimeter locations was collected at the JAK air station for the collection period of April 2011. The SCDHEC average measured activity for tritium in precipitation was 376.42 (±189.23) pCi/L. The DOE-SR average measured value for tritium activity in precipitation at the SRS perimeter was 723.38 (± 482.23) pCi/L (SRNS 2012). The SCDHEC and DOE-SR averages for tritium activity were well below the EPA standard of 20,000 pCi/L in drinking water (USEPA 2002). The DOE-SR averages for tritium activity were within one standard deviation of the SCDHEC average. Section 5.0, Figure 5 shows average tritium in precipitation activity for SRS perimeter locations and illustrates trending tritium in precipitation values for SCDHEC and DOE-SR. Section 5.0, Figures 15-17 show trending for 2011 for SCDHEC.

Post Fukushima Sampling

Following the 2011 Japan earthquake, tsunami, and subsequent meltdown at the Fukushima Daichi Nuclear Power Plant, SCDHEC conducted additional sampling to assess the impact of those events to the local environment. In connection with normal sampling, four additional precipitation samples were taken around the SRS (AIK, BGN, ALN, SCT). These additional samples were screened for gross alpha/beta and gamma emitting radionuclides as well as tritium. No gamma emitting radionuclides were detected; tritium was detected in two of the four samples, ALN 213 (±131) pCi/L and BGN 3510 (± 208) pCi/L, these detections are in the range of normal values associated with SRS operations; gross alpha was detected in two of the four samples, AIK 1.91 (±1.63) pCi/L and ALN 1.81 (±1.42) pCi/L; gross beta was also detected in the same two locations, AIK 2.61 (±1.75) pCi/L and ALN was 2.94 (±1.75) pCi/L. These detections are below their respective EPA limit or trigger level, 15 pCi/L for gross alpha and 8 pCi/L for gross beta (EPA 2007).

3.0 CONCLUSIONS/RECOMMENDATIONS

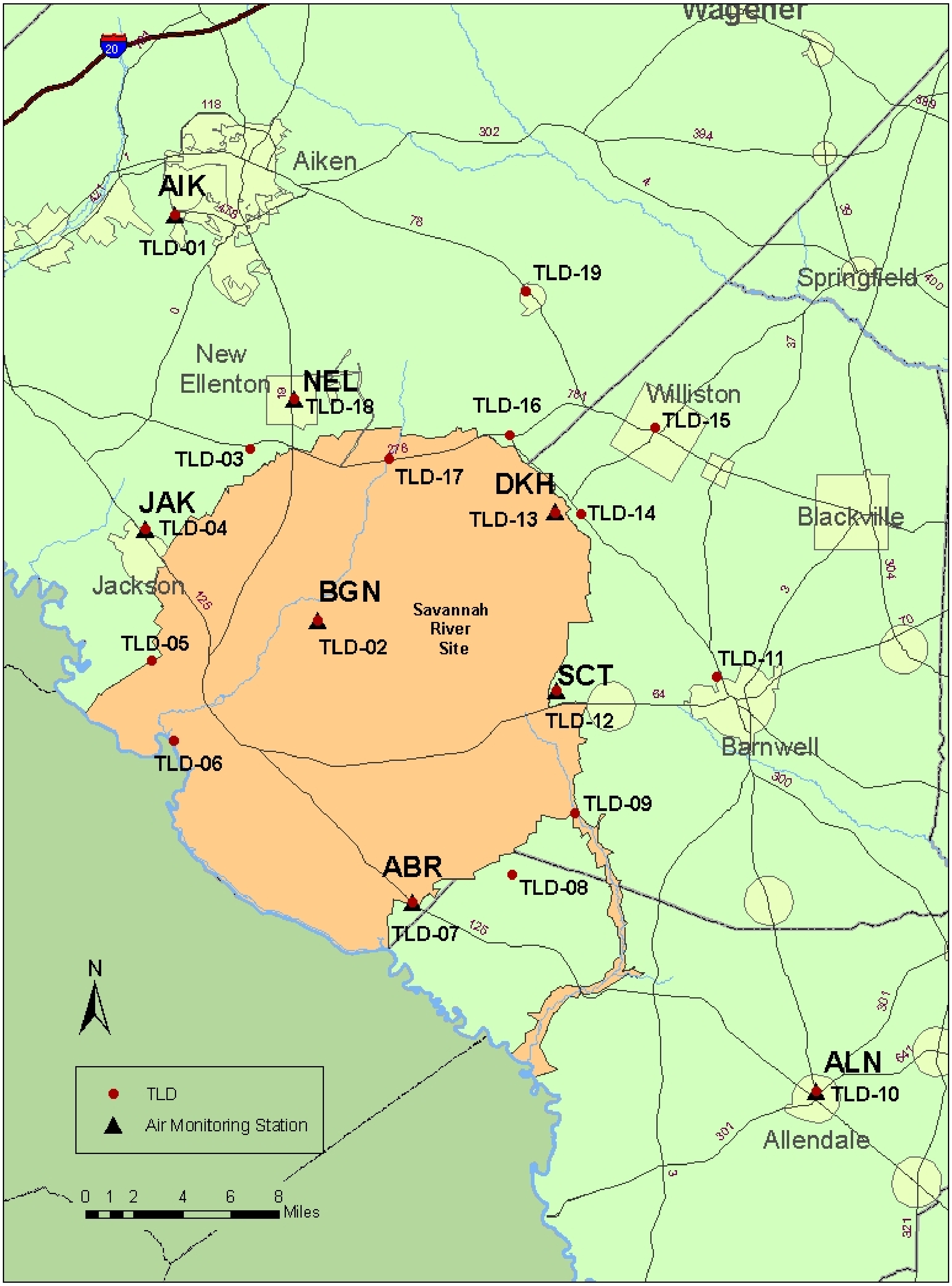
All SCDHEC data collected in 2011 confirmed historically reported DOE-SR values for gross alpha/beta, ambient beta/gamma and tritium in the environment at the SRS boundary with no anomalous data noted for any monitored parameters.

Due to the variability of environmental data and the frequency of collecting samples, DOE-SR gross alpha/beta in air, tritium in precipitation, tritium in air, and ambient beta/gamma averages were within two standard deviations of SCDHEC measured averages.

No EPA air standards were exceeded at the monitored locations and there were no elevations of radiological pollutant concentrations associated with SRS operations. Sampling results by SCDHEC indicate that SRS activities did have a measurable but negligible impact on local air quality.

Due to continued releases from site facilities (tritium facilities, separations areas, etc.), SCDHEC will continue to collect weekly TSP for gross alpha/beta, monthly for atmospheric and precipitation tritium, and quarterly ambient beta/gamma samples.

4.0 2011 RADIOLOGICAL ATMOSPHERIC MONITORING
Map 1. 2011 ESOP RADIOLOGICAL ATMOSPHERIC MONITORING LOCATIONS



5.0 TABLES AND FIGURES

2011 Radiological Atmospheric Monitoring on and Adjacent to SRS

Table 1. SCDHEC and DOE-SR Sample Frequency Comparison

Sample Frequency		
	SCDHEC	DOE-SR
Total Suspended Particulates	Weekly	Bi-weekly
Precipitation	Monthly	Bi-weekly
Atmospheric Moisture	Monthly	Monthly
Thermoluminscent Dosimeters	Quarterly	Quarterly

Figure 1. DOE-SR and SCDHEC Comparison of Average Gross Alpha For Total Suspended Particulates at the SRS Perimeter

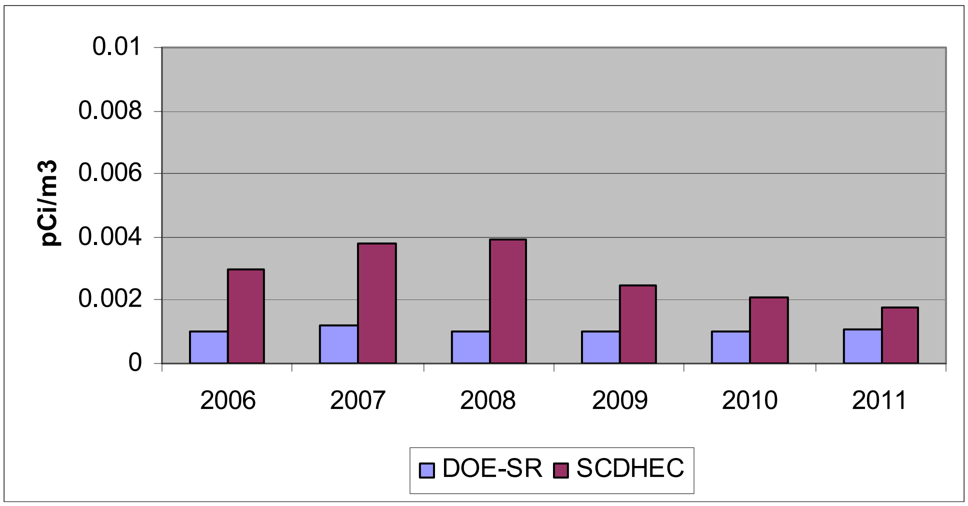


Figure 2. DOE-SR and SCDHEC Comparison of Average Gross Beta For Total Suspended Particulates at the SRS Perimeter

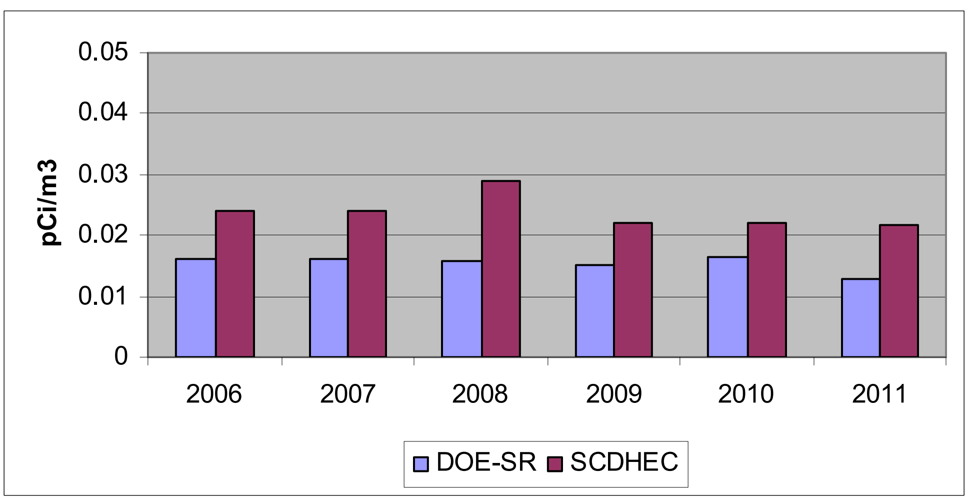


Figure 3. DOE-SR and SCDHEC Comparison of Average Ambient Beta/Gamma at the SRS Perimeter

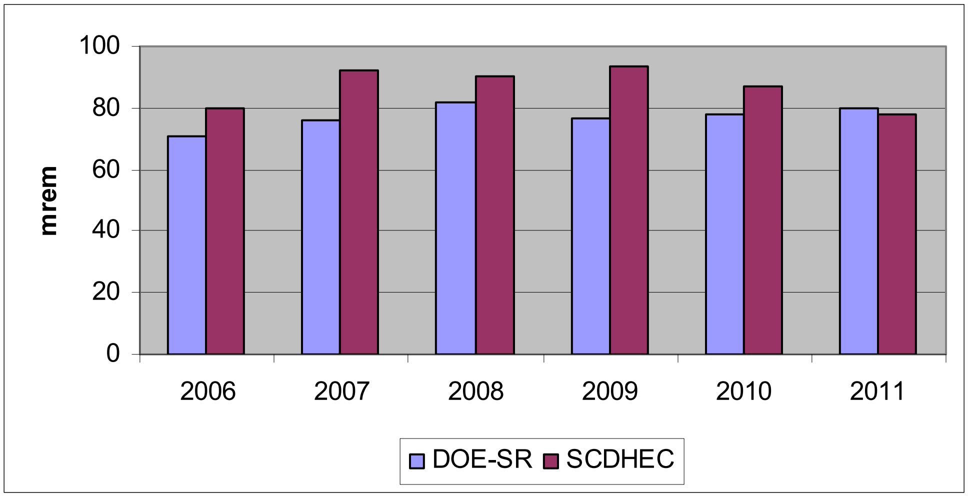


Figure 4. DOE-SR and SCDHEC Comparison of Average Tritium in Air at the SRS Perimeter

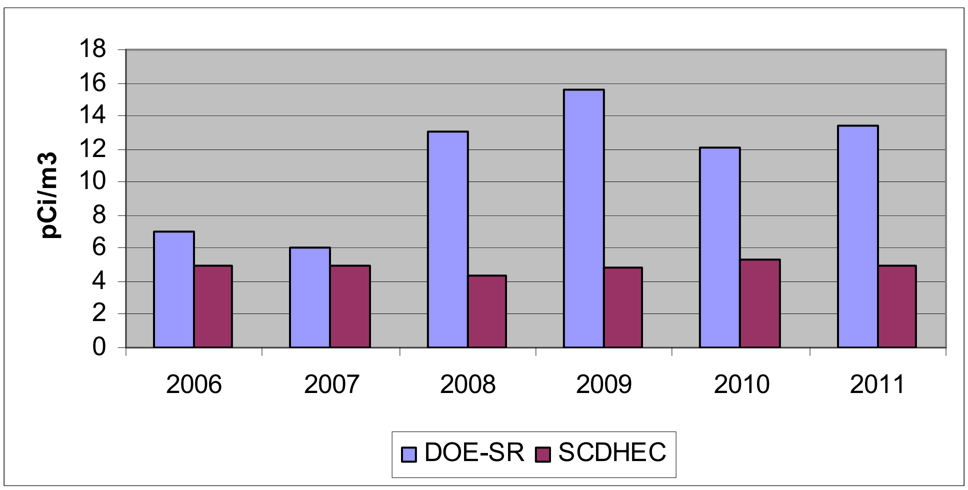


Figure 5. DOE-SR and SCDHEC Comparison of Average Tritium in Precipitation at the SRS Perimeter

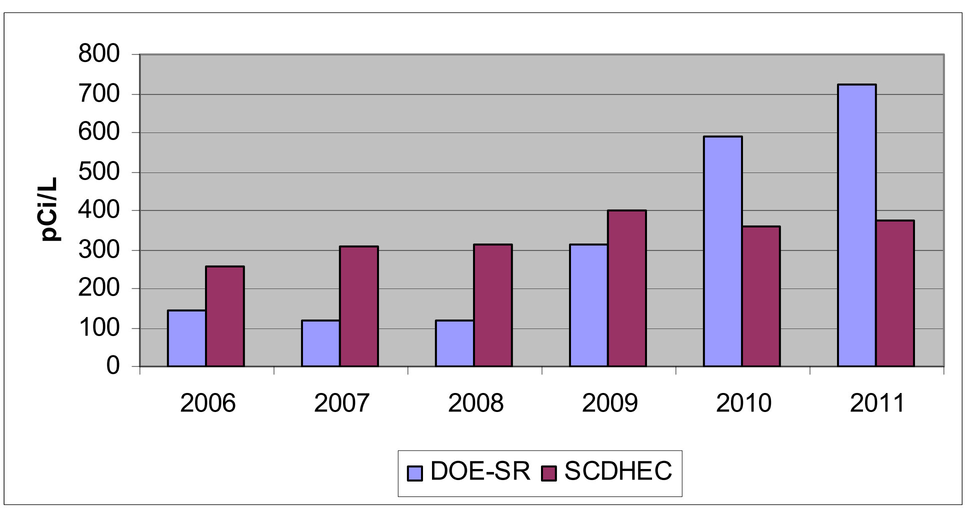


Figure 6. Weekly Gross Alpha in Air (Perimeter Stations)

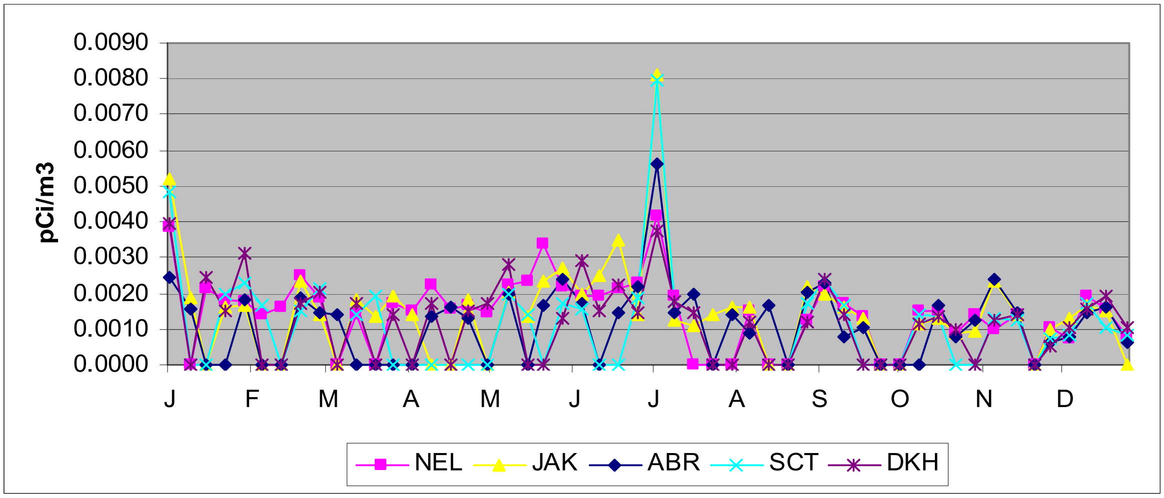


Figure 7. Weekly Gross Alpha in Air (Non-Perimeter Stations)

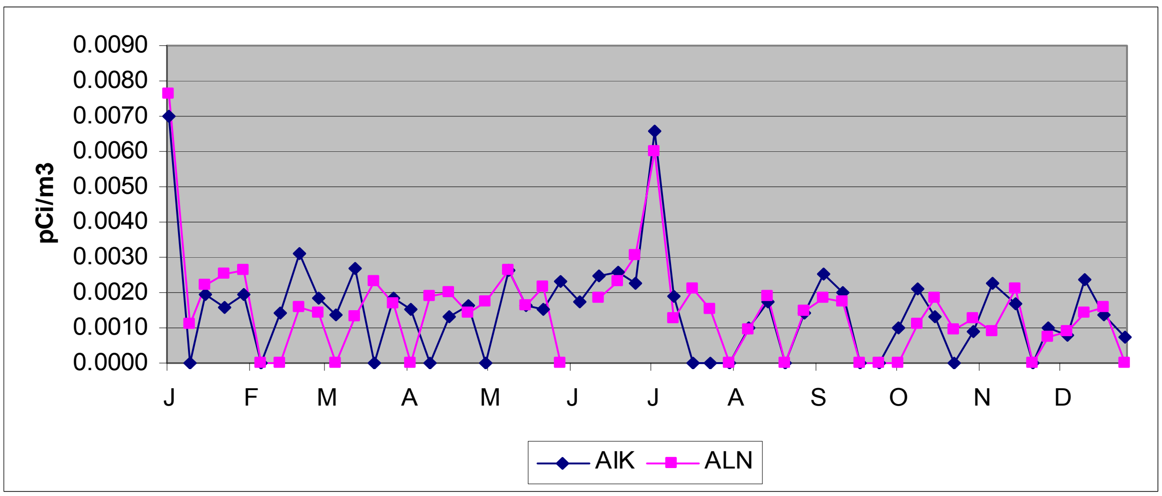
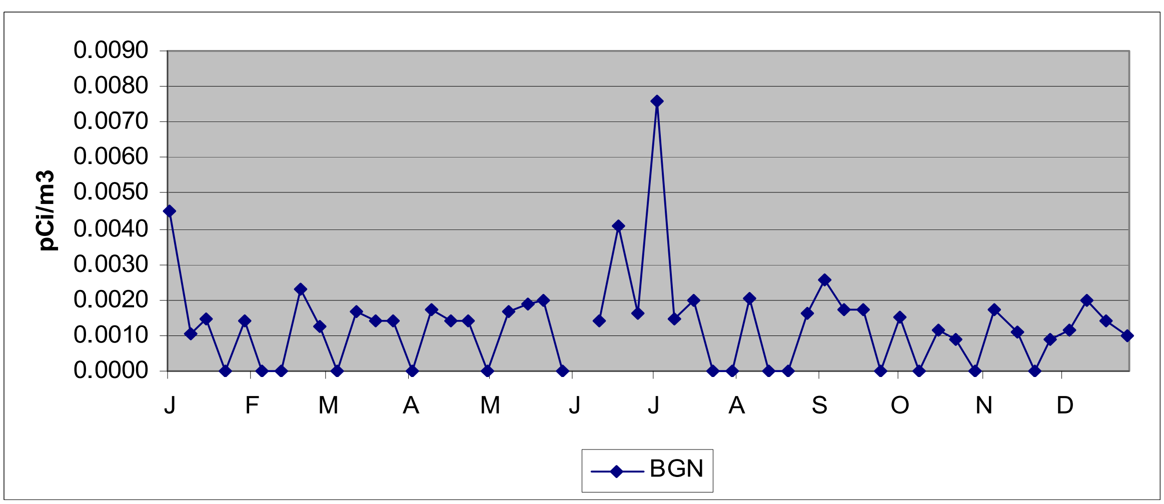


Figure 8. Weekly Gross Alpha in Air (SRS Center Station)



Note: Breaks in data indicate where no sample was available.

Figure 9. Weekly Gross Beta in Air (Perimeter Stations)

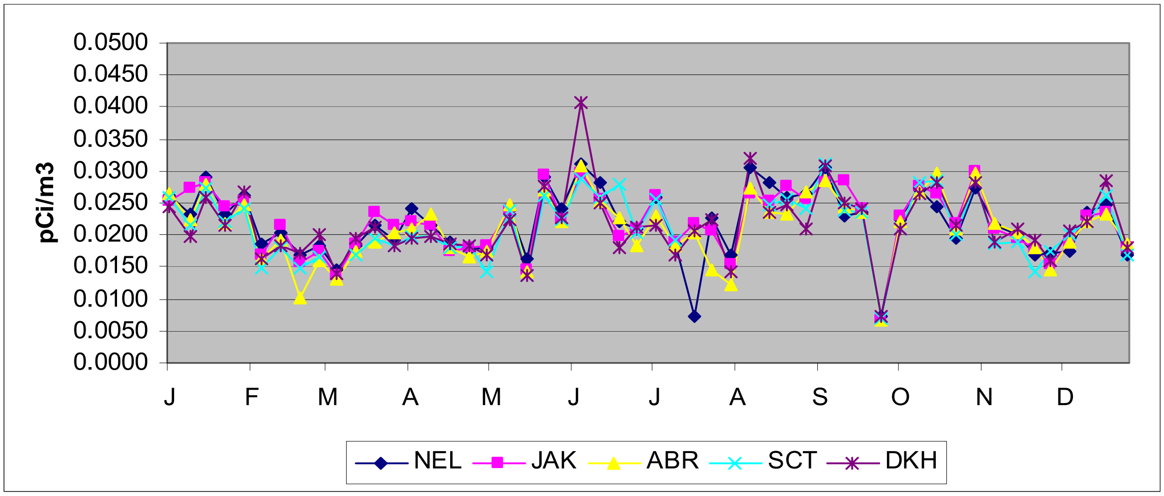


Figure 10. Weekly Gross Beta in Air (Non-Perimeter Stations)

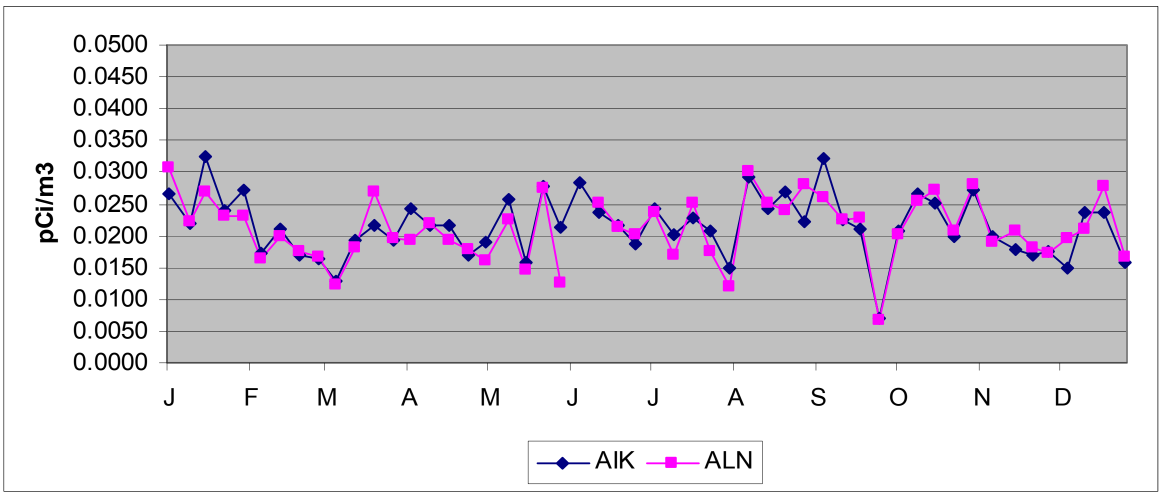
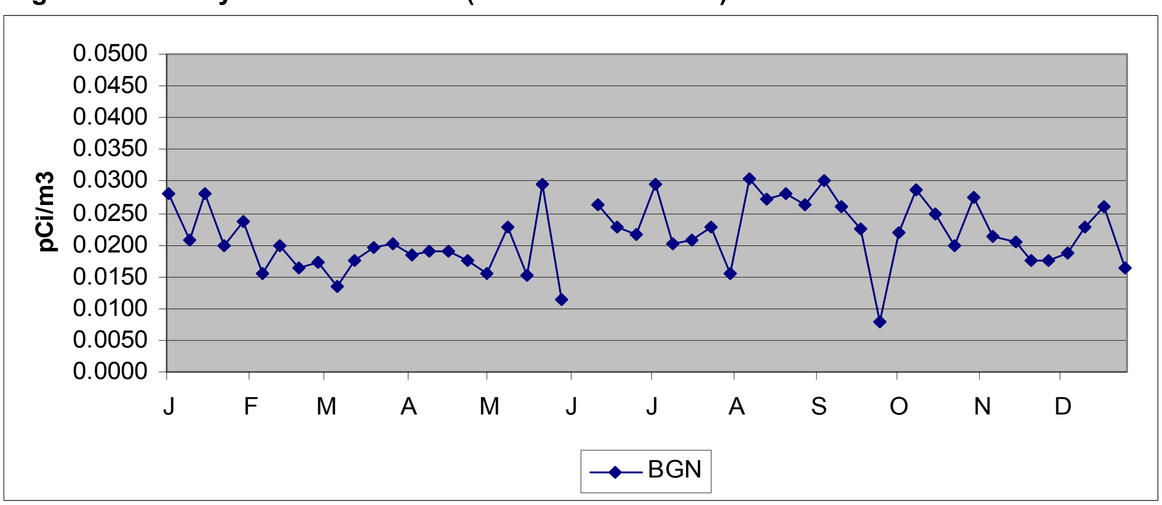


Figure 11. Weekly Gross Beta in Air (SRS Center Station)



Note: Breaks in data indicate where no sample was available.

Figure 12. Tritium in Air (Perimeter Stations)

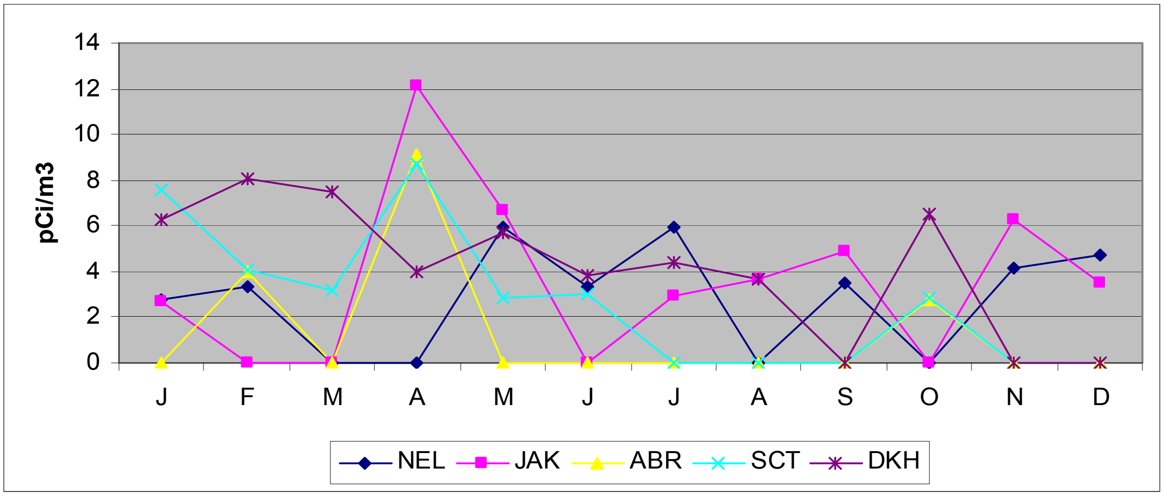


Figure 13. Tritium in Air (Non-Perimeter Stations)

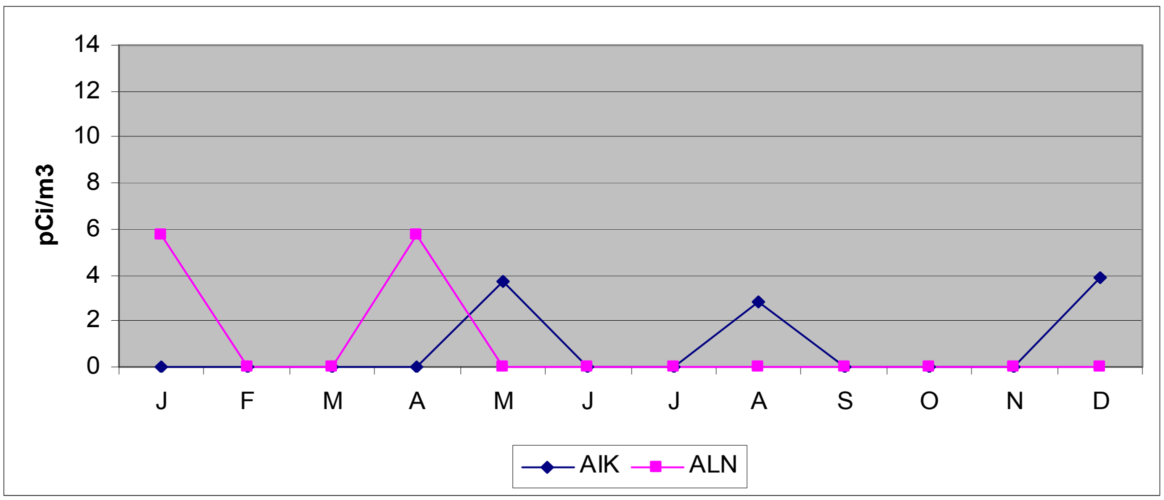
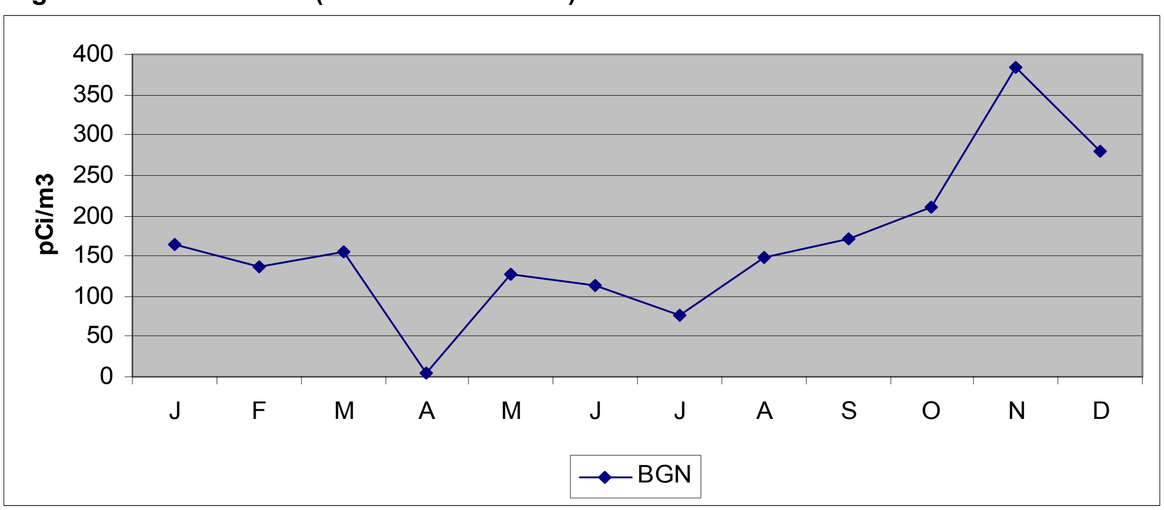


Figure 14. Tritium in Air (SRS Center Station)



Note: Breaks in data indicate where no sample was available.

Figure 15. Tritium in Precipitation (Perimeter Stations)

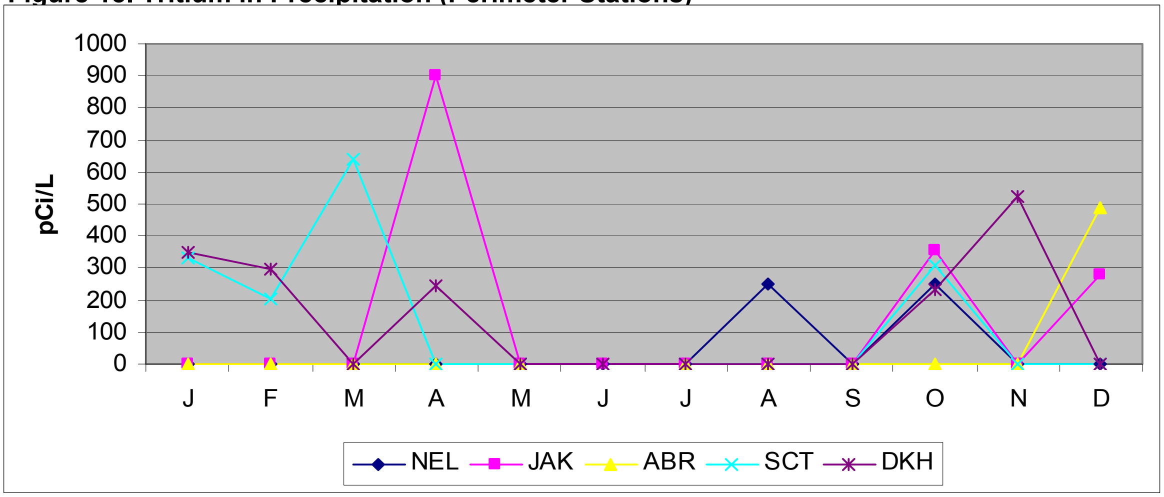


Figure 16. Tritium in Precipitation (Non-Perimeter Stations)

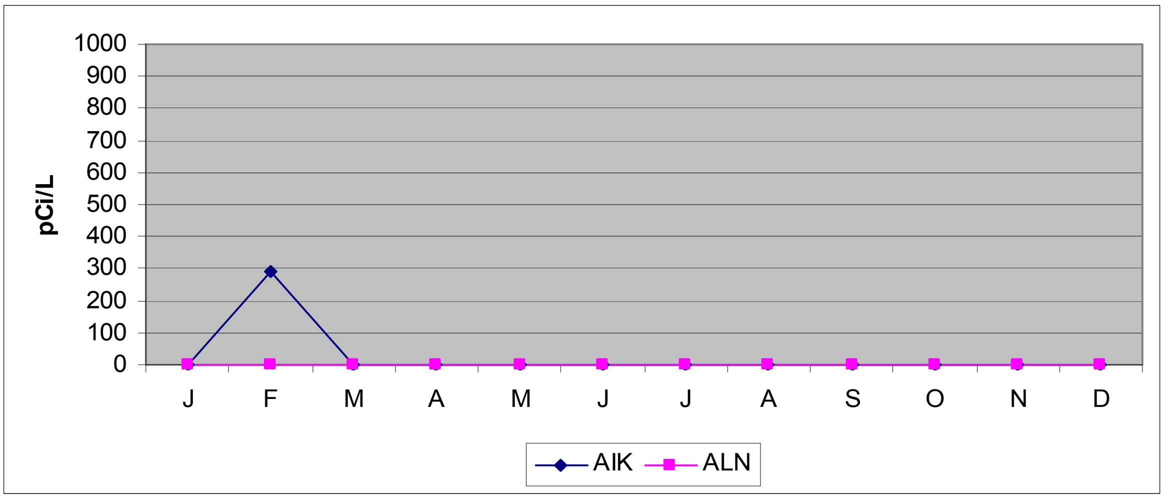
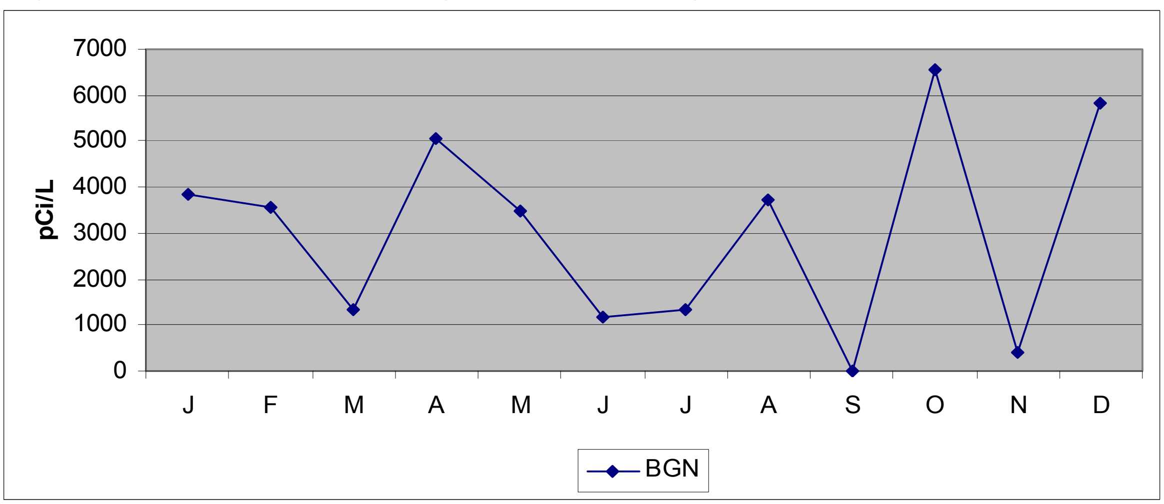


Figure 17. Tritium in Precipitation (SRS Center Station)



Note: Breaks in data indicate where no sample was available.

6.0 DATA
2011 Radiological Atmospheric Monitoring on and Adjacent to SRS

2011 Quarterly TLD Beta/Gamma Data **14**

2011 Air Station Data **15**

Notes:
Blank Spaces -- No Sample Available
NA -- Not Applicable
< -- Less Than LLD
LE – Lab Error
MDA – Minimum Detectable Activity

Quarterly TLD Beta/Gamma Summary 2011

Sample Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
	mrem	mrem	mrem	mrem	mrem
Colocated with AIK Air Station	16	13	13	16	58.00
Colocated with BGN Air Station	37	27	25	31	120.00
Green Pond (P)	22	16	17	21	76.00
Colocated with JAK Air Station (P)	18	14	17	17	66.00
Crackerneck Gate (P)	21	18	18	21	78.00
TNX Boat Ramp (P)	29	20	17	23	89.00
Colocated with ABR Air Station (P)	17	13	12	17	59.00
Junction of Millet Road and Round Tree Road (P)	21	18	17	24	80.00
Patterson Mill Road at Lower Three Runs Creek (P)	23	20	20	25	88.00
Colocated with ALN Air Station	18	15	16	18	67.00
Barnwell Airport	22	16	17	22	77.00
Colocated with SCT Air station (P)	20	18	16	24	78.00
Colocated with DKH Air station (P)	23	17	16	24	80.00
Bates Cemetery (P)	18	15	15	18	66.00
Williston Police Department	25	21	21	23	90.00
Junction of US 278 and SC 781 (P)	23	16	17	19	75.00
US 278 near Upper Three Runs Creek (P)	29	21	22	29	101.00
Colocated with NEL Air Station (P)	22	18	17	21	78.00
Windsor Post Office	20	17	17	21	75.00
Control TLD (Kept in Office)	27	20	19	24	90.00
Lead (Kept in Lead Brick Enclosure)	10	10	10	14	44.00

Note: (P) indicates perimeter TLD

Routine Radiological Atmospheric Monitoring Data

Sample Location:	Aiken Elementary Water Tower (AIK)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/04/11	0.0070	0.0019	0.0265	0.0025				
01/12/11	<0.0011	NA	0.0220	0.0016				
01/18/11	0.0020	0.0012	0.0325	0.0023				
01/25/11	0.0016	0.0009	0.0240	0.0018	<2.55	NA	<221.86	NA
02/01/11	0.0019	0.0010	0.0271	0.0019				
02/08/11	<0.0012	NA	0.0173	0.0016				
02/15/11	0.0014	NA	0.0211	0.0017				
02/22/11	0.0031	0.0010	0.0170	0.0016	<2.50	NA	288.28	89.95
03/01/11	0.0018	0.0010	0.0163	0.0016				
03/08/11	0.0014	0.0009	0.0130	0.0014				
03/15/11	0.0027	0.0010	0.0192	0.0017				
03/22/11	<0.0013	NA	0.0217	0.0017				
03/29/11	0.0018	0.0009	0.0193	0.0017	<2.60	NA	<215.67	NA
04/05/11	0.0015	0.0010	0.0244	0.0019				
04/12/11	<0.0013	NA	0.0217	0.0017				
04/19/11	0.0013	0.0009	0.0215	0.0017				
04/26/11	0.0017	0.0009	0.0169	0.0016	<2.42	NA	<236.70	NA
05/03/11	<0.0014	NA	0.0189	0.0017				
05/11/11	0.0026	0.0009	0.0256	0.0018				
05/18/11	0.0016	0.0009	0.0158	0.0016				
05/24/11	0.0016	0.0010	0.0277	0.0020				
05/31/11	0.0023	0.0009	0.0213	0.0016	3.70	1.20	<222.08	NA
06/07/11	0.0017	0.0010	0.0284	0.0018				
06/14/11	0.0025	0.0011	0.0238	0.0018				
06/21/11	0.0026	0.0011	0.0215	0.0017				
06/28/11	0.0022	0.0009	0.0186	0.0016	<2.48	NA	<208.15	NA
07/05/11	0.0066	0.0013	0.0242	0.0018				
07/12/11	0.0019	0.0007	0.0203	0.0017				
07/19/11	<0.0011	NA	0.0227	0.0017				
07/26/11	<0.0014	NA	0.0207	0.0017	<2.52	NA	<213.82	NA
08/02/11	<0.0012	NA	0.0150	0.0015				
08/09/11	0.0010	0.0006	0.0293	0.0020				
08/16/11	0.0017	0.0011	0.0242	0.0018				
08/23/11	<0.0015	NA	0.0269	0.0019				
08/30/11	0.0014	0.0006	0.0222	0.0017	2.86	1.11	<209.50	NA
09/06/11	0.0025	0.0008	0.0322	0.0020				
09/13/11	0.0020	0.0007	0.0225	0.0017				
09/20/11	<0.0009	NA	0.0211	0.0017				
09/27/11	<0.0008	NA	0.0069	0.0011	<2.42	NA	LE	NA
10/04/11	0.0010	0.0006	0.0209	0.0017				
10/11/11	0.0021	0.0009	0.0265	0.0019				
10/18/11	0.0013	0.0006	0.0251	0.0018				
10/25/11	<0.0007	NA	0.0199	0.0016	<2.55	NA	<206.17	NA
11/01/11	0.0009	0.0006	0.0271	0.0019				
11/08/11	0.0023	0.0008	0.0200	0.0016				
11/17/11	0.0017	0.0006	0.0178	0.0014				
11/23/11	<0.0013	NA	0.0171	0.0017				
11/29/11	0.0010	0.0006	0.0174	0.0017	<2.56	NA	<211.18	NA
12/06/11	0.0008	0.0005	0.0149	0.0015				
12/13/11	0.0024	0.0008	0.0236	0.0018				
12/20/11	0.0014	0.0006	0.0238	0.0018				
12/28/11	0.0007	0.0005	0.0159	0.0014	3.90	1.19	<206.82	NA

Note: Breaks in data indicate where no sample was available.

Routine Radiological Atmospheric Monitoring Data

Sample Location: New Ellenton, SC (NEL)

Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/04/11	0.0039	0.0015	0.0263	0.0022				
01/12/11	<0.0009	NA	0.0232	0.0015				
01/18/11	0.0021	0.0011	0.0292	0.0020				
01/25/11	0.0018	0.0009	0.0232	0.0017	2.78	1.20	<221.86	NA
02/01/11	0.0018	0.0009	0.0262	0.0018				
02/08/11	0.0014	0.0009	0.0186	0.0017				
02/15/11	0.0016	0.0010	0.0204	0.0017				
02/22/11	0.0025	0.0010	0.0168	0.0017	3.34	1.18	<181.97	NA
03/01/11	0.0019	0.0010	0.0184	0.0017				
03/08/11	<0.0013	NA	0.0146	0.0015				
03/15/11	0.0014	0.0009	0.0183	0.0016				
03/22/11	<0.0013	NA	0.0214	0.0017				
03/29/11	0.0017	0.0009	0.0192	0.0017	<2.60	NA	<215.67	NA
04/05/11	0.0015	0.0010	0.0242	0.0019				
04/12/11	0.0022	0.0010	0.0214	0.0018				
04/19/11	0.0016	0.0010	0.0190	0.0017				
04/26/11	0.0017	0.0010	0.0177	0.0016	<2.42	NA	<236.70	NA
05/03/11	0.0015	0.0010	0.0179	0.0017				
05/11/11	0.0022	0.0009	0.0239	0.0017				
05/18/11	0.0023	0.0010	0.0162	0.0016				
05/24/11	0.0034	0.0012	0.0292	0.0021				
05/31/11	0.0022	0.0009	0.0242	0.0018	5.96	1.28	<222.08	NA
06/07/11	0.0020	0.0011	0.0312	0.0020				
06/14/11	0.0020	0.0011	0.0281	0.0019				
06/21/11	0.0022	0.0010	0.0222	0.0017				
06/28/11	0.0023	0.0009	0.0208	0.0017	3.34	1.17	<208.15	NA
07/05/11	0.0042	0.0011	0.0260	0.0018				
07/12/11	0.0019	0.0007	0.0187	0.0016				
07/19/11	<0.0010	NA	0.0074	0.0011				
07/26/11	<0.0014	NA	0.0228	0.0018	5.98	1.30	<213.82	NA
08/02/11	<0.0012	NA	0.0169	0.0015				
08/09/11	0.0015	0.0007	0.0306	0.0020				
08/16/11	<0.0015	NA	0.0281	0.0019				
08/23/11	<0.0015	NA	0.0258	0.0018				
08/30/11	0.0013	0.0006	0.0264	0.0019	<2.35	NA	249.38	97.94
09/06/11	0.0022	0.0008	0.0304	0.0020				
09/13/11	0.0017	0.0007	0.0229	0.0017				
09/20/11	0.0013	0.0007	0.0235	0.0018				
09/27/11	<0.0009	NA	0.0072	0.0012	3.49	1.16	LE	NA
10/04/11	<0.0008	NA	0.0224	0.0017				
10/11/11	0.0015	0.0008	0.0271	0.0019				
10/18/11	0.0015	0.0007	0.0243	0.0018				
10/25/11	0.0009	0.0006	0.0195	0.0016	<2.55	NA	248.80	96.60
11/01/11	0.0014	0.0007	0.0273	0.0019				
11/08/11	0.0010	0.0006	0.0215	0.0017				
11/17/11	0.0014	0.0006	0.0202	0.0015				
11/23/11	<0.0013	NA	0.0168	0.0018				
11/29/11	0.0011	0.0006	0.0171	0.0017	4.15	1.23	<211.18	NA
12/06/11	0.0007	0.0005	0.0173	0.0015				
12/13/11	0.0019	0.0007	0.0235	0.0018				
12/20/11	0.0016	0.0007	0.0247	0.0018				
12/28/11	0.0008	0.0005	0.0170	0.0014	4.74	106.18	<206.82	NA

Note: Breaks in data indicate where no sample was available.

Routine Radiological Atmospheric Monitoring Data

Sample Location:	Jackson, SC (JAK)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/04/11	0.0052	0.0017	0.0253	0.0023				
01/12/11	0.0019	0.0012	0.0273	0.0022				
01/18/11	<0.0014	NA	0.0281	0.0020				
01/25/11	0.0016	0.0009	0.0245	0.0018	2.71	1.17	<221.86	NA
02/01/11	0.0017	0.0009	0.0254	0.0018				
02/08/11	<0.0012	NA	0.0168	0.0016				
02/15/11	<0.0014	NA	0.0215	0.0017				
02/22/11	0.0024	0.0009	0.0157	0.0016	<2.50	NA	<181.97	NA
03/01/11	0.0014	0.0009	0.0175	0.0017				
03/08/11	<0.0014	NA	0.0138	0.0015				
03/15/11	0.0018	0.0010	0.0185	0.0017				
03/22/11	0.0013	0.0010	0.0235	0.0018				
03/29/11	0.0019	0.0010	0.0214	0.0018	<2.60	NA	<215.67	NA
04/05/11	0.0014	0.0010	0.0220	0.0018				
04/12/11	<0.0013	NA	0.0214	0.0017				
04/19/11	<0.0013	NA	0.0173	0.0016				
04/26/11	0.0018	0.0010	0.0180	0.0016	12.10	1.45	899.23	130.94
05/03/11	<0.0015	NA	0.0184	0.0018				
05/11/11	0.0020	0.0009	0.0238	0.0017				
05/18/11	0.0014	0.0009	0.0146	0.0016				
05/24/11	0.0024	0.0012	0.0293	0.0023				
05/31/11	0.0027	0.0009	0.0224	0.0016	6.68	1.30	<222.08	NA
06/07/11	0.0020	0.0010	0.0297	0.0018				
06/14/11	0.0025	0.0011	0.0255	0.0019				
06/21/11	0.0035	0.0011	0.0198	0.0016				
06/28/11	0.0014	0.0008	0.0210	0.0017	<2.48	NA	<208.15	NA
07/05/11	0.0081	0.0014	0.0263	0.0019				
07/12/11	0.0012	0.0006	0.0188	0.0016				
07/19/11	0.0011	0.0008	0.0217	0.0017				
07/26/11	0.0014	0.0010	0.0205	0.0017	2.91	1.18	<213.82	NA
08/02/11	0.0016	0.0009	0.0153	0.0015				
08/09/11	0.0016	0.0007	0.0264	0.0019				
08/16/11	<0.0015	NA	0.0253	0.0018				
08/23/11	<0.0015	NA	0.0275	0.0019				
08/30/11	0.0022	0.0008	0.0257	0.0019	3.63	1.13	<209.50	NA
09/06/11	0.0020	0.0007	0.0283	0.0019				
09/13/11	0.0016	0.0007	0.0284	0.0019				
09/20/11	0.0013	0.0007	0.0240	0.0018				
09/27/11	<0.0009	NA	0.0067	0.0011	4.89	1.21	LE	NA
10/04/11	<0.0008	NA	0.0231	0.0018				
10/11/11	0.0012	0.0007	0.0276	0.0019				
10/18/11	0.0013	0.0006	0.0264	0.0018				
10/25/11	0.0009	0.0006	0.0217	0.0017	<2.55	NA	356.85	100.74
11/01/11	0.0010	0.0007	0.0298	0.0020				
11/08/11	0.0024	0.0008	0.0209	0.0017				
11/17/11	0.0014	0.0006	0.0196	0.0015				
11/23/11	<0.0013	NA	0.0177	0.0018				
11/29/11	0.0010	0.0006	0.0155	0.0017	6.26	1.32	<211.18	NA
12/06/11	0.0013	0.0006	0.0185	0.0016				
12/13/11	0.0017	0.0007	0.0229	0.0017				
12/20/11	0.0015	0.0007	0.0235	0.0018				
12/28/11	<0.0006	NA	0.0179	0.0015	3.52	1.18	277.27	97.71

Note: Breaks in data indicate where no sample was available.

Routine Radiological Atmospheric Monitoring Data

Sample Location:	Burial Grounds North (BGN)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/04/11	0.0045	0.0016	0.0281	0.0023				
01/12/11	0.0011	0.0007	0.0208	0.0148				
01/18/11	0.0015	0.0010	0.0281	0.0019				
01/25/11	<0.0010	NA	0.0199	0.0015	163.70	3.89	3850.15	194.38
02/01/11	0.0014	0.0009	0.0236	0.0017				
02/08/11	<0.0013	NA	0.0154	0.0017				
02/15/11	<0.0014	NA	0.0200	0.0017				
02/22/11	0.0023	0.0009	0.0163	0.0016	137.49	3.58	3579.63	184.02
03/01/11	0.0012	0.0009	0.0173	0.0016				
03/08/11	<0.0013	NA	0.0135	0.0014				
03/15/11	0.0017	0.0009	0.0174	0.0016				
03/22/11	0.0014	0.0009	0.0196	0.0017				
03/29/11	0.0014	0.0009	0.0202	0.0017	155.72	3.88	1337.79	134.01
04/05/11	<0.0013	NA	0.0184	0.0017				
04/12/11	0.0017	0.0010	0.0190	0.0017				
04/19/11	0.0014	0.0009	0.0191	0.0017				
04/26/11	0.0014	0.0009	0.0176	0.0016	5.39	1.23	5046.97	225.72
05/03/11	<0.0014	NA	0.0155	0.0016				
05/11/11	0.0017	0.0008	0.0229	0.0017				
05/18/11	0.0019	0.0010	0.0151	0.0016				
05/24/11	0.0020	0.0012	0.0296	0.0022				
05/31/11	<0.0012	NA	0.0115	0.0015	127.51	3.50	3473.50	187.94
06/07/11								
06/14/11	0.0014	0.0010	0.0264	0.0018				
06/21/11	0.0041	0.0011	0.0227	0.0017				
06/28/11	0.0016	0.0009	0.0217	0.0017	112.90	3.26	1186.78	127.98
07/05/11	0.0076	0.0014	0.0296	0.0020				
07/12/11	0.0015	0.0007	0.0202	0.0017				
07/19/11	0.0020	0.0009	0.0207	0.0017				
07/26/11	<0.0015	NA	0.0229	0.0018	75.58	2.76	1328.66	133.30
08/02/11	<0.0013	NA	0.0156	0.0016				
08/09/11	0.0020	0.0008	0.0305	0.0020				
08/16/11	<0.0016	NA	0.0272	0.0019				
08/23/11	<0.0016	NA	0.0280	0.0020				
08/30/11	0.0016	0.0007	0.0263	0.0019	147.79	3.67	3704.17	185.92
09/06/11	0.0026	0.0009	0.0302	0.0020				
09/13/11	0.0017	0.0007	0.0260	0.0018				
09/20/11	0.0018	0.0008	0.0226	0.0018				
09/27/11	<0.0009	NA	0.0079	0.0012	169.95	3.99	LE	NA
10/04/11	0.0015	0.0007	0.0220	0.0018				
10/11/11	<0.0011	NA	0.0286	0.0020				
10/18/11	0.0012	0.0006	0.0250	0.0018				
10/25/11	0.0009	0.0006	0.0200	0.0017	210.74	4.38	6553.74	237.12
11/01/11	<0.0009	NA	0.0274	0.0019				
11/08/11	0.0017	0.0007	0.0213	0.0017				
11/17/11	0.0011	0.0005	0.0206	0.0015				
11/23/11	<0.0013	NA	0.0174	0.0017				
11/29/11	0.0009	0.0005	0.0176	0.0018	383.20	5.97	405.97	104.06
12/06/11	0.0012	0.0006	0.0187	0.0016				
12/13/11	0.0020	0.0007	0.0228	0.0017				
12/20/11	0.0014	0.0007	0.0260	0.0019				
12/28/11	0.0010	0.0005	0.0163	0.0014	279.57	4.98	5834.55	223.85

Note: Breaks in data indicate where no sample was available.

Routine Radiological Atmospheric Monitoring Data

Sample Location:	Allendale Barricade (ABR)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/04/11	0.0024	0.0014	0.0264	0.0023				
01/12/11	0.0016	0.0008	0.0225	0.0016				
01/18/11	<0.0015	NA	0.0280	0.0020				
01/25/11	<0.0010	NA	0.0218	0.0016	<2.55	NA	<221.86	NA
02/01/11	0.0018	0.0009	0.0246	0.0018				
02/08/11	<0.0011	NA	0.0163	0.0153				
02/15/11	<0.0014	NA	0.0192	0.0016				
02/22/11	0.0019	0.0008	0.0103	0.0013	3.96	1.18	<181.97	NA
03/01/11	0.0014	0.0009	0.0160	0.0016				
03/08/11	0.0014	0.0009	0.0130	0.0014				
03/15/11	<0.0012	NA	0.0173	0.0016				
03/22/11	<0.0012	NA	0.0189	0.0016				
03/29/11	<0.0012	NA	0.0203	0.0017	<2.60	NA	<215.67	NA
04/05/11	<0.0013	NA	0.0209	0.0018				
04/12/11	0.0013	0.0010	0.0233	0.0018				
04/19/11	0.0016	0.0010	0.0180	0.0016				
04/26/11	0.0013	0.0009	0.0165	0.0016	9.16	1.35	<236.70	NA
05/03/11	<0.0015	NA	0.0174	0.0017				
05/11/11	0.0020	0.0009	0.0248	0.0018				
05/18/11	<0.0013	NA	0.0141	0.0015				
05/24/11	0.0017	0.0012	0.0271	0.0022				
05/31/11	0.0024	0.0010	0.0222	0.0017	<2.50	NA	<222.08	NA
06/07/11	0.0017	0.0010	0.0308	0.0020				
06/14/11	<0.0014	NA	0.0254	0.0018				
06/21/11	0.0015	0.0010	0.0228	0.0018				
06/28/11	0.0022	0.0009	0.0183	0.0016	<2.47	NA		
07/05/11	0.0056	0.0012	0.0230	0.0018				
07/12/11	0.0015	0.0007	0.0184	0.0016				
07/19/11	0.0020	0.0009	0.0204	0.0017				
07/26/11	<0.001	NA	0.0144	0.0012	<2.52	NA	<213.82	NA
08/02/11	0.0014	0.0009	0.0121	0.0014				
08/09/11	0.0009	0.0006	0.0274	0.0019				
08/16/11	0.0017	0.0012	0.0235	0.0019				
08/23/11	<0.0016	NA	0.0234	0.0018				
08/30/11	0.0021	0.0008	0.0267	0.0019	<2.35	NA	<209.50	NA
09/06/11	0.0023	0.0008	0.0285	0.0019				
09/13/11	0.0008	0.0006	0.0243	0.0018				
09/20/11	0.0010	0.0007	0.0235	0.0018				
09/27/11	<0.0009	NA	0.0068	0.0011	<2.42	NA	LE	NA
10/04/11	<0.0008	NA	0.0221	0.0017				
10/11/11	<0.0010	NA	0.0268	0.0019				
10/18/11	0.0017	0.0007	0.0296	0.0020				
10/25/11	0.0008	0.0006	0.0210	0.0017	2.81	1.18	<206.17	NA
11/01/11	0.0013	0.0007	0.0297	0.0020				
11/08/11	0.0024	0.0008	0.0218	0.0017				
11/17/11	0.0014	0.0006	0.0204	0.0015				
11/23/11	<0.0013	NA	0.0179	0.0018				
11/29/11	0.0006	0.0005	0.0145	0.0016	<2.56	NA	<211.18	NA
12/06/11	0.0008	0.0005	0.0189	0.0016				
12/13/11	0.0015	0.0006	0.0221	0.0017				
12/20/11	0.0016	0.0007	0.0232	0.0017				
12/28/11	0.0006	0.0005	0.0187	0.0015	<2.47	NA	487.28	105.15

Note: Breaks in data indicate where no sample was available.

Routine Radiological Atmospheric Monitoring Data

Sample Location: Allendale, SC (ALN)								
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/04/11	0.0076	0.0018	0.0307	0.0024				
01/12/11	0.0011	0.0008	0.0223	0.0015				
01/18/11	0.0022	0.0011	0.0270	0.0020				
01/25/11	0.0026	0.0010	0.0230	0.0017	5.78	1.27	<221.86	NA
02/01/11	0.0026	0.0010	0.0230	0.0017				
02/08/11	<0.0012	NA	0.0163	0.0016				
02/15/11	<0.0014	NA	0.0198	0.0016				
02/22/11	0.0016	0.0008	0.0174	0.0016	<2.50	NA	<181.97	NA
03/01/11	0.0014	0.0009	0.0166	0.0016				
03/08/11	<0.0013	NA	0.0124	0.0014				
03/15/11	0.0013	0.0009	0.0180	0.0016				
03/22/11	0.0023	0.0011	0.0268	0.0019				
03/29/11	0.0017	0.0009	0.0196	0.0017	<3.06	NA	<215.67	NA
04/05/11	<0.0013	NA	0.0194	0.0017				
04/12/11	0.0019	0.0010	0.0218	0.0018				
04/19/11	0.0020	0.0010	0.0193	0.0017				
04/26/11	0.0014	0.0009	0.0177	0.0017	5.77	1.23	<236.70	NA
05/03/11	0.0017	0.0011	0.0161	0.0017				
05/11/11	0.0026	0.0009	0.0224	0.0017				
05/18/11	0.0016	0.0010	0.0145	0.0016				
05/24/11	0.0022	0.0012	0.0275	0.0022				
05/31/11	<0.0012	NA	0.0125	0.0015	<2.50	NA	<222.08	NA
06/07/11								
06/14/11	0.0018	0.0010	0.0252	0.0018				
06/21/11	0.0023	0.0010	0.0213	0.0017				
06/28/11	0.0030	0.0010	0.0203	0.0017	<2.47	NA	<208.15	NA
07/05/11	0.0060	0.0013	0.0238	0.0018				
07/12/11	0.0013	0.0006	0.0171	0.0016				
07/19/11	0.0021	0.0010	0.0252	0.0019				
07/26/11	0.0015	0.0010	0.0176	0.0016	<2.52	NA	<213.82	NA
08/02/11	<0.0013	NA	0.0119	0.0014				
08/09/11	0.0009	0.0006	0.0301	0.0020				
08/16/11	0.0019	0.0012	0.0252	0.0019				
08/23/11	<0.0016	NA	0.0239	0.0019				
08/30/11	0.0015	0.0007	0.0281	0.0020	<2.35	NA	<209.50	NA
09/06/11	0.0018	0.0007	0.0260	0.0018				
09/13/11	0.0017	0.0007	0.0226	0.0017				
09/20/11	<0.0009	NA	0.0229	0.0018				
09/27/11	<0.0009	NA	0.0066	0.0011	<2.42	NA	LE	NA
10/04/11	<0.0009	NA	0.0203	0.0017				
10/11/11	0.0011	0.0008	0.0254	0.0019				
10/18/11	0.0019	0.0007	0.0273	0.0019				
10/25/11	0.0010	0.0006	0.0208	0.0017	<2.55	NA	<206.17	NA
11/01/11	0.0013	0.0007	0.0280	0.0019				
11/08/11	0.0009	0.0005	0.0191	0.0016				
11/17/11	0.0021	0.0007	0.0209	0.0015				
11/23/11	<0.0013	NA	0.0180	0.0018				
11/29/11	0.0007	0.0005	0.0172	0.0017	<2.56	NA	<211.18	NA
12/06/11	0.0009	0.0005	0.0197	0.0017				
12/13/11	0.0014	0.0006	0.0210	0.0017				
12/20/11	0.0016	0.0007	0.0277	0.0019				
12/28/11	<0.0006	NA	0.0167	0.0014	<2.47	NA	<206.82	NA

Note: Breaks in data indicate where no sample was available.

Routine Radiological Atmospheric Monitoring Data

Sample Location:	Snelling, SC South Carolina Advanced Technology Park (SCT)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/04/11	0.0048	0.0016	0.0260	0.0022				
01/12/11	<0.0010	NA	0.0215	0.0015				
01/18/11	<0.0015	NA	0.0272	0.0020				
01/25/11	0.0020	0.0009	0.0222	0.0017	7.55	1.32	330.88	105.73
02/01/11	0.0023	0.0010	0.0240	0.0017				
02/08/11	0.0016	0.0009	0.0147	0.0015				
02/15/11	<0.0013	NA	0.0180	0.0016				
02/22/11	0.0015	0.0008	0.0149	0.0015	4.09	1.18	203.98	86.24
03/01/11	0.0021	0.0010	0.0167	0.0016				
03/08/11								
03/15/11	0.0014	0.0009	0.0169	0.0016				
03/22/11	0.0019	0.0010	0.0195	0.0017				
03/29/11	<0.0012	NA	0.0183	0.0017	3.18	1.22	640.16	114.80
04/05/11	<0.0013	NA	0.0198	0.0017				
04/12/11	<0.0013	NA	0.0199	0.0017				
04/19/11	<0.0013	NA	0.0180	0.0016				
04/26/11	<0.0013	NA	0.0182	0.0017	8.68	1.32	<236.70	NA
05/03/11	<0.0015	NA	0.0141	0.0016				
05/11/11	0.0020	0.0009	0.0239	0.0017				
05/18/11	0.0014	0.0009	0.0138	0.0015				
05/24/11	<0.0016	NA	0.0261	0.0022				
05/31/11	0.0017	0.0009	0.0223	0.0017	2.82	1.15	<222.08	NA
06/07/11	0.0016	0.0010	0.0289	0.0019				
06/14/11	<0.0015	NA	0.0259	0.0018				
06/21/11	<0.0058	NA	0.0280	0.0052				
06/28/11	0.0019	0.0010	0.0203	0.0019	3.03	1.16		
07/05/11	0.0079	0.0015	0.0255	0.0020				
07/12/11	0.0018	0.0007	0.0192	0.0018				
07/19/11								
07/26/11					<2.52	NA	<213.82	NA
08/02/11								
08/09/11								
08/16/11	<0.0014	NA	0.0247	0.0017				
08/23/11	<0.0014	NA	0.0257	0.0018				
08/30/11	0.0017	0.0007	0.0241	0.0018	<2.35	NA	<209.50	NA
09/06/11	0.0024	0.0008	0.0310	0.0020				
09/13/11	0.0017	0.0007	0.0238	0.0018				
09/20/11	<0.0009	NA	0.0236	0.0018				
09/27/11	<0.0009	NA	0.0070	0.0011	<2.42	NA	LE	NA
10/04/11	<0.0009	NA	0.0208	0.0017				
10/11/11	0.0014	0.0008	0.0281	0.0020				
10/18/11	0.0014	0.0007	0.0284	0.0019				
10/25/11	<0.0008	NA	0.0201	0.0017	2.87	1.19	305.66	99.05
11/01/11	<0.0009	NA	0.0283	0.0020				
11/08/11	0.0013	0.0006	0.0186	0.0016				
11/17/11	0.0013	0.0005	0.0188	0.0014				
11/23/11	<0.0013	NA	0.0143	0.0016				
11/29/11	0.0007	0.0005	0.0175	0.0018	<2.56	NA	<211.18	NA
12/06/11	0.0008	0.0005	0.0200	0.0017				
12/13/11	0.0017	0.0007	0.0221	0.0017				
12/20/11	0.0011	0.0006	0.0261	0.0019				
12/28/11	0.0008	0.0005	0.0170	0.0014	<2.47	NA	<206.82	NA

Note: Breaks in data indicate where no sample was available.

Routine Radiological Atmospheric Monitoring Data

Sample Location:	Williston Barricade (DKH)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/04/11	0.0040	0.0015	0.0245	0.0022				
01/12/11	<0.0010	NA	0.0199	0.0015				
01/18/11	0.0024	0.0011	0.0259	0.0019				
01/25/11	0.0015	0.0008	0.0214	0.0016	6.28	1.28	349.28	106.55
02/01/11	0.0031	0.0011	0.0266	0.0019				
02/08/11	<0.0011	NA	0.0162	0.0015				
02/15/11	<0.0014	NA	0.0182	0.0016				
02/22/11	0.0017	0.0009	0.0171	0.0017	8.03	1.31	296.20	90.38
03/01/11	0.0020	0.0010	0.0200	0.0017				
03/08/11	<0.0013	NA	0.0139	0.0014				
03/15/11	0.0017	0.0009	0.0194	0.0017				
03/22/11	<0.0013	NA	0.0213	0.0017				
03/29/11	0.0014	0.0009	0.0183	0.0017	7.47	1.37	<215.67	NA
04/05/11	<0.0013	NA	0.0194	0.0017				
04/12/11	0.0017	0.0010	0.0199	0.0017				
04/19/11	<0.0013	NA	0.0185	0.0017				
04/26/11	0.0015	0.0010	0.0182	0.0017	3.99	1.17	246.82	114.82
05/03/11	0.0017	0.0011	0.0170	0.0017				
05/11/11	0.0028	0.0009	0.0223	0.0017				
05/18/11	<0.0013	NA	0.0137	0.0015				
05/24/11	<0.0016	NA	0.0277	0.0022				
05/31/11	0.0013	0.0009	0.0227	0.0018	5.67	1.27	<222.08	NA
06/07/11	0.0029	0.0014	0.0408	0.0026				
06/14/11	0.0015	0.0009	0.0251	0.0017				
06/21/11	0.0022	0.0010	0.0181	0.0016				
06/28/11	0.0015	0.0009	0.0213	0.0017	3.81	1.19	<208.15	NA
07/05/11	0.0038	0.0011	0.0216	0.0018				
07/12/11	0.0018	0.0007	0.0168	0.0016				
07/19/11	0.0015	0.0009	0.0206	0.0017				
07/26/11	<0.0014	NA	0.0225	0.0018	4.36	1.22	<213.82	NA
08/02/11	<0.0013	NA	0.0141	0.0015				
08/09/11	0.0012	0.0006	0.0320	0.0021				
08/16/11	<0.0015	NA	0.0235	0.0018				
08/23/11	<0.0016	NA	0.0246	0.0018				
08/30/11	0.0012	0.0005	0.0209	0.0015	3.65	0.75	<209.50	NA
09/06/11	0.0024	0.0008	0.0307	0.0020				
09/13/11	0.0014	0.0007	0.0251	0.0018				
09/20/11	<0.0009	NA	0.0241	0.0018				
09/27/11	<0.0009	NA	0.0072	0.0012	<2.42	NA	LE	NA
10/04/11	<0.0009	NA	0.0210	0.0017				
10/11/11	0.0012	0.0008	0.0265	0.0019				
10/18/11	0.0013	0.0006	0.0282	0.0019				
10/25/11	0.0010	0.0006	0.0216	0.0017	6.48	1.30	231.17	95.90
11/01/11	<0.0008	NA	0.0282	0.0019				
11/08/11	0.0012	0.0006	0.0188	0.0016				
11/17/11	0.0014	0.0006	0.0210	0.0015				
11/23/11	<0.0013	NA	0.0191	0.0018				
11/29/11	0.0005	0.0004	0.0160	0.0017	<2.56	NA	523.34	108.51
12/06/11	0.0010	0.0005	0.0206	0.0017				
12/13/11	0.0016	0.0006	0.0220	0.0017				
12/20/11	0.0020	0.0008	0.0285	0.0019				
12/28/11	0.0010	0.0005	0.0179	0.0015	<2.47	NA	<206.82	NA

Note: Breaks in data indicate where no sample was available.

RADIOCHEMICAL PATICULATE DATA

Sample Location: **Aiken (AIK)**

Sample Batch:		1st Quarter 2011	+/- 2 sigma	MDA
Radionuclides pCi/m3	Pu-238	<MDA	NA	1.17E-05
	Pu-239/240	<MDA	NA	1.17E-05

Sample Location: **New Ellenton (NEL)**

Sample Batch:		1st Quarter 2011	+/- 2 sigma	MDA
Radionuclides pCi/m3	Pu-238	<MDA	NA	6.74E-06
	Pu-239/240	<MDA	NA	6.74E-06

Sample Location: **Jackson (JAK)**

Sample Batch:		1st Quarter 2011	+/- 2 sigma	MDA
Radionuclides pCi/m3	Pu-238	<MDA	NA	1.17E-05
	Pu-239/240	<MDA	NA	5.81E-06

Sample Location: **Burial Grounds North (BGN)**

Sample Batch:		1st Quarter 2011	+/- 2 sigma	MDA
Radionuclides pCi/m3	Pu-238	<MDA	NA	1.45E-05
	Pu-239/240	<MDA	NA	1.61E-05

Sample Location: **Allendale Barricade (ABR)**

Sample Batch:		1st Quarter 2011	+/- 2 sigma	MDA
Radionuclides pCi/m3	Pu-238	<MDA	NA	1.46E-05
	Pu-239/240	<MDA	NA	1.07E-05

Sample Location: **Allendale (ALN)**

Sample Batch:		1st Quarter 2011	+/- 2 sigma	MDA
Radionuclides pCi/m3	Pu-238	<MDA	NA	6.60E-06
	Pu-239/240	<MDA	NA	1.14E-05

Sample Location: **Snelling (SCT)**

Sample Batch:		1st Quarter 2011	+/- 2 sigma	MDA
Radionuclides pCi/m3	Pu-238	1.38E-05	1.19E-05	1.08E-05
	Pu-239/240	<MDA	NA	1.53E-05

Sample Location: **Williston Barricade (DKH)**

Sample Batch:		1st Quarter 2011	+/- 2 sigma	MDA
Radionuclides pCi/m3	Pu-238	<MDA	NA	1.64E-05
	Pu-239/240	<MDA	NA	1.27E-05

SUMMARY STATISTICS

2011 Statistical Review of Ambient TLD Beta/Gamma Data Summary 25

2011 Summary Statistics 26

Note:
Avg—Average
Std Dev—Standard Deviation
Min—Minimum
Max—Maximum
N—Number of Samples
( )—Number of Detections

Yearly Average of Ambient TLD Beta/Gamma Summary Statistics 2011

Sample Location	Quarterly Avg	Std Dev	Min	Max	Median
	mrem	mrem	mrem	mrem	mrem
Colocated with AIK Air Station	14.50	1.73	13.00	16.00	14.50
Colocated with BGN Air Station	30.00	5.29	25.00	37.00	29.00
Green Pond (P)	19.00	2.94	16.00	22.00	19.00
Colocated with JAK Air Station (P)	16.50	1.73	14.00	18.00	17.00
Crackerneck Gate (P)	19.50	1.73	18.00	21.00	19.50
TNX Boat Ramp (P)	22.25	5.12	17.00	29.00	21.50
Colocated with ABR Air Station (P)	14.75	2.63	12.00	17.00	15.00
Junction of Millet Road and Round Tree Road (P)	20.00	3.16	17.00	24.00	19.50
Patterson Mill Road at Lower Three Runs Creek (P)	22.00	2.45	20.00	25.00	21.50
Colocated with ALN Air Station	16.75	1.50	15.00	18.00	17.00
Barnwell Airport	19.25	3.20	16.00	22.00	19.50
Colocated with SCT Air station (P)	19.50	3.42	16.00	24.00	19.00
Colocated with DKH Air station (P)	20.00	4.08	16.00	24.00	20.00
Bates Cemetery (P)	16.50	1.73	15.00	18.00	16.50
Williston Police Department	22.50	1.91	21.00	25.00	22.00
Junction of US 278 and SC 781 (P)	18.75	3.10	16.00	23.00	18.00
US 278 near Upper Three Runs Creek (P)	25.25	4.35	21.00	29.00	25.50
Colocated with NEL Air Station (P)	19.50	2.38	17.00	22.00	19.50
Windsor Post Office	18.75	2.06	17.00	21.00	18.50
Control TLD (Kept in Office)	22.50	3.70	19.00	27.00	22.00
Lead (Kept in Lead Brick Enclosure)	11.00	2.00	10.00	14.00	10.00

Note: (P) indicates perimeter TLD

Summary Statistics

Statistical Review Of Radiological Monitoring at Aiken Elementary Water Tower (AIK)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m^3	pCi/m^3	pCi/m^3	pCi/L
N	52 (39)	52 (52)	12 (3)	12 (1)
Mean	0.0020	0.0216	3.49	One detect of 288.28
Std Dev	0.0013	0.0049	0.55	NA
Median	0.0017	0.0215	3.70	NA
Min	0.0007	0.0069	2.86	NA
Max	0.0070	0.0325	3.90	NA

Statistical Review Of Radiological Monitoring at New Ellenton, SC (NEL)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m^3	pCi/m^3	pCi/m^3	pCi/L
N	52 (41)	52 (52)	12 (8)	12 (2)
Mean	0.0018	0.0219	4.22	249.09
Std Dev	0.0007	0.0052	1.23	0.41
Median	0.0017	0.0223	3.82	249.09
Min	0.0007	0.0072	2.78	248.80
Max	0.0042	0.0312	5.98	249.38

Statisical Review Of Radiological Monitoring at Jackson, SC (JAK)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m^3	pCi/m^3	pCi/m^3	pCi/L
N	52 (39)	52 (52)	12 (8)	12 (3)
Mean	0.0019	0.0220	5.34	511.12
Std Dev	0.0013	0.0048	3.11	338.47
Median	0.0016	0.0219	4.26	356.85
Min	0.0009	0.0067	2.71	277.27
Max	0.0081	0.0298	12.10	899.23

Statisical Review Of Radiological Monitoring at Burial Grounds North, SRS (BGN)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m^3	pCi/m^3	pCi/m^3	pCi/L
N	51 (38)	51 (51)	12 (12)	12 (11)
Mean	0.0019	0.0214	164.13	3300.17
Std Dev	0.0012	0.0051	96.09	2030.14
Median	0.0016	0.0207	151.76	3579.63
Min	0.0009	0.0079	5.39	405.97
Max	0.0076	0.0305	383.20	6553.74

Statistical Review Of Radiological Monitoring at Allendale Barricade (ABR)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m^3	pCi/m^3	pCi/m^3	pCi/L
N	52 (35)	52 (52)	12 (3)	12 (1)
Mean	0.0017	0.0211	5.31	One detect of 487.28
Std Dev	0.0009	0.0052	3.38	NA
Median	0.0016	0.0218	3.96	NA
Min	0.0006	0.0068	2.81	NA
Max	0.0056	0.0308	9.16	NA

Summary Statistics

Statistical Review Of Radiological Monitoring at Allendale, SC (ALN)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m^3	pCi/m^3	pCi/m^3	pCi/L
N	51 (39)	51 (39)	12 (2)	12 (0)
Mean	0.0020	0.0211	5.77	No Detections
Std Dev	0.0013	0.0050	0.00	NA
Median	0.0017	0.0209	5.77	NA
Min	0.0007	0.0066	5.77	NA
Max	0.0076	0.0307	5.78	NA

Statistical Review Of Raiological Monitoring at Snelling, SC (SCT)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m^3	pCi/m^3	pCi/m^3	pCi/L
N	47 (27)	47 (47)	12 (7)	12 (5)
Mean	0.0019	0.0214	4.60	370.17
Std Dev	0.0014	0.0050	2.46	188.17
Median	0.0017	0.0208	3.18	318.27
Min	0.0007	0.0070	2.82	203.98
Max	0.0079	0.0310	8.68	640.16

Statistical Review Of Radiological Monitoring at Dark Horse (DKH)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m^3	pCi/m^3	pCi/m^3	pCi/L
N	52 (34)	52 (52)	12 (9)	12 (5)
Mean	0.0018	0.0215	5.53	329.36
Std Dev	0.0008	0.0054	1.65	117.88
Median	0.0015	0.0210	5.67	296.20
Min	0.0005	0.0072	3.65	231.17
Max	0.0040	0.0408	8.03	523.34

LIST OF ACRONYMS

ABR	Allendale Barricade
AIK	Aiken
ALN	Allendale
BGN	Burial Grounds North
DKH	Dark Horse at the Williston Barricade
DOE-SR	Department of Energy-Savannah River
ESOP	Environmental Surveillance and Oversight Program
JAK	Jackson
LLD	Lower Limit of Detection
MDA	Minimum Detectable Activity
NEL	New Ellenton
SCDHEC	South Carolina Department of Health and Environmental Control
SCT	South Carolina Advanced Technology Park
SRS	Savannah River Site
TLD	Thermoluminescent Dosimeter
TSP	Total Suspended Particulates
USEPA	United States Environmental Protection Agency

Units of Measure

Ci	Curie
mrem	millirem
pCi/L	picoCuries per liter
pCi/m³	picoCuries per cubic meter
±	Plus or minus. Refers to one standard deviation unless otherwise stated

References

Argonne National Laboratory (ANL). 2007. Health-Based Radionuclide Concentrations in Drinking Water and Air. Human Health Fact Sheet.

Kathren, R.L. 1984. Radioactivity in the Environment: Sources, Distribution, and Surveillance. Harwood Academic Publishers, New York, New York.

National Council on Radiation Protection and Measures (NCRP). 1984. Radiological Assessment: Predicting the Transport, Bioaccumulation, and Uptake by Man of Radionuclides Released to the Environment. NCRP Report No. 76, Bethesda, MD.

Savannah River Nuclear Solutions, LLC (SRNS). 2012. Savannah River Site Environmental Report for 2011. Savannah River Site Aiken, SC. SRNS–STI–2012–00200

Sears, Rhonda. 2005. USEPA National Air and Radiation Environmental Laboratory. Montgomery, AL. Telephone Conversation September 17, 2005.

SCDHEC. 2007. 2006 Radiological Atmospheric Monitoring Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

United States Environmental Protection Agency. 2002. National Primary Drinking Water Regulations. Title 40, Chapter 1, Part 141.

USEPA. 2005. Office of Radiation and Indoor Air, Environmental Radiation Data, Report 123 July - September, Montgomery, AL.

USEPA. 2007. Maximum Contaminant Levels and Regulatory Dates for Drinking Water U.S.EPA vs. California

Walter, A. E., 1995. America the Powerless, Facing our Nuclear Energy Dilemma, Library of Congress Card Number: 95-080187.

This Page Intentionally Left Blank

Section 2 2011 Water Monitoring

Chapter 2 Ambient Groundwater Monitoring Adjacent to SRS

Chapter 3 Drinking Water Quality Monitoring

Chapter 4 Radiological Monitoring of Surface Water on and Adjacent to the SRS

Chapter 5 Nonradiological Monitoring of Surface Water

Chapter 6 Radiological and Nonradiological Monitoring of Sediments

2011 Ambient Groundwater Monitoring Adjacent to the Savannah River Site

Environmental Surveillance and Oversight Program

96GW003
Michael D. May, Jr. Project Manager
January 01, 2011 - December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health
and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 2
- **2011 RADIOLOGICAL PARAMETER RESULTS** 2
- **2011 NONRADIOLOGICAL PARAMETER RESULTS** 3
- **2011 ESOP AND DOE-SR DATA COMPARISON** 4
- **2011 SUMMARY STATISTICS** 4

3.0 CONCLUSIONS AND RECOMMENDATIONS 5

4.0 MAPS 6

5.0 TABLES AND FIGURES 7

6.0 DATA 12
- **2011 RADIOLOGICAL DATA** 13
- **2011 NONRADIOLOGICAL DATA** 19

7.0 SUMMARY STATISTICS 21
- **RADIOLOGICAL STATISTICS** 22

LIST OF ACRONYMS AND UNITS OF MEASURE 23

REFERENCES 24

APPENDIX A. A-1

1.0 PROJECT SUMMARY

The Environmental Surveillance and Oversight Program (ESOP) of the South Carolina Department of Health and Environmental Control (SCDHEC) samples an ambient groundwater monitoring network adjacent to the Savannah River Site (SRS) to characterize groundwater quality in the area. This annual evaluation is conducted to determine possible offsite groundwater impacts due to operations conducted at the SRS. The well network consists of existing groundwater wells owned by neighboring municipalities, businesses, and members of the public. Radiological and nonradiological contaminants have historically been detected in some network, random background and random perimeter groundwater wells. ESOP provides this project report annually as an independent source of information concerning Department of Energy-Savannah River (DOE-SR) activities and the potential impacts of those activities to public health and the environment.

SCDHEC currently utilizes a regional groundwater monitoring well network consisting of cluster wells (C-wells) and network wells (consisting of private wells and public water systems). This groundwater well network consists of approximately 75 wells that are routinely sampled by SCDHEC. The C-wells are owned and maintained by the South Carolina Department of Natural Resources (SCDNR). These cluster wells are screened from shallow surficial aquifers to depths exceeding 1100 feet below ground surface. The C-well clusters are situated throughout the perimeter of the SRS and have been historically sampled by other agencies including DOE-SR, and the United States Geological Survey (USGS).

The following items outline the objectives of the project, as well as the importance of sampling for radionuclides throughout the groundwater well network:

- Evaluate groundwater quality adjacent to SRS;
- Compare results with historical data;
- Determine any SRS contaminant migration offsite;
- Expand current ambient water quality databases;
- Provide the public with independently generated, region specific, groundwater quality information.

The study area is composed of a 10-mile perimeter extending from the SRS boundary, as well as random background and random perimeter locations found throughout the state of South Carolina. As part of the ongoing ambient groundwater study, sampling of random background (B locations) will continue throughout the state of South Carolina. These sample locations are selected at random using a designated quadrant system that extends throughout the state of South Carolina. These samples are collected from either private or municipal groundwater wells. Map 1 in Section 4.0 depicts the network groundwater well locations, the extent of the study area, and the wells sampled during the 2011 sampling event. ESOP evaluates five aquifer zones (Upper Three Runs, Gordon, Crouch Branch, McQueen Branch, and Piedmont Aquifer) from the water table to confined aquifers more than 1400 feet deep (Section 5.0, Table 2).

The SCDHEC analytical laboratory data from the 2011 groundwater sampling event revealed limited contaminants present in the groundwater wells sampled. These groundwater wells, along with the extent of contaminants, will be detailed in Section 2.0 of this report. Due to the low concentrations and limited extent of the contaminants identified in these groundwater wells, it is likely the sources of these contaminants are a result of naturally occurring processes in the subsurface.

2.0 RESULTS AND DISCUSSION

The 2011 groundwater sampling event was scheduled for 17 wells. Fourteen of these wells are designated as network wells (Section 4.0, Map 1), and the remaining three wells are classified as background wells. Two of the 14 network wells scheduled for sampling (G06113, G06115), are no longer in service and have been removed from the groundwater sampling schedule. Groundwater well M06005 has been dry for over 10 years and no sample was collected as a result. This well was also removed from the groundwater sampling schedule. Based on a review of the wet chemistry, metals, tritium, gross alpha, non-volatile beta, and gamma-emitting radioisotope analytical data provided by the SCDHEC analytical and radiological laboratories, various contaminants were detected in the 14 groundwater wells sampled.

Alpha activity was detected at two of the groundwater well locations sampled during the 2011 sampling event (GWG06139, GWG06147), neither of which exceeded the maximum contaminant level (MCL) of 15 picocuries per liter (pCi/L). Beta activity was detected at one well location (GWG06147) and did not exceed the MCL of 8 pCi/L. Tritium was not detected at any of the network groundwater wells sampled. However, one background location (GWB02) yielded a tritium activity of 767 pCi/L.

The 2011 groundwater sampling event revealed additional contamination in several groundwater well locations. One or more of the following contaminants: nitrate/nitrite, barium, copper, cadmium, lead, and antimony were detected in 10 well locations. None of these contaminants exceeded the United States Environmental Protection Agency (USEPA) MCL drinking water standard.

Due to the extent of the known groundwater contamination on the SRS, SCDHEC will continue to monitor groundwater quality to identify any future SRS offsite contaminant migration.

Radiological Parameter Results

The presence of naturally occurring radionuclides has been well documented in the groundwater regime across the state of South Carolina. Groundwater investigations performed by state and federal agencies such as SCDHEC, SCDNR and the USGS have confirmed the presence of these radionuclides.

Gross alpha was detected at two of the 14 groundwater wells sampled during the 2011 event. These two locations are identified as GWG06139 and GWG06147 and yielded activities of 4.34 pCi/L and 2.19 pCi/L respectively. Neither location exceeded the USEPA drinking water limit of 15 pCi/L.

Beta was detected in one of the 14 groundwater wells analyzed. This well location is identified as G06147 with an activity of 2.57 pCi/L. This detection does not exceed the 8 pCi/L USEPA MCL non-volatile beta drinking water standard. As the presence of naturally occurring radionuclides has been well documented in the groundwater regime across the state of South Carolina, the non-volatile beta activity found in this well is likely due to the natural decay process of uranium deposits within the subsurface.

A single background groundwater location (GWB02) yielded a tritium activity of 767 pCi/L. Tritium was not detected in any of the 14 network groundwater wells sampled in 2011. Although the GWB02 tritium activity was detectable, the activity is well below the USEPA established drinking water limit of 20,000 pCi/L. As stakeholder interests in tritium levels continue to rise (DOE 2006), tritium sampling will continue and be addressed in future project reports.

Gamma analysis was conducted on all groundwater samples for the 2011 sampling event. However, gamma activity was below the detection level for all samples collected.

Nonradiological Parameter Results

The presence of metals and other nonradiological contaminants in the environment can be attributed to man-made processes such as industrial manufacturing and/or the natural decay of deposits. However, a review of the following metal and nonradiological contaminants detected indicates their limited presence is most likely due to the erosion of natural deposits. Additionally, the position of these wells, as related to the location of SRS's centrally located process areas, supports the theory of natural occurrence. All analytical results can be found in Section 6.0.

During the 2011 groundwater sampling event no VOCs were detected at any of the sampling locations.

Cadmium was detected in five groundwater monitoring wells (GWD06002, GWG06111, GWD06004, GWM06010, GWM06004). The calculated average for cadmium in these wells is 0.0002 mg/L. Although the concentrations of cadmium in these wells are detectable, they are well below the 0.005 mg/L MCL established by the USEPA.

Copper was detected at one groundwater well location (GWG06128) with a concentration of 0.053 mg/L. The USEPA has established an MCL for copper of 1.3 mg/L. Although the copper concentration found in this groundwater well is detectable, this concentration is well below the USEPA established MCL.

Lead was detected in two groundwater monitoring wells (GWG06147, GWM06004) yielding an average concentration of 0.0032 mg/L. The USEPA has established an MCL for lead of 0.015 mg/L. Although the lead concentrations found in these wells are detectable, the concentrations are still below the MCL and are not considered to be a known human health risk.

Nitrate/Nitrite was detected at concentrations well below the 10 mg/L MCL in seven groundwater wells (GWD06002, GWG06128, GWG06111, GWG06109, GWD06004, GWM06014, GWM06010). Calculation revealed a nitrate/nitrite average of 0.25 mg/L in these seven groundwater well locations. The presence of nitrate/nitrite is most likely due to the erosion of natural deposits and/or runoff from fertilizer use. Once in the soil, nitrate is mobile due to its water solubility characteristic, and therefore moves easily through the soil matrix at a speed comparable to groundwater flow velocity.

Barium was detected in five groundwater monitoring wells (GWG06139, GWG06128, GWG06109, GWM06014, GWM06004). The calculated average for barium in these wells is 0.067 mg/L. Although the concentration of barium in these wells are detectable, these concentrations do not exceed the 2.00 mg/L MCL established by the USEPA. As a result, these concentrations are not considered known human health risks.

Antimony was detected at one groundwater well location (GWM06004) with a concentration of 0.0033 mg/L. The USEPA has established an MCL for antimony of 0.006 mg/L. Although the antimony concentration found in this groundwater well is detectable, this concentration is below the USEPA established MCL.

ESOP and DOE-SR Data Comparison

Due to the fact DOE-SR collects groundwater samples from a separate onsite monitoring well network, direct SCDHEC offsite groundwater comparisons could not be made to their findings in the latest SRS Environmental Report for 2011. However, the 2011 SRS report identifies numerous areas of groundwater contamination throughout the SRS property. These areas of impacted groundwater include A-Area, C-Area, D-Area, E-Area, F-Area, H-Area, K-Area, L-Area, M-Area, P-Area, R-Area, Sanitary Landfill, TNX, and Chemicals Metals Pesticides (CMP) pits. The extent of the contamination varies and the contaminants include chlorinated volatile organics, tritium, gross alpha, beta radionuclides, and strontium 90 (SRNS 2012). SCDHEC groundwater contaminates detected in the 2011 sample event include tritium, gross alpha, non-volatile beta, and various metals. Due to the presence of the aforementioned contaminants in the groundwater on the SRS, the ESOP groundwater project will continue sampling for these contaminants in future sampling events.

Summary Statistics

During the 2011 groundwater sampling event, 14 wells were sampled. Of these 14 wells, three of the wells are classified as random background wells. The remaining 11 wells are classified as network wells. These wells are located on private property (either a private residence, public water system, or church) and situated throughout the state of South Carolina.

Laboratory analytical data revealed a random background tritium detection of 767 pCi/L located at GWB02. This activity is well below the USEPA MCL of 20,000 pCi/L for tritium. Therefore, the activity found in this groundwater well is unlikely to pose health risks to humans.

Summary statistics from network groundwater well sampling revealed a gross alpha average of 3.27 pCi/L (based on two detections) and a non-volatile beta average of 2.57 pCi/L (based on a single detection). Neither the gross alpha or non-volatile beta detections exceeded the respective 15 pCi/L and 8 pCi/L safe drinking water limits established by the USEPA.

3.0 CONCLUSIONS AND RECOMMENDATIONS

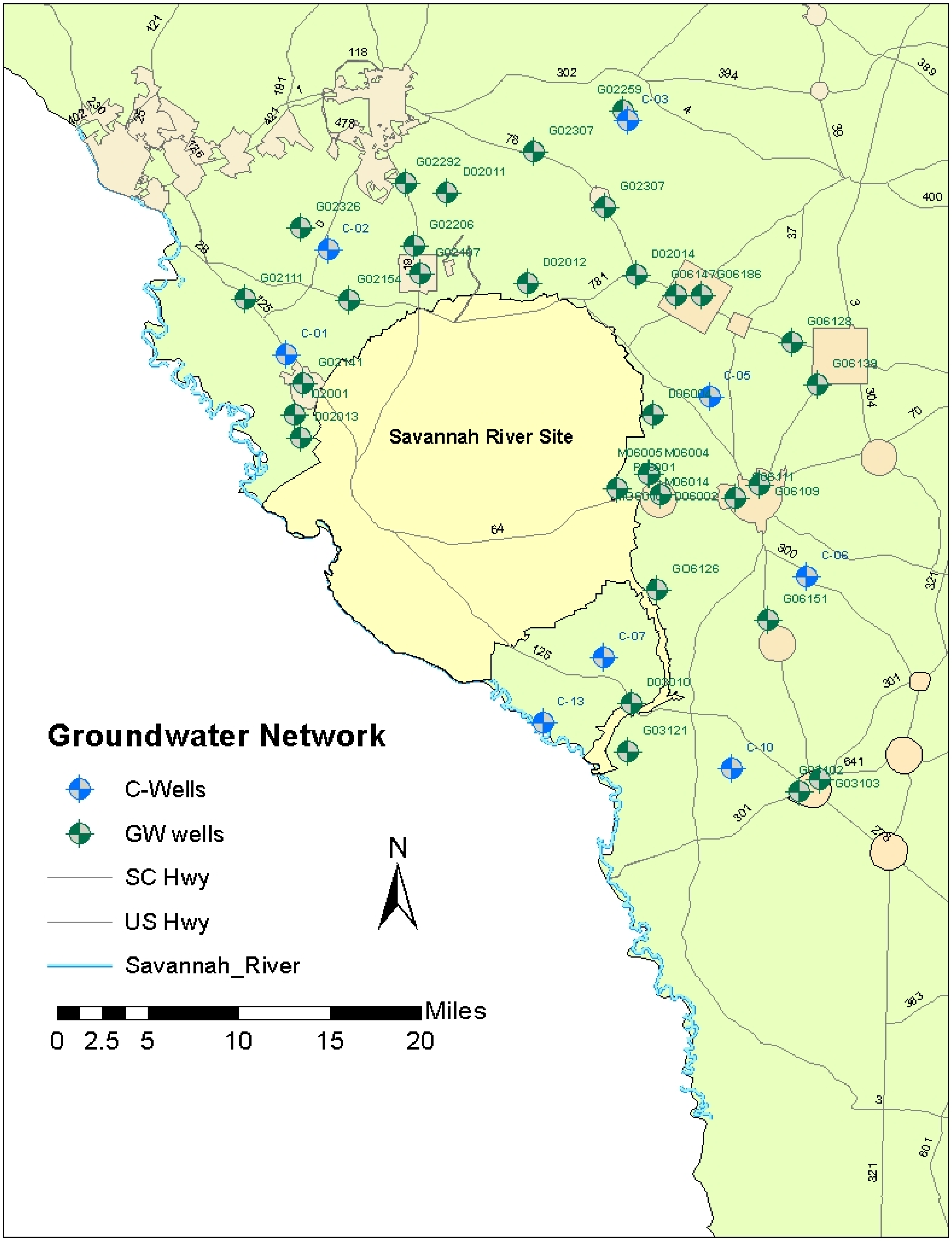
A review of the 2011 analytical data revealed various but limited nonradiological and/or radiological constituents in the majority of the 14 groundwater wells sampled. Although several of these wells sampled during the 2011 sampling event revealed detectable concentrations, the data suggests the extent of the contaminants are isolated and likely the result of dissolved metals and radionuclides from naturally occurring geologic formations.

The Ambient Groundwater Quality Monitoring Project (AGQMP) attempted to determine if constituents, other than naturally occurring, have impacted groundwater within the AGMN. The results of the 2011 groundwater sampling event indicate several nonradiological constituents and naturally occurring radionuclides are impacting groundwater quality in isolated regions throughout the groundwater monitoring well network as well as background locations. Independent monitoring of basic water quality parameters, metals, VOCs, tritium, gross alpha, non-volatile beta, and gamma-emitting radionuclides will continue throughout future annual groundwater investigations. In addition, statistical analysis of perimeter and background data along with evaluating DOE-SR groundwater monitoring data, will be performed. Continued groundwater monitoring will provide a better understanding of actual groundwater quality parameters, their extent, and trends. As a result, comparisons with historical data can be made. In addition, ESOP will provide SCDHEC's Bureau of Water with groundwater data to assist in their evaluation of the extent of naturally occurring radionuclides in the region.

During future DOE-SR ambient groundwater sampling events (using the SRS P-wells), SCDHEC will request the opportunity to conduct split QA/QC (Quality Assurance/Quality Control) sampling. The term P-Wells is used to describe the groundwater monitoring well network used to sample groundwater within the SRS site boundary. Split sampling at random well locations throughout the SRS groundwater well network will help provide SCDHEC further annual confirmation.

4.0 AMBIENT GROUNDWATER MONITORING

Map 1 Ambient Groundwater Quality Monitoring Well Network



5.0 Tables and Figures
Ambient Groundwater Monitoring

Table 1 ESOP Groundwater Monitoring Well Data, 2011

Well No.	Well Name	Sample Year	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Aquifer
G02292	Hunter's Glen	2010	unknown	210	SP
G02206	Oak Hill Subdivision	2010	445	240	SP
G02107	New Ellenton	2010	421	425	CB
G02259	Aiken State Park	2010	262	*	SP
G02154	Talatha Water District	2010	250	185	CB
G02141	Jackson	2010	225	105	SP
G02111	Beech Island Water District	2010	380	360	CB
G02326	ORA Site	2010	300	397	MB
D02014	Messer Well	2010	unknown	144	SP
G02307	Oakwood School	2010	428	404	CB
D02013	Cowden Plantation, Well 2	2010	124	*	SP
I02001	Cowden Plantation, Well 1	2010	132	*	CB
D02011	Mettlen Well	2010	400	180	SP
D02012	Windsome Plantation, House Well	2010	260	*	SP
G06109	Barnwell, Hwy. 3	**2011**	230	146	UTR
G06111	Barnwell, Rose St.	**2011**	220	166	UTR
G06128	Edisto Station	**2011**	322	360	GOR
G06147	Williston, Halford St.	**2011**	352	530	CB
G06139	Barnwell State Park	**2011**	248	163	UTR
D06002	Moore Well	**2011**	240	*	UTR
P06001	Allied General Nuclear, Well 1	**2011**	250	*	MB
D06004	J. Williams Well	**2011**	245	76.15	UTR
M06004	Chem Nuclear WO0061	**2011**	254.52	401	CB
M06014	Chem Nuclear WO0071	**2011**	255.33	250	GOR
M06010	Chem Nuclear WO0069	**2011**	254.28	145	UTR
D03010	Martin Post Office	2012	108	105	UTR
I03002	Ingrim Residence	2012	*	*	UTR
G03102	Allendale, Water St.	2012	201	343	UTR
G03103	Allendale, Googe St.	2012	180	347	UTR
G03112	Allendale Welcome Center	2012	143	100	UTR
G06151	Chappels Labor Camp	2012	250	260	UTR
G03121	Clariant	2012	180	812	CB
G03115	Martin District Fire Department	2012	*	*	*
G06126	Starmet (Carolina Metals)	2012	200	323	GOR

Table 1 (continued) ESOP Groundwater Monitoring Well Data, 2011

Well No.	Well Name	Sample Year	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Aquifer
M02101	SCDNR Cluster C-01, AIK-2378	2013	220.3	185	CB
M02102	SCDNR Cluster C-01, AIK-2379	2013	224.2	266	CB
M02103	SCDNR Cluster C-01, AIK-2380	2013	228.9	385	MB
M02104	SCDNR Cluster C-01, AIK-902	2013	231.9	511	MB
M02202	SCDNR Cluster C-02, AIK-825	2013	418.8	231	CB
M02203	SCDNR Cluster C-02, AIK-824	2013	418.6	365	CB
M02204	SCDNR Cluster C-02, AIK-818	2013	418.3	425	MB
M02205	SCDNR Cluster C-02, AIK-817	2013	418.9	535	MB
M02301	SCDNR Cluster C-03, AIK-849	2013	301.6	97	SP
M02302	SCDNR Cluster C-03, AIK-848	2013	299.7	131	CB
M02303	SCDNR Cluster C-03, AIK-847	2013	299	193	CB
M02304	SCDNR Cluster C-03, AIK-846	2013	297.8	255	CB
M02305	SCDNR Cluster C-03, AIK-845	2013	296.9	356	MB
M02306	SCDNR Cluster C-03, AIK-826	2013	294.9	500	MB
M06501	SCDNR Cluster C-05, BRN-360	2013	264.3	140	UTR
M06502	SCDNR Cluster C-05, BRN-359	2013	265.5	214	GOR
M06503	SCDNR Cluster C-05, BRN-367	2013	263.8	285	GOR
M06504	SCDNR Cluster C-05, BRN-368	2013	265.1	443	CB
M06505	SCDNR Cluster C-05, BRN-365	2013	263.5	539	CB
M06506	SCDNR Cluster C-05, BRN-366	2013	266.7	715	MB
M06507	SCDNR Cluster C-05, BRN-358	2013	265.6	847	MB
M03706	SCDNR Cluster C-07, ALL-368	2014	246.6	691	CB
M03707	SCDNR Cluster C-07, ALL-369	2014	242.1	800	CB
M03708	SCDNR Cluster C-07, ALL-370	2014	245.1	975	MB
M03709	SCDNR Cluster C-07, ALL-358	2014	243.1	1123	MB
M03131	SCDNR Cluster C-13, Artesian	2014	80	*	GOR
M03132	SCDNR Cluster C-13, ALL-378	2014	90	1060	MB
M03702	SCDNR Cluster C-07, ALL-364	2014	245.2	225	UTR
M03703	SCDNR Cluster C-07, ALL-365	2014	244.3	333	GOR
M03704	SCDNR Cluster C-07, ALL-366	2014	243.5	400	GOR
M03705	SCDNR Cluster C-07, ALL-367	2014	245.7	566	CB
M06601	SCDNR Cluster C-06, BRN-351	2014	207.3	95	UTR
M06602	SCDNR Cluster C-06, BRN-350	2014	207.4	170	UTR
M06603	SCDNR Cluster C-06, BRN-352	2014	207.1	293	GOR

Table 1 (continued) ESOP Groundwater Monitoring Well Data, 2011

Well No.	Well Name	Sample Year	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Aquifer
M06604	SCDNR Cluster C-06, BRN-354	2014	207.6	411	GOR
M06605	SCDNR Cluster C-06, BRN-353	2014	207.7	588	CB
M06608	SCDNR Cluster C-06, BRN-349	2014	208.6	1045	MB
M03101	SCDNR Cluster C-10, ALL-347	2014	281.6	1423	MB
M03104	SCDNR Cluster C-10, ALL-374	2014	280.9	580	GOR
D02640	Green Pond Road	2014	*	222	*
D00383	Brown Road	2014	*	*	*

Notes:
1. * - Total depth/top of casing information unknown, Aquifer assigned based on owner information.
2. ft amsl – feet above mean sea level
3. ft bgs – feet below ground surface
4. UTR – Upper Three Runs, CB – Crouch Branch, SP – Steeds Pond, GOR – Gordon, MB- McQueen Branch

Tables and Figures

Ambient Groundwater Monitoring

Table 2 Summary of the Stratigraphy and Hydrostratigraphy of the Study Area

PERIOD/EPOCH	GROUP	FORMATION	HYDROLOGIC UNIT	
Middle Miocene	Cooper	Upland Unit	Unsaturated Zone	
Tertiary / Eocene	Barnwell	Tobacco Road	Steed Pond Aquifer	Upper Three Runs Aquifer (UTR)
		Dry Branch/Clinchfield		
	Orangeburg	Tinker/Santee		
		Warley Hill		Gordon Confining Unit
		Congaree		Gordon Aquifer (GOR)
	Black Mingo	Fourmile		
Tertiary / Paleocene		Snapp	Crouch Branch Confining Unit	
		Lang Syne/Sawdust Landing		
Late Cretacious	Lumbee	Steel Creek	Crouch Branch Aquifer	
		Black Creek	McQueen Branch Confining Unit	
		Middendorf	McQueen Branch Aquifer	
Paleozoic or Precambrian		Cape Fear	Appleton Confining System	
		Crystalline Basement	Piedmont Hydrogeologic Province	

Tables and Figures

Ambient Groundwater Monitoring

Figure 1. 2011 Tritium Activity

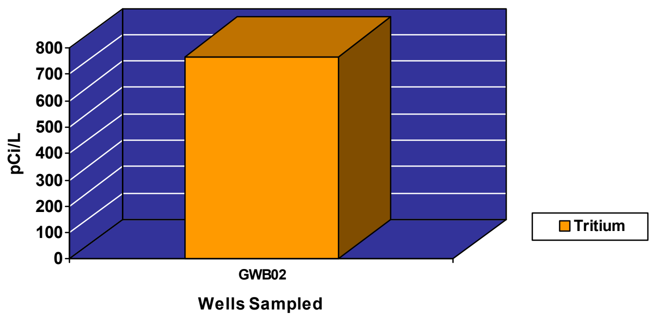


Figure 2. 2011 Gross Alpha Activity

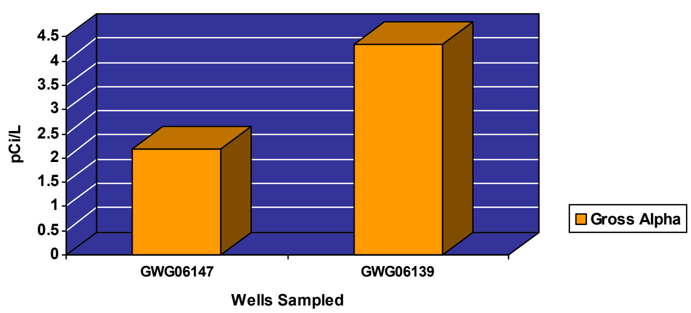
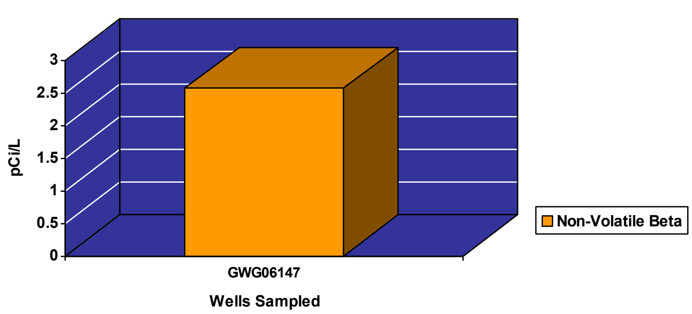


Figure 3. 2011 Non-Volatile Beta Activity



6.0 Data

Ambient Groundwater Monitoring

2011 RADIOLOGICAL DATA **13**
2011 NONRADIOLOGICAL DATA **19**

Notes:
1. Bold numbers with dark shaded boxes denotes a detection
2. LLD = Lower Limit of Detection
3. MDA = Minimum Detectable Activity
4. NA = Not Applicable

2011 Radiological Data (Gamma)

Location Description Collection Date	GWD06002 4/26/2011	GWG06139 4/26/2011	GWG06147 4/27/2011	GWG06128 4/27/2011	GWD06004 5/5/2011
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA
Be-7 MDA	43.20	39.40	41.70	46.20	40.60
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA
Na-22 MDA	3.17	3.05	3.48	2.89	2.98
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA
K-40 MDA	35.20	49.70	45.60	51.00	46.40
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA
Mn-54 MDA	2.75	2.95	3.62	2.98	2.86
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA
Co-58 MDA	4.27	4.22	4.24	4.22	3.95
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA
Co-60 MDA	2.66	3.16	2.76	3.15	2.88
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA
Zn-65 MDA	7.28	7.33	6.32	6.65	7.29
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA
Y-88 MDA	3.83	4.41	4.05	3.08	3.89
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA
Zr-95 MDA	8.30	8.38	8.60	8.45	7.60
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA
Ru-103 MDA	5.59	5.81	6.69	6.30	5.33
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA
Sb-125 MDA	8.33	8.38	8.29	8.21	8.16
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA
I-131 MDA	116.00	126.00	163.00	175.00	81.90
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA
Cs-134 MDA	3.31	2.72	2.81	3.13	3.10
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA
Cs-137 MDA	3.35	3.59	3.45	3.37	3.49
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA
Ce-144 MDA	20.90	21.50	22.20	22.30	20.30
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA
Eu-152 MDA	6.88	7.41	7.65	7.13	7.37
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA
Eu-154 MDA	4.92	5.08	5.42	5.43	5.12
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA
Eu-155 MDA	7.49	7.20	7.18	7.38	6.96
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA
Pb-212 MDA	5.90	5.96	6.12	5.72	5.85
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA
Pb-214 MDA	6.66	6.25	6.89	6.45	6.49
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA
Ra-226 MDA	76.00	61.00	78.40	62.10	75.00
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA
Ac-228 MDA	13.70	12.90	11.70	11.80	12.20
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA
U/Th-238 MDA	54.70	54.90	56.70	54.90	55.30
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA
Am-241 MDA	6.28	5.86	5.86	5.97	6.05

2011 Radiological Data (Gamma)

Location Description Collection Date	GWG06111 5/5/2011	GWP06001 5/12/2011	GWG06109 5/12/2011	GWM06014 6/14/2011	GWM06010 6/14/2011
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA
Be-7 MDA	46.50	138.00	129.00	87.00	89.80
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA
Na-22 MDA	3.00	2.59	2.70	2.29	2.44
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA
K-40 MDA	49.20	57.30	58.20	19.90	60.60
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA
Mn-54 MDA	3.44	3.36	3.11	3.14	3.01
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA
Co-58 MDA	4.47	8.58	8.27	6.47	6.27
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA
Co-60 MDA	2.98	2.50	2.23	2.44	2.31
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA
Zn-65 MDA	6.04	6.82	6.64	6.60	6.25
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA
Y-88 MDA	3.34	4.60	5.03	3.43	3.97
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA
Zr-95 MDA	7.24	17.50	17.30	14.00	13.20
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA
Ru-103 MDA	6.24	27.90	30.90	16.00	15.20
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA
Sb-125 MDA	8.44	9.71	9.21	9.57	8.96
I-131 Activity	<MDA	Lab Error	Lab Error	Lab Error	Lab Error
I-131 Confidence Interval	NA	NA	NA	NA	NA
I-131 MDA	87.30	NA	NA	NA	NA
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA
Cs-134 MDA	2.89	2.99	2.87	2.87	2.83
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA
Cs-137 MDA	3.08	2.71	2.72	2.79	3.02
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA
Ce-144 MDA	21.40	42.20	41.80	37.60	38.60
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA
Eu-152 MDA	7.23	10.20	10.40	10.40	10.20
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA
Eu-154 MDA	5.10	6.83	7.10	6.14	6.55
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA
Eu-155 MDA	7.06	14.00	13.20	13.70	13.90
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA
Pb-212 MDA	5.80	8.13	8.16	7.95	7.65
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA
Pb-214 MDA	6.74	7.25	7.41	7.52	7.08
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA
Ra-226 MDA	76.40	94.40	96.80	95.50	93.20
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA
Ac-228 MDA	13.50	13.60	12.60	13.20	12.70
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA
U/Th-238 MDA	55.40	82.10	81.20	81.10	83.10
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA
Am-241 MDA	6.42	21.10	21.30	21.40	20.80

2011 Radiological Data (Gamma)

Location Description	GWM06004
Collection Date	6/15/2011
Be-7 Activity	<MDA
Be-7 Confidence Interval	NA
Be-7 MDA	88.10
Na-22 Activity	<MDA
Na-22 Confidence Interval	NA
Na-22 MDA	2.59
K-40 Activity	<MDA
K-40 Confidence Interval	NA
K-40 MDA	55.00
Mn-54 Activity	<MDA
Mn-54 Confidence Interval	NA
Mn-54 MDA	2.84
Co-58 Activity	<MDA
Co-58 Confidence Interval	NA
Co-58 MDA	5.96
Co-60 Activity	<MDA
Co-60 Confidence Interval	NA
Co-60 MDA	2.44
Zn-65 Activity	<MDA
Zn-65 Confidence Interval	NA
Zn-65 MDA	6.69
Y-88 Activity	<MDA
Y-88 Confidence Interval	NA
Y-88 MDA	4.22
Zr-95 Activity	<MDA
Zr-95 Confidence Interval	NA
Zr-95 MDA	12.50
Ru-103 Activity	<MDA
Ru-103 Confidence Interval	NA
Ru-103 MDA	16.70
Sb-125 Activity	<MDA
Sb-125 Confidence Interval	NA
Sb-125 MDA	9.03
I-131 Activity	Lab Error
I-131 Confidence Interval	NA
I-131 MDA	NA
Cs-134 Activity	<MDA
Cs-134 Confidence Interval	NA
Cs-134 MDA	2.68
Cs-137 Activity	<MDA
Cs-137 Confidence Interval	NA
Cs-137 MDA	2.90
Ce-144 Activity	<MDA
Ce-144 Confidence Interval	NA
Ce-144 MDA	38.90
Eu-152 Activity	<MDA
Eu-152 Confidence Interval	NA
Eu-152 MDA	10.00
Eu-154 Activity	<MDA
Eu-154 Confidence Interval	NA
Eu-154 MDA	6.96
Eu-155 Activity	<MDA
Eu-155 Confidence Interval	NA
Eu-155 MDA	13.60
Pb-212 Activity	<MDA
Pb-212 Confidence Interval	NA
Pb-212 MDA	7.78
Pb-214 Activity	<MDA
Pb-214 Confidence Interval	NA
Pb-214 MDA	7.21
Ra-226 Activity	<MDA
Ra-226 Confidence Interval	NA
Ra-226 MDA	92.90
Ac-228 Activity	<MDA
Ac-228 Confidence Interval	NA
Ac-228 MDA	13.40
U/Th-238 Activity	<MDA
U/Th-238 Confidence Interval	NA
U/Th-238 MDA	80.10
Am-241 Activity	<MDA
Am-241 Confidence Interval	NA
Am-241 MDA	21.50

2011 Radiological Data (Gross Alpha, Beta)

Location Description	GWG06139	GWD06002	GWG06128	GWG06147	GWM06014
Collection Date	4/26/2011	4/26/2011	4/27/2011	4/27/2011	6/14/2011
Alpha Activity	**4.34**	<LLD	<LLD	**2.19**	<LLD
Alpha Confidence Interval	2.95	N/A	N/A	1.59	N/A
Alpha LLD	3.51	2.94	2.56	1.92	5.34
Beta Activity	<LLD	<LLD	<LLD	**2.57**	<LLD
Beta Confidence Interval	N/A	N/A	N/A	1.61	N/A
Beta LLD	2.43	4.11	2.36	2.30	4.08

Location Description	GWG06111	GWP06001	GWG06109	GWM06004	GWM06010
Collection Date	5/5/2011	5/12/2011	5/12/2011	6/15/2011	6/14/2011
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A	N/A	N/A
Alpha LLD	1.93	2.96	4.01	4.52	4.25
Beta Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	N/A	N/A	N/A	N/A	N/A
Beta LLD	2.30	3.97	4.03	4.05	4.04

Location Description	GWD06004
Collection Date	5/5/2011
Alpha Activity	<LLD
Alpha Confidence Interval	N/A
Alpha LLD	2.26
Beta Activity	<LLD
Beta Confidence Interval	N/A
Beta LLD	2.33

Network Wells

2011 Radiological Data (Gross Alpha, Beta)

Location Description	GWB01	GWB02	GWB03
Collection Date	12/6/2011	12/14/2011	12/15/2011
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A
Alpha LLD	3.26	2.84	2.61
Beta Activity	<LLD	<LLD	<LLD
Beta Confidence Interval	N/A	N/A	N/A
Beta LLD	3.85	3.81	3.78

Background Wells

2011 Radiological Data (Tritium)

Location Description	GWD06002	GWG06139	GWG06147	GWG06128	GWD06004
Collection Date	**4/26/2011**	**4/26/2011**	**4/27/2011**	**4/27/2011**	**5/5/2011**
Tritium Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium Confidence Interval	N/A	N/A	N/A	N/A	N/A
Tritium LLD	222	222	222	222	222

Location Description	GWG06111	GWP06001	GWG06109	GWM06010	GWM06014
Collection Date	**5/5/2011**	**5/12/2011**	**5/12/2011**	**6/14/2011**	**6/14/2011**
Tritium Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium Confidence Interval	N/A	N/A	N/A	N/A	N/A
Tritium LLD	222	212	212	212	212

Location Description	GWM06004
Collection Date	**6/15/2011**
Tritium Activity	<LLD
Tritium Confidence Interval	N/A
Tritium LLD	212

Network Wells

Location Description	GWB01	GWB02	GWB03
Collection Date	**12/6/2011**	**12/14/2011**	**12/15/2011**
Tritium Activity	<LLD	**767**	<LLD
Tritium Confidence Interval	N/A	116	N/A
Tritium LLD	209	209	209

Background Wells

2011 Nonradiological Data

Location Description	GWD06002	GWG06139	GWG06147	GWG06128	GWG06111
Collection Date	4/26/2011	4/26/2011	4/27/2011	4/27/2011	5/5/2011
Field Water Quality Data					
pH (s)	4.23	7.00	4.56	6.34	6.32
Conductivity (umhos/cm)	0.149	0.406	0.054	0.198	0.035
Turbidity (ntu)	0.00	0.00	0.00	0.00	0.00
Dissolved Oxygen (mg/L)	9.01	3.98	5.84	8.88	7.15
Temperature ©	21.54	21.32	21.14	21.28	20.84
Analyte					
Nitrate/Nitrite (mg/L)	**1.1**	<0.020	<0.020	**0.24**	**0.28**
Barium (mg/L)	<0.050	**0.090**	<0.050	**0.060**	<0.050
Beryllium (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Copper (mg/L)	<0.010	<0.010	<0.010	**0.053**	<0.010
Mercury (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cadmium (mg/L)	**0.00014**	<0.00010	<0.00010	<0.00010	**0.00026**
Lead (mg/L)	<0.0020	<0.0020	**0.0030**	<0.0020	<0.0020
Antimony (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Selenium (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thallium (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Vinyl Chloride (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Trichloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Tetrachloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500

Location Description	GWP06001	GWG06109	GWD06004	GWM06014	GWM06010
Collection Date	5/12/2011	5/12/2011	5/5/2011	6/14/2011	6/14/2011
Field Water Quality Data					
pH (s)	4.41	6.36	6.86	11.62	10.30
Conductivity (umhos/cm)	0.058	0.135	0.102	0.516	0.160
Turbidity (ntu)	0.00	0.00	0.00	20.30	7.60
Dissolved Oxygen (mg/L)	3.66	7.01	7.10	8.10	7.90
Temperature ©	23.24	20.55	19.27	20.41	19.84
Analyte					
Nitrate/Nitrite (mg/L)	<0.020	**0.066**	**0.039**	**0.030**	**0.027**
Barium (mg/L)	<0.050	**0.059**	<0.050	**0.050**	<0.050
Beryllium (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Copper (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cadmium (mg/L)	<0.00010	<0.00010	**0.00019**	<0.00010	**0.00013**
Lead (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Antimony (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Selenium (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thallium (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Vinyl Chloride (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Trichloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Tetrachloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500

2011 Nonradiological Data

Location Description	GWM06004
Collection Date	**6/15/2011**
Field Water Quality Data	
pH (s)	13.36
Conductivity (umhos/cm)	0.276
Turbidity (ntu)	9.80
Dissolved Oxygen (mg/L)	0.16
Temperature ©	19.35
Analyte	
Nitrate/Nitrite (mg/L)	<0.020
Barium (mg/L)	**0.079**
Beryllium (mg/L)	<0.0010
Copper (mg/L)	<0.010
Mercury (mg/L)	<0.00020
Arsenic (mg/L)	<0.0050
Cadmium (mg/L)	**0.00065**
Lead (mg/L)	**0.0034**
Antimony (mg/L)	**0.0033**
Selenium (mg/L)	<0.0020
Thallium (mg/L)	<0.00050
Vinyl Chloride (mg/L)	<0.00500
Trichloroethene (mg/L)	<0.00500
Tetrachloroethene (mg/L)	<0.00500

7.0 Summary Statistics

Ambient Groundwater Monitoring

2011 RADIOLOGICAL SUMMARY STATISTICS..22

Notes:

1. N/A = Not Applicable
2. LLD = Lower Limit of Detection

2011 Ambient Groundwater Monitoring Summary Statistics

Location Description	Well Designation	Alpha (pCi/L)	Beta (pCi/L)	Tritium (pCi/L)
GWG06147	Network Well	**2.19**	**2.57**	N/A
GWG06139	Network Well	**4.34**	N/A	N/A
GWB02	Background Well	N/A	N/A	**767**

Network Wells						
	Mean	**Std Dev**	**Median**	**Max**	**Min**	**Number**
Alpha (pCi/L)	3.27	1.52	3.27	4.34	2.19	2
Beta (pCi/L)	2.57	N/A	2.57	2.57	2.57	1

Background Wells						
	Mean	**Std Dev**	**Median**	**Max**	**Min**	**Number**
Tritium (pCi/L)	767	N/A	767	767	767	1

LIST OF ACRONYMS

AGMN	Ambient Groundwater Monitoring Network
AGQMP	Ambient Groundwater Quality Monitoring Project
CMP	Chemicals Metals Pesticides
DOE-SR	Department of Energy - Savannah River
ESOP	Environmental Surveillance and Oversight Program
FT AMSL	Feet Above Mean Sea Level
FT BGS	Feet Below Ground Surface
GW	Groundwater
LLD	Lower Limit of Detection
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
QA/QC	Quality Assurance/Quality Control
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SD	Standard Deviation
SRS	Savannah River Site
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

UNITS OF MEASURE

C	temperature in Celsius
mg/L	milligrams per liter
ntu	nephelometric turbidity units
pCi/L	Picocuries per liter
su	standard units
umhos/cm	specific conductance
±	Plus or minus. Refers to one standard deviation unless otherwise stated

References

Aadland, R. K., J. A. Gellici, P. A. Thayer 1995, "Hydrogeologic Framework of West Central South Carolina", South Carolina Department of Natural Resources, WRD Report 5.

Department of Energy (DOE) 2006. Stakeholder Sensitivity To Tritium Releases. Retrieved May 22, 2007 from http://hss.energy.gov/CSA/csp/advisory/SAd_2006-04.pdf.

South Carolina Department of Health and Environmental Control (SCDHEC) 1999. Determination of Ambient Groundwater Quality Adjacent to the Savannah River Site, Annual Report, 1997, SCDHEC Environmental Surveillance and Oversight Program.

United States Environmental Protection Agency 2011. http://www.epa.gov/safewater/contaminants/index.html

APPENDIX A

Regional Geology

The study area, including SRS, is located in west-central South Carolina. The regional geology is characterized as the Aiken Plateau of the Coastal Plain physiographic province. SRS is located approximately 20 miles southeast of the fall line of the Piedmont physiographic province. A thickening wedge of Cenozoic and Cretaceous sediment, which overlies Paleozoic crystalline basement rock and Triassic sedimentary rocks, underlies the area south of the fall line (Aadland et al 1995). The sediment, consisting of alternating sands and clays with Tertiary carbonates, thickens toward the southeast from zero at the fall line to more than 1,800 feet at the Allendale-Hampton County line. The sediment is about 1,100 feet thick beneath the central portion of SRS and dips toward the southeast at about 35 feet per mile. Table 2 in Section 5.0 summarizes the stratigraphy and hydrostratigraphy of the study area. For a more detailed review of regional geology and hydrogeology, refer to the 1997 Annual Report (SCDHEC 1999).

Radiological Analytes Table

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Yttrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

This Page Intentionally Left Blank

2011 Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Environmental Surveillance and Oversight Program

97DW006
Michael D. May, Jr. Project Manager
January 01, 2011 - December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY ... 1

2.0 RESULTS AND DISCUSSION ... 2
SURFACE WATER SYSTEM NETWORK RESULTS ... 2
GROUNDWATER SYSTEM NETWORK RESULTS ... 3
ESOP AND DOE-SR DATA COMPARISON ... 4

3.0 CONCLUSIONS AND RECOMMENDATIONS ... 4

4.0 MAP ... 6

5.0 TABLES AND FIGURES ... 7

6.0 DATA ... 13

2011 RADIOLOGICAL DATA FOR SURFACE WATER SYSTEMS ... 14
2011 RADIOLOGICAL DATA FOR GROUNDWATER SYSTEMS ... 15

7.0 SUMMARY STATISTICS ... 17

2011 SURFACE WATER FED SUMMARY STATISTICS ... 18
2011 GROUNDWATER FED SUMMARY STATISTICS ... 19

LIST OF ACRONYMS AND UNITS OF MEASURE ... 20

REFERENCES ... 21

1.0 PROJECT SUMMARY

The Environmental Surveillance and Oversight Program (ESOP) Drinking Water Monitoring Project, as part of South Carolina Department of Health and Environmental Control (SCDHEC), evaluates drinking water quality in communities that could be impacted by Savannah River Site (SRS) operations. ESOP monitoring provides information to the public regarding the extent that radiological constituents may or may not have impacted community drinking water systems adjacent and downstream to the SRS. Additionally, ESOP provides analytical data from this project for comparison to published Department of Energy-Savannah River (DOE-SR) data. The project objectives are to collect monthly composite surface water samples from one location upstream from the SRS (North Augusta) as well as three locations downstream from the SRS (Purrysburg, Beaufort, and Savannah,GA). Additionally, semi-annual grab samples are collected from selected public drinking water systems within 30 miles from the center point of the SRS. SCDHEC analyzes all samples for gross alpha, non-volatile beta, gamma-emitting radionuclides, and tritium.

The study area was established as a 30-mile radius circle centered in the SRS. Using SCDHEC geographical information system, 19 primarily groundwater fed and four surface water fed public drinking water systems were selected (Section 4.0, Map 1). These sample locations were selected specifically to help ensure complete sample coverage around the perimeter of the SRS. These water systems serve approximately 281,000 customers with approximately 105,000 receiving their water from groundwater sources (Section 5.0, Table 1). None of the drinking water samples collected originated from the SRS drinking water system.

During 2011, DOE-SR collected surface water samples from four locations (North Augusta, Purrysburg, Beaufort and Savannah) that are colocated with the ESOP surface water fed drinking water systems. Currently, DOE-SR does not conduct drinking water sampling from groundwater fed wells off-site.

Historically, tritium has been the main environmental release due to operations at the SRS. Tritium was produced as a nuclear weapon enhancement component. The majority of tritium releases came from the production reactors and the separation areas (Till et al 2001). In addition to SRS activities, tritium can be attributed to releases from nuclear facilities within close proximity of the study area.

Man-made gamma-emitting radionuclides, such as iodine-131, cesium-137, and cobalt-60, were products of SRS activities. These radionuclides were produced by fission in reactor fuels and were primarily released in surface streams in the 1960s or into the atmosphere in the separation areas (WSRC 1998).

2.0 RESULTS AND DISCUSSION

Surface Water System Network Results

Tritium

Tritium is naturally present in surface waters at 10 to 30 picocuries per liter (pCi/L) (ANL 2007). The maximum contaminant level (MCL) developed by the United States Environmental Protection Agency (USEPA) for tritium in drinking water supplies is 20,000 pCi/L. Tritium continues to be the most abundant radionuclide detected in public drinking water in the study area. Detected in both groundwater and surface water systems, the ESOP tritium detectable average was 254 pCi/L (based on a single detection) for groundwater systems and 459.53 (± 156.28) pCi/L for surface water systems. The DOE-SR detectable average for surface water systems was 412.75 (± 15.80) pCi/L (SRNS 2012). These tritium activities, however, were quite low when compared to the USEPA drinking water MCL of 20,000 pCi/L (USEPA 2002).

The primary tritium releases originated from processes associated with the reactors (R, P, K, L, and C), separation facilities (F-area and H-area), the heavy water facility (D-area), and tritium recovery in the tritium facilities. The main types of tritium releases originate from site facilities, migration from seepage basins in F-area and H-area, the burial ground, and the K-area containment basin. In the early operational years, almost 100% of the releases to streams were related to direct releases. After the cessation of operational activities, most releases were a result of migration from the seepage basins. Since the mid 1970s, migration and outcropping to streams have accounted for most of the SRS tritium released to surface water (Till et al. 2001).

Based on a review of the surface water data from the Savannah River, tritium was detected above the lower limit of detection (LLD) in approximately 73% of surface water composite samples. Detectable tritium activity in these samples yielded an average of 459.53 (± 156.28) pCi/L and ranged from 219 to 893 pCi/L. These tritium activities are measurable but not significant when compared to the 20,000 pCi/L USEPA MCL (USEPA 2002). Of the 12 upstream North Augusta surface water composites, there were two detections above the LLD. Tritium activity in the North Augusta samples ranged from 223 to 239 pCi/L and averaged 231.00 (± 11.31) pCi/L. Of the 36 composite samples collected downstream from the SRS, 33 samples had a tritium activity slightly above the minimum detectable activity (MDA). The tritium activity in these three downstream intakes, Chelsea Plant, Purrysburg Plant, and City of Savannah, had a range of 219 to 893 and averaged 535.70 (± 42.63) pCi/L. Figure 1 of Section 5.0 illustrates the trending data for surface water fed systems over the past five years.

Gamma-emitting Radionuclides

Gamma-emitting radionuclides of concern (Section 5.0, Table 2) were not detected above the MDA and have not been detected for any of the surface water samples collected by ESOP or DOE-SR since 2002.

Gross Alpha and Non-volatile Beta

Gross alpha-emitting radionuclides were released to liquid effluent from the reactor materials area (M-area), separations areas (F-area and H-area), and the reactor areas. The primary stream affected by the M-area releases was Tims Branch, which ultimately flows into Upper Three Runs. Fourmile Creek is the stream most affected by releases coming from the separation areas. Releases from the reactor areas affected all streams with the exception of Upper Three Runs (Till et al 2001). Gross beta-emitting radionuclides were released to liquid effluent from the separations areas (F-area and H-area). The aforementioned streams ultimately flow directly or indirectly into the Savannah River.

Gross alpha was detected at Chelsea, North Augusta, and Purrysburg with an average activity of 3.76 (± 0.80) pCi/L. Non-volatile beta was detected at three locations (North Augusta, City of Savannah, and Purrysburg). These three locations revealed non-volatile beta detections that averaged 4.36 (± 0.56) pCi/L and ranged from 4.01 to 5.01 pCi/L. Speciation is not conducted for gross alpha or non-volatile beta unless there is detection above the USEPA MCL of 15 pCi/L or 8 pCi/L, respectively (USEPA 2002). Alpha and beta activity is likely attributable to naturally occurring radionuclides.

Section 5.0 (Figures 2 and 3) illustrates the trends in gross alpha and non-volatile beta activities since the year 2007. Although there are several detections identified during the 2011 sampling event, none of these analytes have exceeded the USEPA established MCL for each of these contaminants. As a result, these concentrations are not considered to be known health risks for humans.

Groundwater System Network Results

Tritium

Based on a review of the analytical data, only one of the 19 groundwater fed systems sampled had tritium activities above the LLD. This tritium detection, located at the Talatha public water system (system # 0220005), yielded an activity of 254 pCi/L. This tritium activity is measurable but not significant when compared to the 20,000 pCi/L USEPA MCL (USEPA 2002). Figure 1 in Section 5.0 shows trending data from the past five years for the samples from groundwater fed systems that showed detections.

Gamma-emitting Radionuclides

Gamma-emitting radionuclides of concern were not detected above the MDA in any groundwater samples tested in nine years of testing by ESOP. As a result of the history of non-detections for gamma-emitting radionuclides, no summary statistics were calculated (Section 6.0).

Gross Alpha and Non-volatile Beta

Gross alpha was detected in two of the 19 groundwater systems (Jackson, College Acres) tested in 2011. The range for gross alpha activity was 3.19 to 4.70 pCi/L with an average activity of 3.95 (± 1.07) pCi/L. All gross alpha samples were below the USEPA MCL of 15 pCi/L (USEPA

2002). Speciation is not conducted for gross alpha unless there is a detection above the USEPA MCL of 15 pCi/L. Summary statistics for groundwater fed systems are located in Section 7.

There were no detections found for non-volatile beta during the 2011 sampling event.

ESOP and DOE-SR Data Comparison

DOE-SR conducts monthly composite sampling at the four water treatment plants (North Augusta, Purrysburg, Beaufort and Savannah) that use Savannah River surface water to supply drinking water for the local population.

Based on the DOE-SR 2011 annual report (SRNS 2012), tritium in the three downstream water intakes averaged 490.66 (± 16.03) pCi/L ranging from 212.00 to 930.00 pCi/L while ESOP downstream detections averaged 535.70 (± 202.98) pCi/L ranging from 219.00 to 893.00 pCi/L. Figure 4 and Figure 5 illustrate DOE-SR finished water tritium detection averages over a five year time period. DOE-SR had an overall detected tritium average of 412.75 (± 15.8) pCi/L for all surface water samples collected in 2011. This was lower than the ESOP detected tritium average of 459.53 (± 156.28) pCi/L for the same period. The ESOP calculated average tritium activity for North Augusta is 231.00 (± 11.31) pCi/L. This average is lower than the averages for the other downstream locations due to the fact North Augusta is located upstream from the SRS (Section 5.0, Table 3). All samples were within two standard deviations as well as being lower than the USEPA MCL of 20,000 pCi/L (USEPA 2002). Tritium activity in 2011 is within two standard deviations of the running 5-year average. These activity levels are well below the USEPA MCL. Naturally occurring radionuclides may account for variability in tritium activities. Tritium continues to be the most abundant radionuclide in the Savannah River.

Gamma-emitting radionuclides were not detected in DOE-SR or ESOP samples in 2011. DOE-SR and ESOP detected non-volatile beta in surface water samples. The DOE-SR non-volatile beta average (for all four locations) of 2.03 (± 0.11) pCi/L was slightly less than the ESOP non-volatile beta average (for North Augusta, City of Savannah, and Purrysburg) of 4.36 (± 0.56) pCi/L. DOE-SR reported an average gross alpha activity (for all four locations) of 0.17 (± 0.06) pCi/L. ESOP had surface water gross alpha detections at the Chelsea, North Augusta, and Purrysburg plants with an average of 3.76 (± 0.80) pCi/L. All detections were less than the established USEPA MCL for gross alpha and non-volatile beta in drinking water (USEPA 2002).

Alphas (or betas) are not directly comparable due to the unknown nature (species) of the contributing alphas (or betas) in any two compared samples.

3.0 CONCLUSIONS AND RECOMMENDATIONS

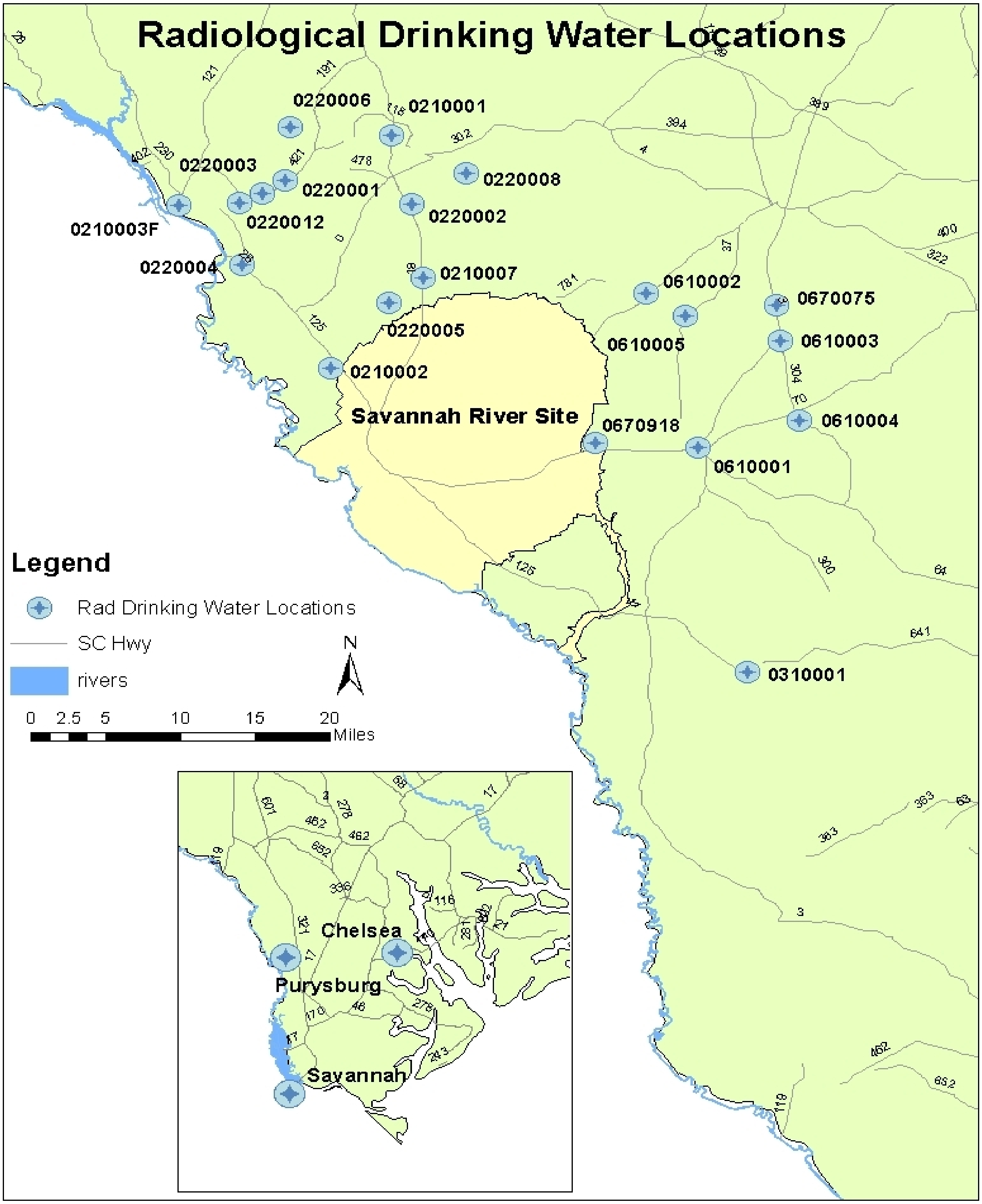
Tritium continues to be the most abundant radionuclide detected in public drinking water supplies potentially impacted by the SRS. Tritium was detected in both groundwater and surface water systems. However, these tritium activities are low considering the USEPA 20,000 pCi/L MCL for drinking water. Detections of gross alpha and non-volatile beta radionuclides of concern were all below their respective MCLs. Comparative analysis with DOE-SR for groundwater systems cannot be performed because DOE-SR does not sample groundwater systems off the Savannah River Site.

The SCDHEC Drinking Water Monitoring Project continues to be an important source of essential data for assessing human health exposure pathways. Due to the extent of the surface water contamination on the SRS and its potential to migrate south/southwest and discharge to the Savannah River, SCDHEC will continue to monitor surface water quality to identify any future contaminant migration that could potentially impact drinking water systems downstream from the SRS. SCDHEC will continue sampling to provide the public with an independent source of radiological data for drinking water systems within the SRS study area.

SCDHEC will continue collecting background samples that will provide a better idea of what ambient radioactivity levels are present in South Carolina. The data from these samples will be used in statistical analysis with the routine samples.

4.0 Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Map 1. SCDHEC ESOP Drinking Water Network



5.0 Tables and Figures

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Table 1. Drinking Water Systems Sampled by ESOP

System Number	System Name	Number of Taps	Population
0210001	Aiken	18,443	42,374
0210002	Jackson	1,309	3,602
0210007	New Ellenton	2,231	5,303
0220001	Langley Water District	367	838
0220002	College Acres Public Water District	529	1,350
0220003	Bath Water District	314	1,064
0220004	Beech Island	3,094	7,436
0220005	Talatha Water District	571	1,553
0220006	Breezy Hill Water District	5,080	12,495
0220008	Montmorenci Water District	1,396	3,428
0220012	Valley Public Service Authority	3,409	7,803
0310001	Allendale	1,521	4,052
0610001	Barnwell	2,494	6,727
0610002	Williston	1,650	3,307
0610003	Blackville	1,141	2,973
0610004	Hilda	131	466
0610005	Elko	150	462
0670075	Healing Springs	1	6*
0670918	SCAT Park	6	125
0210003F	North Augusta Surface Water	12,022	31,506
0720003F	Chelsea B/J Plant	44,227	133,353
0720004F	Purrysburg B/J Plant		
SAVF	City of Savannah (Industrial)	35	10,619
	TOTAL	100,121	280,842
	Approximate Groundwater	43,837	105,364
	Approximate Surface Water	56,284	175,478

* This information is likely higher due to public access to the natural spring.
Note: Data was obtained from SCDHEC Environmental Facility Information System database.

Tables and Figures
Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Table 2. Gamma Analyte Table

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Yttrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Tables and Figures
Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Table 3. DOE-SR and ESOP Data Comparisons

	ESOP Tritium	DOE-SR Tritium	ESOP Gross Alpha	DOE-SR Gross Alpha	ESOP NV Beta	DOE-SR NV Beta
North Augusta	231.00	179.00	4.41	0.08	4.01	1.85
Chelsea	491.00	471.00	4.00	0.21	N/A	2.33
Purrysburg	575.91	510.00	2.87	0.14	4.07	1.88
Savannah	540.20	491.00	N/A	0.23	5.01	2.04
Average	**459.53**	**412.75**	**3.76**	**0.17**	**4.36**	**2.03**

Tables and Figures
Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Figure 1. ESOP Yearly Tritium Averages in Drinking Water Systems

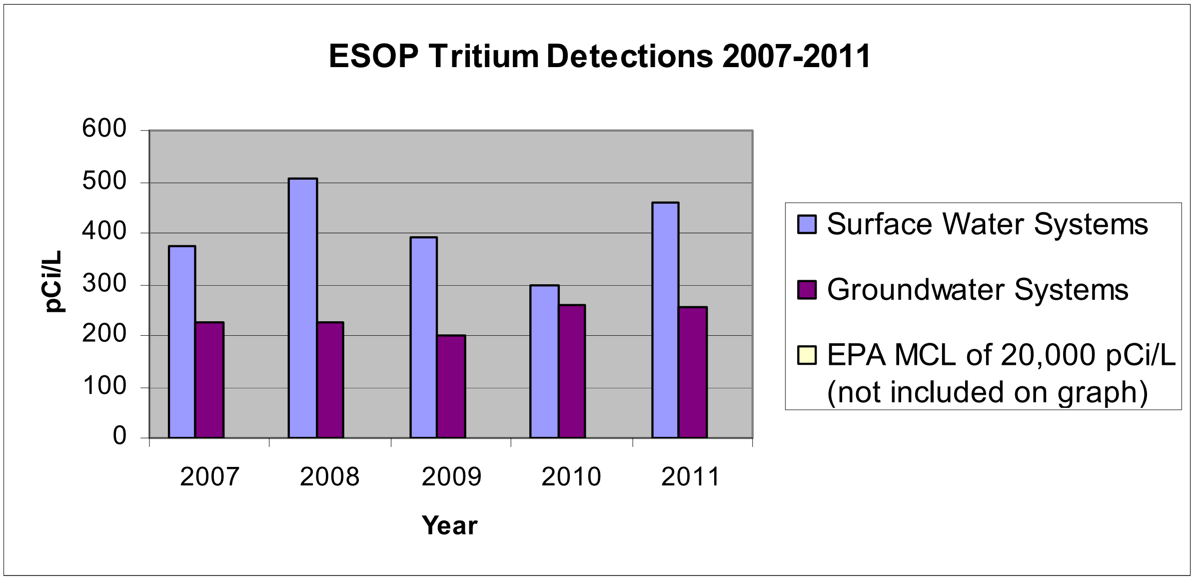


Figure 2. ESOP Yearly Gross Alpha Averages in Drinking Water Systems

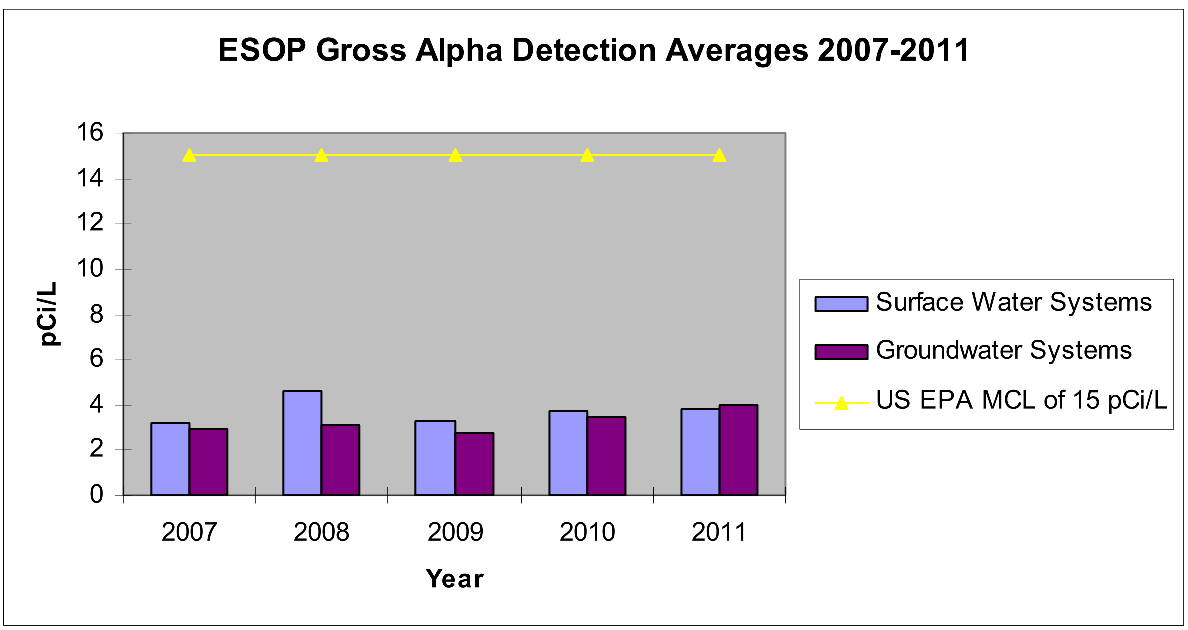
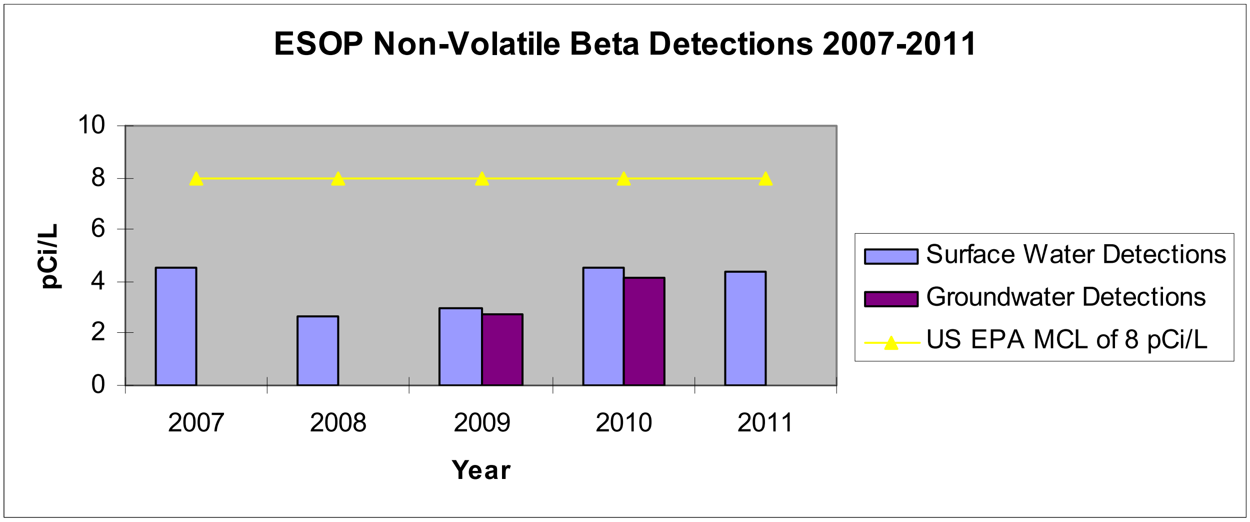


Figure 3. ESOP Yearly Non-Volatile Beta Averages in Drinking Water Systems



Note: Missing data for 2007, 2008, and 2011 indicates no groundwater detections were found for those years.

Figure 4. DOE-SR Yearly Tritium Averages in Drinking Water Systems

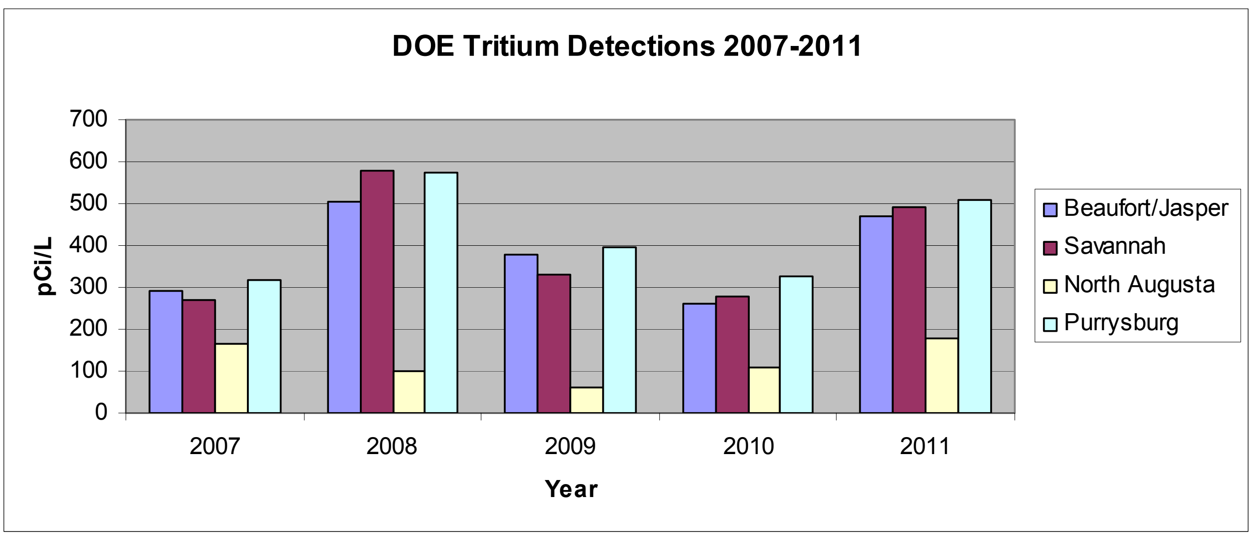
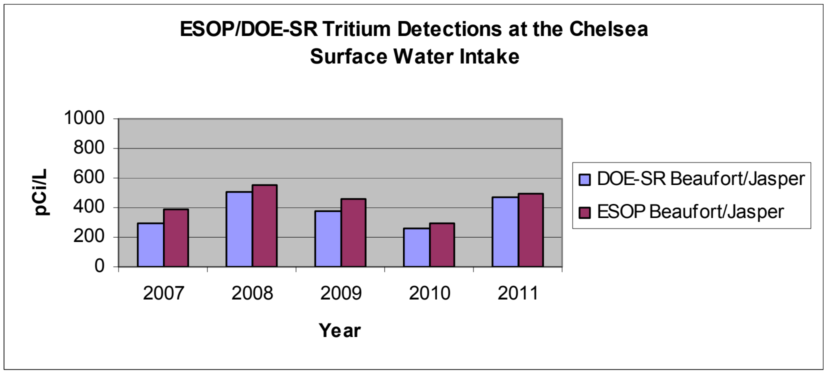
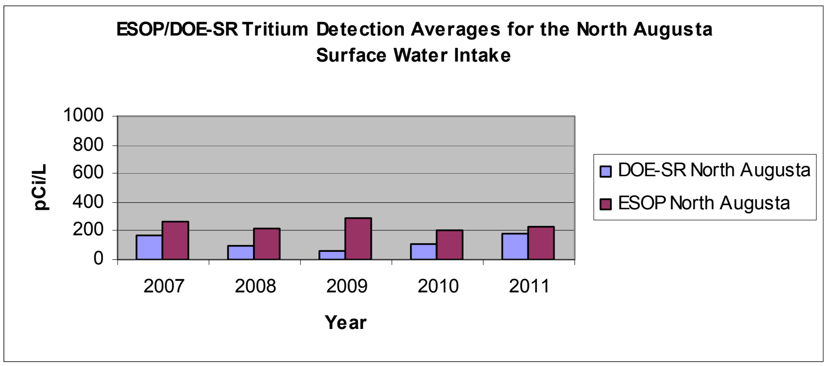
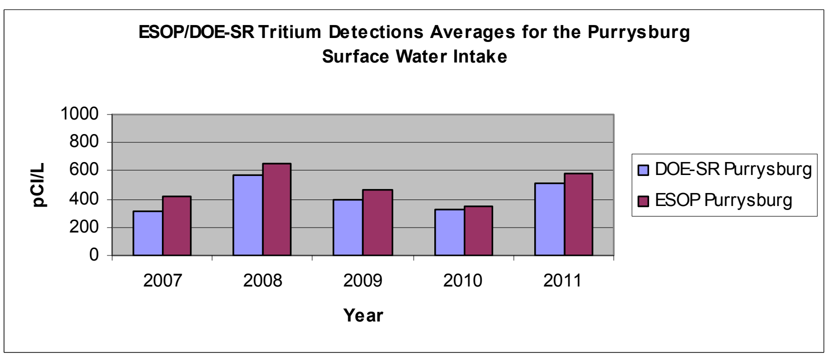
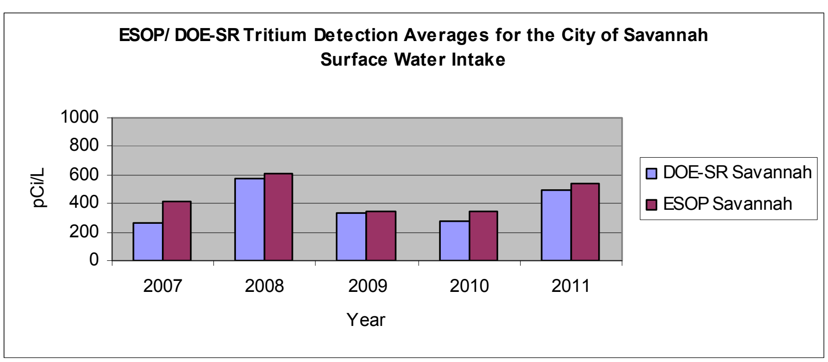


Figure 5. ESOP/DOE-SR Comparison of 2011 Averages of Tritium in Drinking Water Systems









6.0 Data

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

2011 RADIOLOGICAL DATA FOR SURFACE WATER SYSTEMS..14

2011 RADIOLOGICAL DATA FOR GROUNDWATER SYSTEMS..15

Notes:

1. Bold numbers denote detection.
2. N/A = Not Applicable
3. LLD = Lower Limit of Detection
4. MDA = Minimum Detectable Activity
5. NV = Non-volatile

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site Data
Radiological Data for Surface Water Systems

Sample Number:		DW0210003F											
Sample Name:		North Augusta Surface Water											
Date:		Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	**4.41**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	2.01	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	2.86	2.91	3.56	3.54	1.49	1.51	3.11	3.15	2.83	2.91	2.66	2.72
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**4.01**	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.32	N/A	N/A	N/A
	(LLD)	2.73	2.73	4.14	4.14	4.09	4.09	3.92	3.92	3.49	3.50	4.04	4.05
Tritium	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**223**	<LLD	<LLD	**239**	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	93	N/A	N/A	98	N/A	N/A
	(LLD)	214	214	211	211	216	216	200	200	212	212	216	216
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	3.392	2.979	3.040	2.898	3.205	3.707	2.958	3.344	3.522	3.305	3.334	3.188

Sample Number:		DW0720003F											
Sample Name:		Chelsea B/J Surface Water Canal Intake											
Date:		Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	**5.27**	**2.73**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	2.48	1.96	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	3.25	3.24	4.23	4.55	1.89	1.91	3.73	3.79	3.24	3.35	3.17	3.20
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	2.76	2.76	4.17	4.19	4.13	4.13	3.95	3.95	3.53	3.54	4.09	4.10
Tritium	(pCi/L)	**425**	**386**	**790**	**535**	**309**	**340**	**520**	**604**	**567**	**789**	**345**	**286**
±2	(sigma)	106	105	116	108	101	102	104	108	109	117	102	100
	(LLD)	214	214	211	211	216	216	200	200	212	212	216	216
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	3.539	3.333	3.052	3.376	3.512	3.456	3.744	3.274	3.877	3.518	3.417	3.738

Sample Number:		DWSAVF											
Sample Name:		City of Savannah Surface Water (Industrial)											
Date:		Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	3.19	3.20	4.24	4.04	1.74	1.76	3.57	3.68	3.20	3.27	3.01	3.02
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**5.01**
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.69
	(LLD)	2.76	2.76	4.17	4.17	4.12	4.12	3.94	3.94	3.52	3.53	4.08	4.08
Tritium	(pCi/L)	**427**	**608**	**772**	<LLD	**308**	**370**	**698**	**643**	**745**	**612**	<LLD	**219**
±2	(sigma)	106	113	114	N/A	102	103	110	108	116	112	N/A	98
	(LLD)	214	214	211	211	216	216	200	200	212	212	216	216
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	3.106	3.195	3.076	3.650	3.076	3.451	3.386	3.011	3.181	3.326	3.642	3.536

Sample Number:		DW0720004F											
Sample Name:		Purrysburg B/J Plant Surface Water SR Intake											
Date:		Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	**2.62**	**3.12**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	1.79	1.92	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	3.10	3.23	4.16	3.96	1.69	1.72	3.59	3.61	3.15	3.28	2.98	3.01
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**4.07**	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.57	N/A	N/A	N/A	N/A
	(LLD)	2.21	2.76	4.17	4.16	4.11	4.11	3.94	3.94	3.52	3.53	4.07	4.08
Tritium	(pCi/L)	**479**	**642**	**893**	**433**	**338**	**240**	**611**	**745**	**858**	**833**	<LLD	**263**
±2	(sigma)	108	114	120	105	102	99	107	112	120	119	N/A	100
	(LLD)	214	214	211	211	216	216	200	200	212	212	216	216
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	3.322	3.582	3.743	3.448	3.241	3.761	3.557	3.585	3.191	3.303	3.218	3.554

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site Data
Radiological Data for Groundwater Systems

System Number:	DW0210001		DW0210002		DW670075		DW0210007		DW0220001	
System Name:	Aiken		Jackson		Healing Springs		New Ellenton		Langley Water	
Date:	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11
Gross Alpha (pCi/L)	<LLD	<LLD	<LLD	**3.19**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	2.32	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	3.60	3.17	3.24	2.98	4.48	3.83	3.23	2.86	3.76	3.74
N-V Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	4.09	3.90	4.07	3.89	3.98	3.95	4.07	3.88	4.10	3.94
Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	215	214	215	214	221	214	215	214	215	214
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(MDA)	3.999	3.425	3.452	3.606	3.013	3.129	3.622	3.567	3.115	3.410

System Number:	DW0220005		DW0220006		DW0220008		DW0220012		DW0310001	
System Name:	Talatha Water		Breezy Hill		Montmorenci		Valley PSA		Allendale	
Date:	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11
Gross Alpha (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	3.46	3.19	3.21	3.12	3.75	3.22	4.56	3.72	5.51	4.41
N-V Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	4.08	3.91	4.07	3.90	4.10	3.91	4.13	3.94	4.16	3.98
Tritium (pCi/L)	**254**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	215	214	215	214	215	214	215	214	215	214
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(MDA)	3.529	3.584	3.293	3.010	3.261	3.282	3.300	3.568	3.357	3.112

System Number:	DW0610004		DW0610001		DW0220003		DW0220002		DW0610002	
System Name:	Hilda		Barnwell		Bath Water Dist.		College Acres		Williston	
Date:	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11
Gross Alpha (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**4.70**	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.74	N/A	N/A
(LLD)	3.49	3.39	4.14	1.89	4.20	3.57	3.30	3.33	3.85	3.51
N-V Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	3.94	3.92	4.12	2.81	4.12	3.93	4.08	3.92	4.10	3.93
Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	221	214	215	215	215	214	215	214	215	214
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(MDA)	3.267	3.513	3.293	3.987	3.290	3.344	3.934	3.521	3.248	3.658

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site Data
Radiological Data for Groundwater Systems

System Number:		DW0610005		DW0610003		DW0220004		DWDuplicate01		DWDuplicate02	
System Name:		Elko		Blackville		Beech Island					
Date:		Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11	Mar-11	Oct-11
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	4.37	2.06	5.20	5.38	3.29	2.80	3.18	1.74	2.99	2.10
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	4.13	2.83	4.00	4.02	4.08	3.88	3.92	2.79	3.91	2.84
Tritium	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	215	215	221	214	215	214	221	215	221	215
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	3.093	3.261	3.499	2.834	3.587	3.496	3.362	3.310	3.539	3.598

System Number:		DW0670918	
System Name:		SCAT Park	
Date:		Mar-11	Oct-11
Gross Alpha	(pCi/L)	<LLD	<LLD
±2	(sigma)	N/A	N/A
	(LLD)	3.06	1.66
N-V Beta	(pCi/L)	<LLD	<LLD
±2	(sigma)	N/A	N/A
	(LLD)	4.06	2.78
Tritium	(pCi/L)	<LLD	<LLD
±2	(sigma)	N/A	N/A
	(LLD)	215	215
Cesium-137	(pCi/L)	<MDA	<MDA
±2	(sigma)	N/A	N/A
	(MDA)	3.303	2.935

7.0 Summary Statistics

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

2011 SURFACE WATER FED SUMMARY STATISTICS 18

2011 GROUNDWATER FED SUMMARY STATISTICS 19

Notes:

1. N/A = Not Applicable
2. Min. = Minimum
3. Max. = Maximum
4. Num = Number of Detections
5. NV = Non-volatile
6. Avg. = Average
7. St. Dev. = Standard Deviation

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site
Surface Water Fed Summary Statistics

Radionuclide:	Gross Alpha (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
North Augusta SW	DW0210003F	4.41	4.41	N/A	4.41	4.41	1
Chelsea B/J SW	DW0720003F	4.00	4.00	1.80	5.27	2.73	2
Purrysburg	DW0720004F	2.87	2.87	0.35	3.12	2.62	2
Yearly Average of Detectable gross alpha			**3.76**				
Standard Deviation			**0.80**				

Radionuclide:	Gross NV Beta (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
North Augusta SW	DW0210003F	4.01	4.01	N/A	4.01	4.01	1
Purrysburg	DW0720004F	4.07	4.07	N/A	4.07	4.07	1
City of Savannah	DWSAVF	5.01	5.01	N/A	5.01	5.01	1
Yearly Average of Detectable non-volatile beta			**4.36**				
Standard Deviation			**0.56**				

Radionuclide:	Tritium (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
North Augusta SW	DW0210003F	231.00	231.00	11.31	239	223	2
Chelsea B/J SW	DW0720003F	472.50	491.00	174.30	790	286	12
City of Savannah	DWSAVF	610.00	540.20	194.30	772	219	10
Purrysburg	DW0720004F	611.00	575.91	240.33	893	240	11
Yearly Average of Detectable Tritium			**459.53**				
Standard Deviation			**156.28**				

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site
Groundwater Fed Summary Statistics

Radionuclide:	Gross Alpha (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Jackson	**DW0210002**	3.19	3.19	N/A	3.19	3.19	1
College Acres	**DW0220002**	4.70	4.70	N/A	4.70	4.70	1
Yearly Average of Detectable gross alpha			**3.95**				
Standard Deviation			**1.07**				

Radionuclide:	Tritium (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Talatha Water	**DW0220005**	254	254	N/A	254	254	1
Yearly Average of Detectable Tritium			**254.00**				
Standard Deviation			**N/A**				

LIST OF ACRONYMS

DOE-SR	Department of Energy - Savannah River
ESOP	Environmental Surveillance and Oversight Program
LLD	Lower Limit of Detection
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
SCAT	South Carolina Advanced Technology
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
USEPA	United States Environmental Protection Agency

UNITS OF MEASURE

pCi/L	Picocuries per liter
±	Plus or minus. Refers to one standard deviation unless otherwise stated
±2	Plus or minus 2 standard deviations.

REFERENCES

Argonne National Laboratory (ANL). 2007. Health-Based Radionuclide Concentrations in Drinking Water and Air. Human Health Fact Sheet.

Savannah River Nuclear Solutions, LLC (SRNS). 2012. Savannah River Site Environmental Report for 2011. Savannah River Site, Aiken, South Carolina. SRNS-STI-2012-00200

Till, J.E., et al. 2001. Savannah River Site Environmental Dose Reconstruction Project, Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval, Evaluation of Materials Released From the Savannah River Site. RAC Report No. 1-CDC-SRS-1999-Final. Risk Assessment Corporation (RAC).

United States Environmental Protection Agency (USEPA). 2002. National Primary Drinking Water Regulations. Title 40, Chapter 1, Part 141.

Washington Savannah River Company (WSRC). 1998. Assessment of Radionuclides in The Savannah River Site Environment-Summary (U), Environmental Protection Department, Environmental Monitoring Section, Aiken, South Carolina. WSRC-TR-98-00162.

This Page Intentionally Left Blank

2011 Radiological Monitoring of Surface Water on and Adjacent to the Savannah River Site

Environmental Surveillance and Oversight Program

97RW002
Beth Cameron, Project Manager
January 01, 2011 - December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street, NE
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 4

SCDHEC SURFACE WATER DATA 4
- TRITIUM 4
- GAMMA 4
- ALPHA 4
- BETA 5
- IODINE-129 AND TECHNETIUM-99 5

SCDHEC/DOE-SR DATA COMPARISON 6
- TRITIUM 6
- GAMMA 6
- ALPHA 6
- BETA 7

3.0 Conclusions AND Recommendations 7

4.0 MAPS 9

5.0 TABLES AND FIGURES 10

6.0 DATA 24
- 2011 AMBIENT MONITORING DATA 25
- 2011 CREEK MOUTH DATA 38
- 2011 IODINE-129 AND TECHNETIUM-99 39

7.0 SUMMARY STATISTICS 40
- 2011 TRITIUM 41
- 2011 ALPHA 42
- 2011 BETA 42

LIST OF ACRONYMS AND UNITS OF MEASURE 43

REFERENCES 44

1.0 PROJECT SUMMARY

The U.S. Atomic Energy Commission established the Savannah River Site (SRS) in 1950 to produce plutonium, tritium, and other materials for national defense and civilian purposes (Till et al. 2001). Due to the large number of materials that could potentially be released from SRS, the Centers for Disease Control and Prevention (CDC) performed a site assessment to determine the potential health effects of any released radionuclides to the offsite public. In 1992, CDC hired Radiological Assessments Corporation (known as Risk Assessment Corporation as of 1998) to perform screening procedures to determine the key radionuclides released to the environment. These screening methods indicated that the main radionuclides released to surface water were tritium (H3) and cesium-137 (Cs-137). Other radionuclides of interest are strontium-90 (Sr-90), cobalt-60 (Co-60), americium-241 (Am-241), and uranium (U). The five production reactors (R, K, P, L, and C) were the primary sources for these radionuclide releases directly to onsite streams. Additionally, effluent from the separation areas (F-Area and H-Area) was discharged into storage tanks and seepage basins, but not directly into streams. However, some releases from these areas occurred due to leaks in cooling coils, which contained water pumped from deep wells. The fuel fabrication area (M-Area), heavy water reprocessing facility (D-Area), and the administration area (A-Area) also contributed radionuclides to liquid discharge. Onsite streams affected by these releases are Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Tims Branch, Steel Creek, and Lower Three Runs Creek. All of these SRS streams are tributaries to the Savannah River (Till et al. 2001).

Tritium was one of the principle nuclear materials produced at SRS to multiply the firepower of plutonium in nuclear weapons (Till et al. 2001). The primary tritium releases originated from processes associated with the reactors, separation areas, D-Area, and tritium recovery in the tritium facilities. The two main types of tritium releases came from direct site facility releases and migration from seepage basins in separation area, the burial ground, and the K-Area containment basin. In the early operational years, almost 100% of the releases to streams were related to direct releases. After the cessation of active reactor activities, most releases were a result of migration from the seepage basins. Since the mid 1970s, migration and outcropping to streams have accounted for most of the SRS tritium released to surface water (Zeigler et al. 1985, Murphy et al. 1991, Murphy and Carlton 1991). After 1988, the Effluent Treatment Facility (ETF) went into operation and the F-Area and H-Area basins were not used (CDC 2006). The primary purpose of ETF was to process low level radioactive wastewater from the separation areas (SRS 2008). Periodically, ETF has controlled tritium releases to Upper Three Runs Creek. Additionally, tritium occurs naturally from the cosmic interaction of radiation with atmospheric gases (USEPA 2008a) and also as a result of past nuclear testing (Till et al. 2001).

Most of the radiocesium at SRS was formed as a byproduct of the nuclear fuel and targets during operation of the five production reactors. Cesium-137 (Cs-137) is an important radionuclide to monitor due to its 30-year half-life. Additionally, the biological behavior of Cs-137 is similar to potassium, which is essential to the function of living cells (USEPA 2008b). Therefore, the potential for Cs-137 uptake into humans is important considering the potential health effects. The streams that were largely affected by Cs-137 are Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek, with Steel Creek showing the highest activity (Till et al. 2001).

Alpha-emitting radionuclides were released to liquid effluent from M-Area, separation areas, and the reactor areas. The primary stream affected by the M-area releases was Tims Branch, which ultimately flows into Upper Three Runs Creek. Fourmile Branch is the stream most affected by releases coming from the separation areas. Releases from the reactor areas affected all streams with the exception of Upper Three Runs Creek (Till et al. 2001).

Beta-emitting radionuclides were released to liquid effluent from separation areas and the reactors. Fourmile Branch is the stream primarily affected by releases from the separations areas. Steel Creek, Pen Branch, and Lower Three Runs Creek were mainly affected by releases from the reactors. Strontium-90 is a main contributor of beta activity and came primarily from the reactors (Till et al. 2001).

The previously mentioned SRS surface water bodies, as well as the Savannah River, continue to be the focus for monitoring and surveillance activities of the Radiological Monitoring of Surface Water (RSW) project that is part of the South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP). Since the Savannah River is the primary drinking water source for downstream communities, it is important to ensure radionuclide concentrations in the river are well below limits considered safe for human consumption. Surface water samples are collected and analyzed for radionuclides, and the results are compared to Department of Energy-Savannah River (DOE-SR) data. DOE-SR conducts surveillance and monitoring activities for the following purposes: determining concentrations and migration of radionuclides in the aquatic environment, detecting and verifying accidental releases, characterizing concentration trends, and determining associated impacts on human health and the environment. ESOP supports DOE-SR's objectives to ensure the primary goal of drinking water safety is established and met. Project databases were expanded and data trends for radionuclides are given (Section 5.0, Tables and Figures; Section 6.0, Data Tables; and Section 7.0, Summary Statistics). These activities will allow the RSW project to generate independent data to compare with DOE-SR data, and is shared with the public.

Section 5.0, Table 1 identifies sample ID, location, rationale, and frequency. The RSW Project continues to collect surface water samples from 13 specific locations within and outside of the SRS boundary as part of an ambient sampling network (Section 4.0, Map 1.). Seven of these locations use ISCO™ automatic water samplers to collect aliquots every 30 minutes to produce a composite. Grab samples are collected from the remaining six locations. Samples are collected three days per week (Monday, Wednesday, Friday) from the locations that have the automatic water samplers. The composite sampler is utilized to collect composite samples over a 48-hour period (Monday through Wednesday and Wednesday through Friday) or a 72-hour period (Friday through Monday). An 80 ml bottle is separated for same day tritium analysis. Seven hundred milliliters is poured into a secondary bottle from the composited on Monday Wednesday, and Friday. This composite sample is then composited in a tertiary container to be analyzed monthly for gross alpha, gross beta, and gamma (Table 1.). Some locations were chosen because they are considered to be public access locations. The public access locations are downstream of SRS, with the exception of the background location of Jackson Boat Landing, SV-2010, and provide a potential means for exposure to radionuclides.

Quarterly samples are collected for tritium analysis from the five creek mouths that flow from SRS directly into the Savannah River (Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs Creek). Pen Branch is not sampled because the Savannah River Swamp interrupts the flow for this creek and there is no creek mouth access.

An enhanced surface water monitoring program is implemented to provide downstream drinking water customers with advance notice of the potential for increased tritium levels in the Savannah River due to an SRS release. This early detection facet is possible because of the continuous monitoring of the six SRS streams that flow to the Savannah River. Samples for tritium analysis are collected from the seven locations with automatic water samplers. Additionally, a grab sample is collected from Johnson's Boat Landing (SV-2080) and US Highway 301 at the Savannah River (SV-118). Sampling devices at SV-118 consist of an ISCO™ composite sampler and a 24 bottle carousel sampler. The carousel sampler provides hourly samples collected for the same respective time frame as the composite sampler. This gives ESOP a more accurate method for detecting potential tritium concentrations. Samples are analyzed at the Region 5 Environmental Quality Control (EQC) tritium laboratory on the day of collection and results from the tritium analysis are used to project tritium activity in the Savannah River. Results from the enhanced program are considered to be unofficial results and are used only for notification purposes.

An additional component of the RSW Project is the Supplemental Surface Water Monitoring Program implemented in 2005. The purpose of this sampling program is to monitor any potential releases of gross alpha/beta emitting radionuclides primarily along Upper Three Runs and Fourmile Branch. Sample locations are established along Upper Three Runs Creek, McQueen Branch, and Fourmile Branch. This monitoring was established for early detection of unplanned releases from SRS source term areas. Samples are collected on Monday, prepped the same day, and analyzed the next day as part of a quick scan early detection procedure. These samples are collected as unofficial results for notification purposes only.

In August of 2007, ESOP began collecting ambient grab samples from a location at SC Highway 125 and Lower Three Runs Creek. This sampling was conducted in response to elevated tritium levels detected in groundwater samples near the Energy Solutions (formerly Chem-Nuclear) facility in Snelling, SC. The purpose of adding this location was to determine any potential tritium contributions to Lower Three Runs from Energy Solutions. This sampling location was moved to a location (Lower Three Runs Creek and Patterson Mill Road, SV-328) closer to the source during November of 2007.

Quarterly sampling for iodine-129 (I-129) and technetium-99 (Tc-99) was conducted at the ambient location on Fourmile Branch due to concerns that these are possible constituents related to effluent from the burial grounds.

The automatic water samplers located at SV-118 are powered by alternating current. This power source can be interrupted at times due to power outages most often associated with seasonal thunderstorms. Although this interruption of power typically is not frequent, only a partial sample may be collected in the composite sampler. Additionally, the sampling program in the carousel sampler may be halted, resulting in missed samples during a sampling event. All other automatic water samplers are powered by marine batteries and can also run low causing the sampler to not collect a full sample. Any missed composite samples are collected as grab samples.

2.0 RESULTS AND DISCUSSION

SCDHEC Surface Water Data

All monitoring data are in Section 6.0 and summary statistics are in Section 7.0. All established sampling locations are in Section 5.0, Table 1.

Tritium

In 2011, tritium activity was detected at all ambient locations where weekly samples were collected (Section 7.0, Summary Statistics). Average tritium activities at Jackson Boat Landing (SV-2010), TNX Boat Landing (SV-2012), Beaver Dam Creek (SV-2040), and Upper Three Runs Creek at United States Forestry Service (USFS) Rd E-2 (SV-2027), were lower than average tritium activities at the other ambient sample locations. The 2011 tritium average for these locations was 250 (±31) picocuries per liter (pCi/L) for SV-2010, 267 (±40) pCi/L for SV-2012, 404 (± 487) for SV-2040 and 268 (±56) pCi/L for SV-2027. Fourmile Branch at USFS Rd. 13.2 (SV-2039) and Pen Branch at USFS Rd. 13.2 (SV-2047) continue to yield the highest levels of tritium activity. SV-2039 had an average tritium activity of 41,616 (±6229) pCi/L and SV-2047 had an average tritium activity of 31,984 (±11,581) pCi/L. Tritium detected activity at all locations ranged from 250 pCi/L at SV-2010 to 41,616 pCi/L at SV-2039**.** Section 5.0, Figure 1 shows trending for 2007-2011 tritium averages.

Tritium activity in the Savannah River at the creek mouths of the five SRS streams was scheduled for monitoring on a quarterly basis in 2011 (Section 7.0, Summary Statistics). However, samples were not collected in the second quarter. Three samples were collected at Fourmile Branch (SV-2015): one from the creek mouth, one from 30 feet downstream of the creek mouth, and one from 150 feet downstream of the creek mouth. Samples were taken at these three intervals to show the effect of the mixing zone created by the Savannah River flow. Samples collected directly at the creek mouth of Fourmile Branch (SV-2015a) had the highest average tritium activity (39,523 (±10,648) pCi/L) of all creek mouth locations**.**

Gamma

As part of a gamma spectroscopy analysis, samples were analyzed for gamma-emitting radionuclides (Section 5.0, Table 2) at the Radiological Environmental Monitoring Division (REMD) Laboratory in Columbia, SC. Cesium-137 has been detected in samples collected from SV-2039 in 2003, 2005, 2006 and 2008, in addition to Lower Three Runs Creek at SRS Road B (SV-2053) in 2002 (SCDHEC 2003, 2004, 2006, 2007, 2009). Fourmile Branch and Lower Three Runs were affected by releases from reactor activities, so periodic Cs-137 detections are likely in samples collected from these locations. In 2008, Co-60 and Am-241 results were incorporated in the RSW project report for comparison purposes with SRS data. All radionuclides from the gamma analysis were below detection.

Alpha

Alpha-emitting radionuclides were detected at five locations where monthly composite samples were collected (Section 7.0, Summary Statistics). Average activity over all locations ranged from a single detection of 2.55 (± 1.70) pCi/L at SV-2039 to a single detection of 25.90 (± 4.08) pCi/L at SV-2018. SV-325 had detections in all but two of the 12 samples collected. In 2011, average alpha detections were lower than in 2010. Three locations in 2011 only had a single detection (SV-2039, SV-2018, SV-2053). Steel Creek (SV-327) had three detections averaging 7.17 (±4.19). Four locations had no detections (SV-2010, SV-2040, SV-2047, SV-118). In 2010, six locations (SV-2040, SV-2039, SV-2047, SV-2018, SV-118, SV-2053) had single detections. The highest alpha average for both years was collected at SV-325. This average decreased from 14.80 (±7.16) pCi/L in 2010 to 11.95 (±5.76).

Historically, SV-325 yields detections for alpha activity (SCDHEC 2000, 2001, 2002-2010). Isotopic analysis performed by DOE-SR revealed the source to be natural uranium (SRNS 2011). This may contribute to the common occurrence of alpha detections at this location. The 2011 average alpha activity at SV-325 was 11.95 (± 5.76), which was below the United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) for drinking water of 15 pCi/L (USEPA 2002). Beginning in 2009, samples collected at this location exhibited particles of sediment and detritus usually associated with rain events. This increase in turbidity seems to be related to storm events. Samples with high turbidity can have potential interferences during alpha/beta analysis. Alpha particles, and to a lesser extent, beta particles, are attenuated by salts and solids dried onto a planchet (USEPA 2010). Furthermore, samples submitted to the REMD underwent a shorter turnaround for analysis during this period. This could have resulted in the detection of short lived radionuclides that had not decayed sufficiently. This sampling location will be monitored for turbidity during 2012, and will continue into the future on an as needed basis, to ensure that turbidity is not a concern in collected samples. Ambient monitoring average annual alpha trends for 2007-2011 are shown in Section 5.0, Figure 2. All 2011averages were below the USEPA MCL of 15 pCi/L for gross alpha-emitting particles in drinking water (USEPA 2002).

Beta

Beta-emitting radionuclide activity was detected in five of nine locations where monthly composite samples were collected (Section 7.0, Summary Statistics). The average activity ranged from 6.72 (±1.84) pCi/L at SV-2039 to a single detect of 3.15 (±1.74) pCi/L at SV-327**.** Four Mile Creek was primarily affected by releases from the separations areas, so gross beta detections can be expected at this location. Ambient monitoring average annual beta trends for 2007-2011 are shown in Section 5.0, Figure 3. The USEPA screening MCL for gross beta-emitting particles for drinking water systems is 50 pCi/L (USEPA 2002)**,** and all averages were below this limit.

Iodine-129 and Technetium-99

Iodine-129 and Technitium-99 sampling of the ambient location on Fourmile Branch was scheduled for monitoring on a quarterly basis in 2011. However, samples were not collected in the first quarter. There were I-129 detections in two of the three quarterly samples collected from SV-2039 in 2011. These detections averaged 1.57 (±0.26) pCi/L. There were Tc-99 detections in all three quarterly samples averaging 2.73 (±1.19) pCi/L (Section 6.0).

EPA has established a Maximum Contaminant Level (MCL) of 4 millirem per year for beta particle and photon radioactivity from man-made radionuclides in drinking water. Technetium-99 would be covered under this MCL. The average concentration of technetium-99, which is assumed to yield 4 millirem per year, is 900 (pCi/L). If other radionuclides, which emit beta particles and photon radioactivity are present in addition to technetium-99, the sum of the annual dose from all the radionuclides shall not exceed 4 millirem/year (USEPA 2002). The EPA-mandated MCL for I-129 in drinking water is 1 pCi/L (USEPA 2002).

SCDHEC/DOE-SR DATA COMPARISON

Data from 2011 reported in this project were compared to DOE-SR reported results (Section 5.0, Tables 3, 4, 5). DOE-SR reports all values, including values that are negative and ones that are below detection. Therefore, DOE-SR reports an average for all locations derived from detections and nondetection values. The SCDHEC and DOE-SR colocated sampling sites were Upper Three Runs Creek and SC Highway 125, Fourmile Branch and USFS Road 12.2, Pen Branch and USFS Road 13.2, Steel Creek and SC Highway 125, Lower Three Runs Creek and SRS Road B, and US Highway 301 Bridge at the Savannah River. DOE-SR sampled at several other locations along these streams, however the data comparisons are only for the collocated sample sites.

Tritium

SCDHEC and DOE-SR had detections for tritium at all colocated sample locations (Section 5.0, Table 3). DOE-SR average tritium activities for all colocated sites were within one Standard Deviation (SD) of SCDHEC average tritium activities except for Lower Three Runs Creek at Road B, which was within two SD. SCDHEC and DOE-SR samples indicate that Fourmile Branch (41,616 (±6,229) pCi/L and 39,500 (±6,240) pCi/L, respectively) and Pen Branch (31,984 (±11,581) pCi/L and 30,800 (±8,368) pCi/L, respectively) have the highest tritium activity of all SRS streams**.** The 2011 SCDHEC and DOE-SR tritium results appear to be consistent with historically reported data values (Section 5.0, Figures 4-9: SCDHEC 2000-2010, WSRC 2000-2008, SRNS 2009-2011).

Gamma

DOE-SR reported a single detection of Cs-137 (15.0 (±3.77) pCi/L) ± 2SD (SRNS 2011) in May at Patterson Mill Rd. They also had one detection of Am-241 (0.08 (±0.01) ± 2SD (SRNS 2011) at Fourmile Branch. SCDHEC had no gamma detections from either collocated sample site in 2011.

Alpha

SCDHEC detected gross alpha activity at all of the colocated sample locations with DOE-SR (Section 5.0, Table 4). DOE-SR average gross alpha activities were over three SD of SCDHEC at Upper Three Runs and Lower Three Runs Creek collocated sample sites. DOE-SR reported an average of 1.57 (±0.2.49) pCi/L at Pen Branch (SRNS 2011). SCDHEC had only one detection of 1.78 pCi/L ± 2SD at this location. Additionally, DOE-SR reported an average of 1.01 (±1.04) pCi/L at Lower Three Runs (SRNS 2011). SCDHEC had two detections averaging 6.26 (±4.38) pCi/L at this location. SCDHEC and DOE-SR samples collected from Upper Three Runs Creek at SC Highway 125 exhibited the highest gross alpha average concentration (14.80 (±7.16) pCi/L and 35.90 (±39.38) pCi/L (SRNS 2011), respectively).

Beta

SCDHEC detected gross beta activity at three of the six colocated sampling locations while DOE-SR detected activity at all six locations (Section 5.0, Table 5). SCDHEC did not detect gross beta activity at Pen Branch (SV-2047), Steel Creek (SV-327) or Lower Three Runs (SV-2053). DOE-SR average gross beta activities were within one SD of SCDHEC average gross beta activities at Four Mile Branch and within two SD at Upper Three Runs and at the Hwy 301 Bridge. DOE-SR reported a monthly average, 1.85 (±0.93) pCi/L (SRNS 2011) at Pen Branch. DOE-SR samples collected from Upper Three Runs exhibited the highest gross beta average activities, 12.50 (±14.70) pCi/L (SRNS 2011). SCDHEC samples collected from Highway 301 had the highest average beta activity, 6.95 (±1.22) pCi/L.

Iodine-129 and Technetium-99

Iodine-129 and Technitium-99 were not compared for SCDHEC and DOE-SR because there was no collocated site analyzed.

3.0 CONCLUSIONS AND RECOMMENDATIONS

While tritium is detected at all public access locations, the results were below the EPA MCL annual average of 20,000 pCi/L for drinking water (USEPA 2002). However, data generated from samples collected at the mouth of Fourmile Branch (SV-2015) indicate that the public could come into contact with tritium activity greater than the MCL at that location.

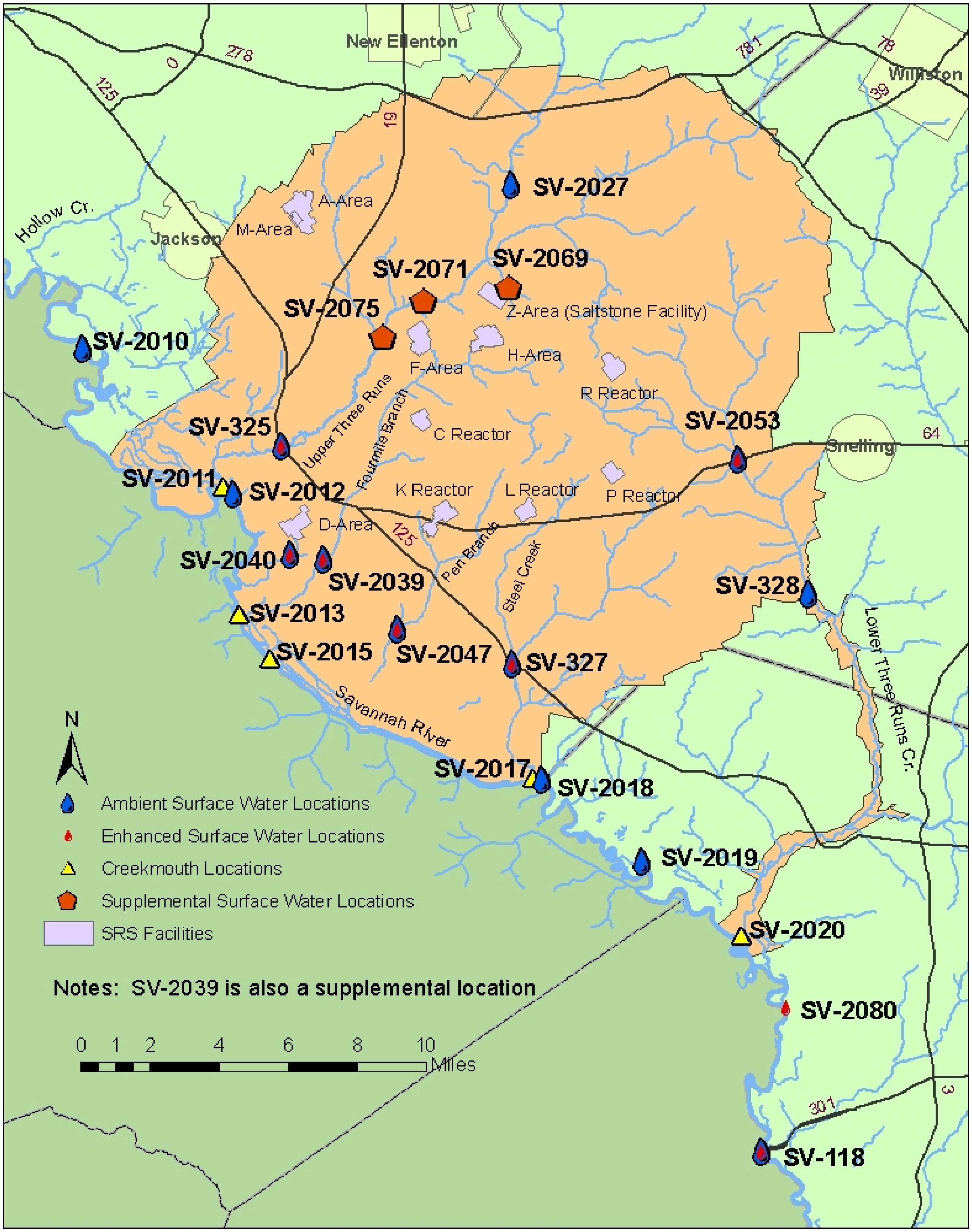
ESOP utilizes Minimum Detectable Activities (MDAs) in reporting radioactivity and does not report anything below MDA. DOE-SR, however, incorporates all values, including those below the MDA and negative numbers. This approach accounts for seemingly large differences between average values, which yield DOE-SR averages that are greater than three SDs from the SCDHEC average. Also, differences could be attributed, in part, to the nature of the water medium and the specific point and time when the sample was collected.

Differences in analytical results for tritium activity at sampling sites colocated with DOE-SR showed DOE-SR results were within one SD of SCDHEC results except for Lower Three Runs Creek at Road B, which was within two SD. Typically, ESOP samples do not exhibit Cs-137 on an annual basis. ESOP showed no detections in the 2011 sample analyses. ESOP had no detections for gross alpha at Pen Branch. DOE-SR average gross beta activities were within one SD of SCDHEC average gross beta activities at the Hwy 301 Bridge, two SD at Four Mile Branch, and more than three SD at Upper Three Runs Creek. ESOP and DOE-SR typically detect gross alpha emitting radionuclides from samples collected from the Upper Three Runs Creek location. ESOP had seven beta detections out of 12 samples and DOE-SR had 12 beta detections out of 12 samples for the sampling location at Fourmile Branch. These beta detections have been determined through isotopic analysis performed by DOE-SR to be natural uranium (SRNS 2011). This sampling location historically yields multiple gross beta detections.

The ESOP RSW Project will continue to independently collect and analyze surface water on and adjacent to SRS. This monitoring effort will provide an improved understanding of radionuclide levels in SRS surface waters and valuable information relative to human health exposure pathways. The RSW project will periodically evaluate modifications of the monitoring activities to better accomplish the project's goals and objectives. Further refinement of the RSW project may result in additional sampling locations being incorporated into the ambient or enhanced monitoring regimes. Furthermore, some historic locations may be removed due to the cessation of operational procedures at specific SRS facilities. This will only be considered if there is no potential for radionuclide exposure to the public at the specified location based on previously accumulated data. Monitoring will continue as long as there are activities at the SRS that create the potential for contamination entering the environment. Continued monitoring will provide an improved understanding of radionuclide activity in SRS surface waters and the Savannah River, which will provide valuable information to human health exposure pathways. This comparison of data results allows for independent data evaluation of DOE-SR monitoring activities.

4.0 Radiological Monitoring of Surface Water on and Adjacent to the SRS

Map 1. Surface Water Sampling Locations for 2011



5.0 Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Table 1. 2011 Surface Water Sampling Locations and Frequency

Ambient Monitoring Locations

ID	Location	Rationale	Frequency
SV-2010	Savannah River at RM 170.5 (Jackson Boat Landing)	Accessible to public; Above all SRS operations; Near Jackson population center; Upriver control; River monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-325	Upper Three Runs Creek at SC 125 (SRS Road A)	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2012	Savannah River at TNX Boat Landing	Adjacent to SRS perimeter; River monitoring	Weekly H3
SV-2040	Beaver Dam Creek at D-Area	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2039	Fourmile Branch at Road A-13.2	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2047	Pen Branch at Road A-13.2	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-327	Steel Creek at SC 125 (SRS Road A)	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2018	Savannah River at RM 141 (Steel Creek Boat Landing)	Accessible to public; Adjacent to SRS perimeter; Below SRS operations and tributaries; River monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2019	Savannah River at RM 134.5 (Little Hell Boat Landing)	Accessible to public; Below SRS operations and tributaries; River monitoring	Weekly H3
SV-2080	Svannah River at RM 125 (Johnson's Boat Landing)	Accessible to public; Below SRS operations and tributaries; River monitoring	TriWeekly H3 Grab
SV-118	Savannah River at RM 118.8 (Highway 301 Bridge)	Accessible to public; Below SRS operations and tributaries; River monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-328	Lower Three Runs Creek at Patterson Mill Rd.	Within SRS perimeter; Below SRS operations areas and PAR pond; Tributary monitoring	Weekly H3
SV-2053	Lower Three Runs Creek at Road B	Within SRS perimeter; Below SRS operations areas and PAR pond; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2027	Upper Three Runs Creek at SRS Road 2-1	Within SRS perimeter; Upstream from SRS operations; Upstream control; Tributary monitoring	Weekly H3

Notes:
1. ID is Sampling Location Identification Code Number
2. RM is River Mile
3. H3 is Tritium
4. AB is Alpha/Beta
5. SV-2080 is an enhanced sampling location that is collected three times per week

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Table 1. (Cont.)

Creek Mouth Locations

ID	Location	Rationale	Frequency
SV-2011	Upper Three Runs Creek Mouth at RM 157.4	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2013	Beaver Dam Creek Mouth at RM 152.3	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2015a	Fourmile Branch at RM 150.6 (Creek Mouth)	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2015b	Fourmile Branch at RM 150.6 (30 ' downstream from Creek Mouth)	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2015c	Fourmile Branch at RM 150.6 (150' downstream from Creek Mouth)	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2017	Steel Creek Mouth at RM 141.5	Accessible to public; Adjacent to SRS; Downstream from SRS operations; Tributary monitoring	Monthly H3
SV-2020	Lower Three Runs Creek Mouth at RM 129.1	Accessible to public; Adjacent to SRS; Downstream from SRS operations; Tributary monitoring	Monthly H3

Supplemental Locations

ID	Location	Rationale	Frequency
SV-2069	McQueen Branch off Monroe Owens Rd.	Downstream from SRS operations; Z-Area	Weekly AB
SV-2071	Upper Three Runs Creek at Road C-4	Downstream from F- & H-Area HLW Tanks	Weekly AB
SV-2075	Upper Three Runs Creek at Road C	Downstream from F- & H-Area HLW Tanks	Weekly AB
SV-2039	Fourmile Branch at Road A-12.2	Downstream from F- & H-Area HLW Tanks	Weekly AB

Notes:
1. ID is Sampling Location Identification Code Number
2. RM is River Mile
3. H3 is Tritium
4. AB is Alpha/Beta

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Table 2. Radiological analytes for gamma spectroscopy analysis

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Ytrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Table 3. 2011 Tritium Data Comparison for SCDHEC and DOE-SR Colocated Sampling Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation (pCi/L)	Median (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Upper Three Runs Creek (SV-325)	952	364	917	370	2,358	52	52
U3R-4 at Road A	938	278	917	530	1,390	12	11
Fourmile Branch (SV-2039)	41,616	6,229	40,918	29,555	53,046	51	51
FM-6 at Road A-12.2	39,500	6,240	39,400	29,200	47,800	12	12
Pen Branch (SV-2047)	31,984	11,581	35,970	4,537	47,901	52	52
PB-3 at Road 13.2	30,800	8,368	32,700	11,800	40,300	12	12
Steel Creek (SV-327)	3,244	904	2,989	1,464	4,929	51	50
SC-4 Steel Creek at Road A	2,900	1,056	2,700	316	4,270	12	11
Highway 301 Bridge (SV-118)	632	579	395	233	2,760	52	45
River Mile 118.8	598	333	542	194	1,760	52	49
Lower Three Runs Creek at Patterson Mill Rd. (SV-328)	2,606	812	2,561	465	3,958	52	52
L3R-2 at Patterson Mill Rd	2,720	661	2,650	1,620	3,700	12	12
Lower Three Runs Creek (SV-2053)	414	82	426	249	576	52	50
L3R-1A at Road B	406	252	313	156	264	12	4

Notes:
1. Shaded areas represent SCDHEC data and unshaded areas represent DOE-SR data
2. DOE-SR data is from the SRS Environmental Data Report for 2011 (SRNS 2011)
3. NA is Not Applicable
4. DOE-SR sampling locations:
   U3R-4: Upper Three Runs at SC Highway 125
   FM-6: Fourmile Branch at USFS Road A-12.2
   PB-3: Pen Branch at USFS Road 13.2
   SC-4: Steel Creek at SC Highway 125
   L3R-2: Lower Three Runs at Patterson Mill Road
   L3R-1A: Lower Three Runs at SRS Road B

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Table 4. 2011 Alpha Data Comparison for SCDHEC and DOE-SR Colocated Sampling Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation (pCi/L)	Median (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Upper Three Runs Creek (SV-325)	14.80	7.16	13.6	6.07	29.8	12	12
U3R-4 at Road A	35.90	39.38	19.50	1.94	125.0	12	12
Fourmile Branch (SV-2039)	*2.49	NA	NA	NA	NA	12	1
FM-6 at Road A-12.2	3.19	3.21	1	0.57	9.16	12	11
Pen Branch (SV-2047)	***1.78**	**NA**	NA	NA	NA	12	1
PB-3 at Road 13.2	1.57	2.49	0.58	-0.16	8.78	12	5
Steel Creek (SV-327)	3.32	2.74	3.32	1.38	5.25	12	5
SC-4 Steel Creek at Road A	3.73	5.20	1	0.24	14.80	12	7
Highway 301 Bridge (SV-118)	*10.70	NA	NA	NA	NA	12	1
River Mile 118.8	0.43	0.36	0	-0.19	1.30	52	2
Lower Three Runs Creek (SV-2053)	**6.26**	**4.38**	6.26	3.16	9.36	12	2
L3R-1A at Road B	1.01	1.04	1	0.02	3.5	12	6

Table 5. 2011 Beta Data Comparison for SCDHEC and DOE-SR Colocated Sampling Locations

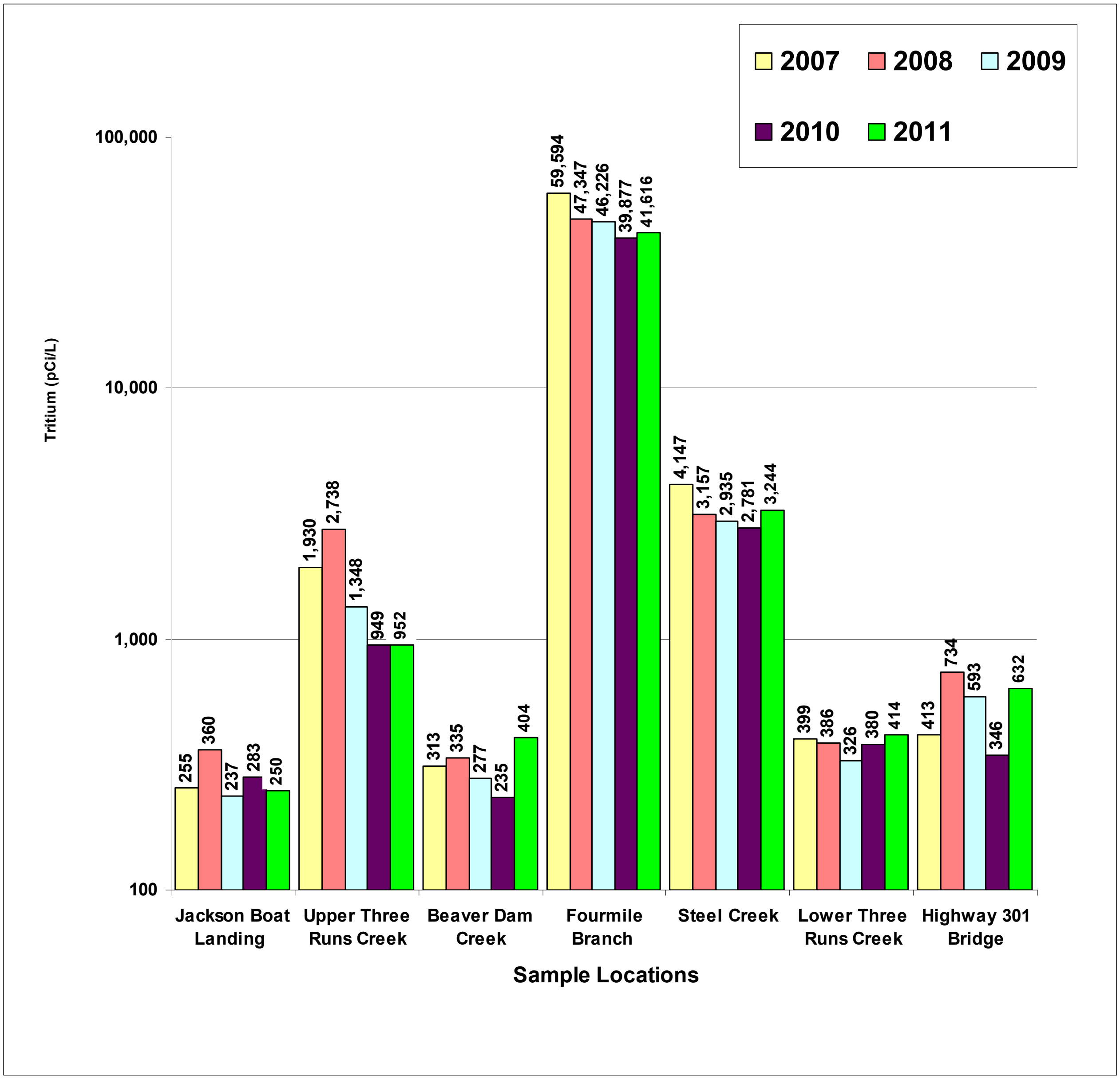
Sample Location	Average Concentration (pCi/L)	Standard Deviation (pCi/L)	Median (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Upper Three Runs Creek (SV-325)	5.74	2.67	6.70	2.73	7.80	12	3
U3R-4 at Road A	12.50	14.70	8	1.36	47.30	12	9
Fourmile Branch (SV-2039)	6.72	1.84	6.93	4.28	9.86	12	7
FM-6 at Road A-12.2	10.40	3.88	9	6.49	17.80	12	12
Pen Branch (SV-2047)	**ND**	**ND**	NA	NA	NA	12	0
PB-3 at Road 13.2	1.85	0.93	2	0.84	4	12	5
Steel Creek (SV-327)	ND	NA	NA	ND	ND	12	0
SC-4 Steel Creek at Road A	3.37	2.31	3	1.20	8.43	12	12
Highway 301 Bridge (SV-118)	6.95	1.22	5.30	4.22	7.49	12	6
River Mile 118.8	2.38	0.70	2	1.40	4.05	52	39
Lower Three Runs Creek (SV-2053)	ND	NA	NA	NA	NA	12	0
L3R-1A at Road B	2.73	0.99	3	1.71	4.54	12	10

Notes:
1. Shaded areas represent SCDHEC data and unshaded areas represent DOE-SR data
2. DOE-SR data is from the SRS Environmental Data Report for 2011 (SRNS 2011)
3. NA is Not Applicable
4. ND is No Detects
5. NR is Not Reported
6. * denotes actual value and uncertainty (±2sd) for one detection for sampling location
7. DOE-SR sampling locations:
   - U3R-4: Upper Three Runs at SC Highway 125
   - FM-6: Fourmile Branch at USFS Road A-12.2
   - PB-3: Pen Branch at USFS Road 13.2
   - SC-4: Steel Creek at SC Highway 125
   - L3R-2: Lower Three Runs at Patterson Mill Road
   - L3R-1A: Lower Three Runs at SRS Road B

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

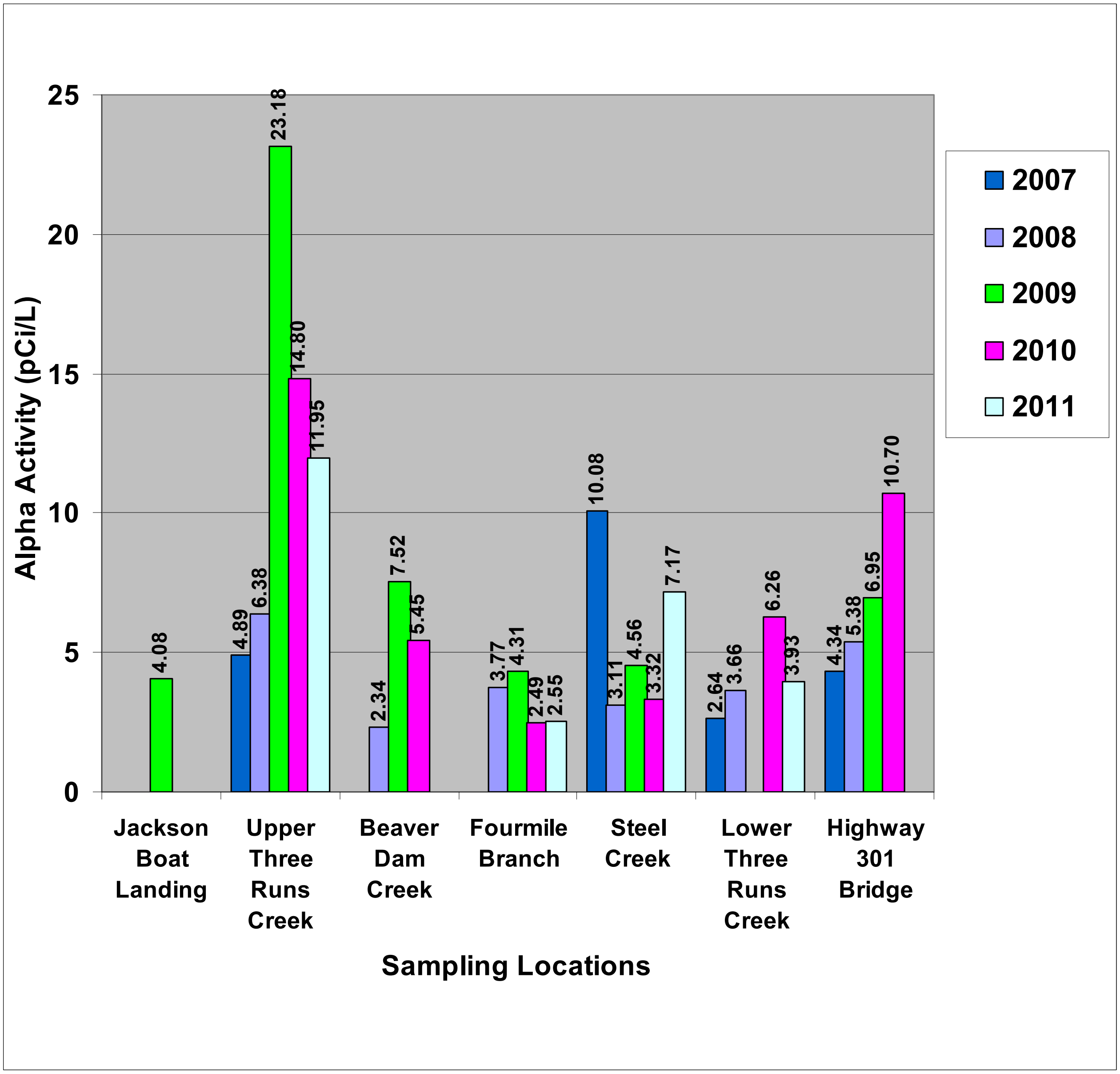
Figure 1. SCDHEC Average Tritium Trends for 2007-2011 (SCDHEC 2008-2011)

Note: Jackson Boat Landing is a background location.



Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

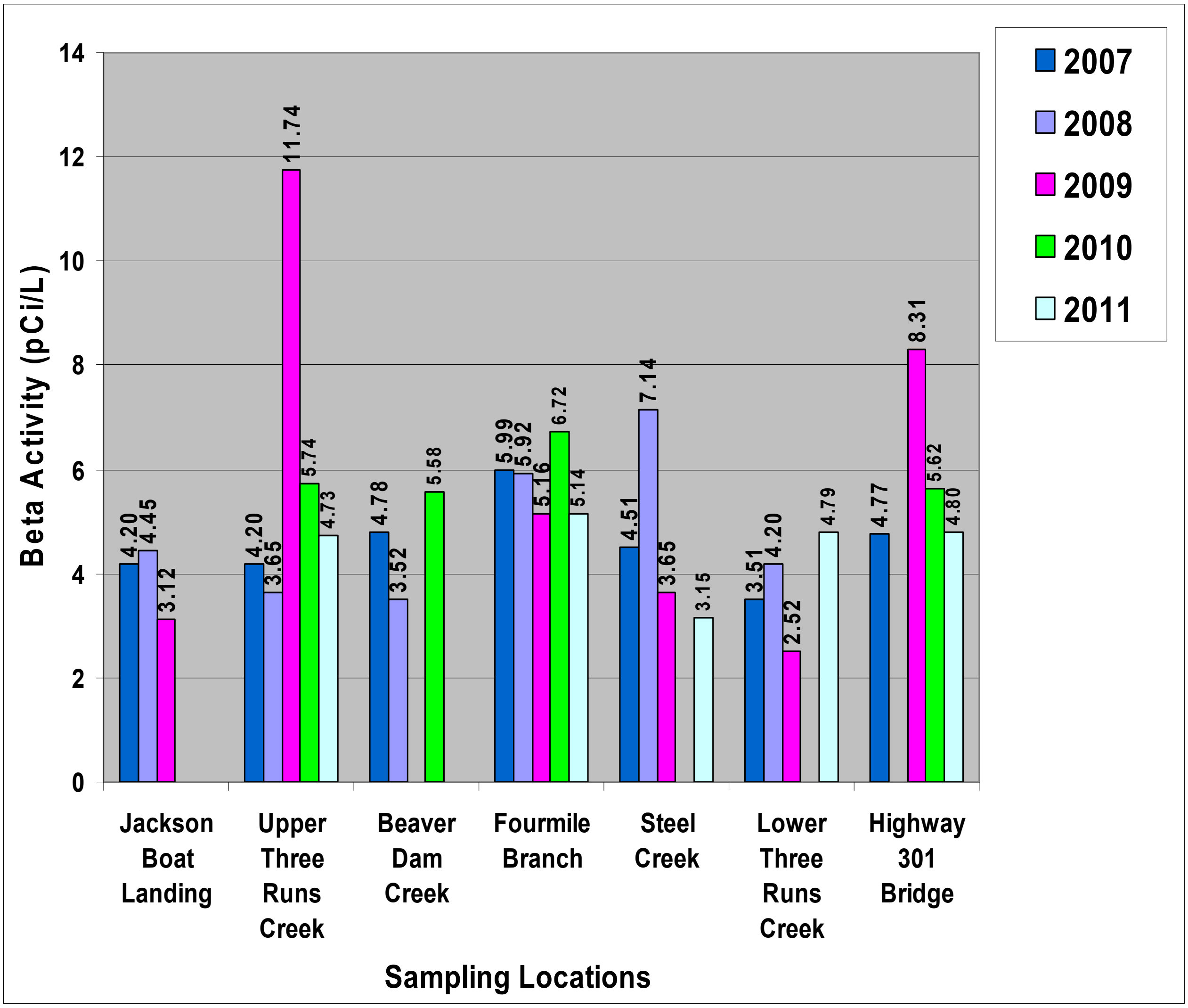
Figure 2. SCDHEC 2007-2011 Average Alpha Data (SCDHEC 2008-2011)



1. No detections at Jackson Landing in 2007, 2008, 2010, and 2011
2. No detections at Beaver Dam Creek 2007 and 2011
3. No detections at Fourmile Branch in 2007
4. No detections at Lower Three Runs Creek in 2009
5. No detections at Highway 301 Bridge in 2011
6. The EPA screening level MCL for Alpha is 15 pCi/L for drinking water.

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

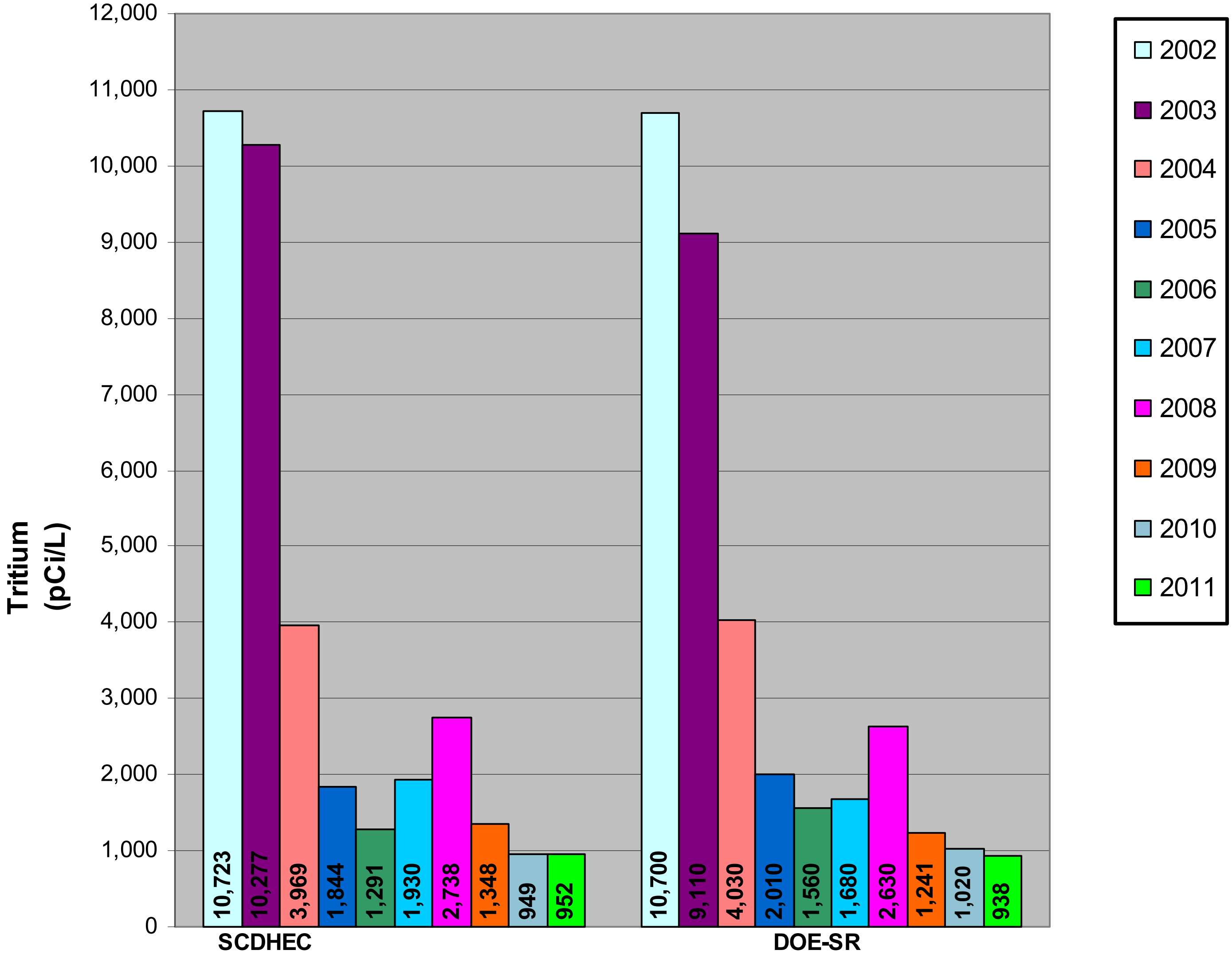
Figure 3. SCDHEC 2007-2011 Average Beta Data (SCDHEC 2008-2011)



Notes:
1. The EPA screening level MCL for gross beta particles is 50 pCi/L for drinking water.
2. No detections at Highway 301 in 2008
3. No detections at Beaver Dam Creek in 2009
4. No detections at Jackson Boat Landing, Steel Creek or Lower Three Runs in 2010
5. No detections at Jackson Boat Landing or Beaver Dam Creek in 2011

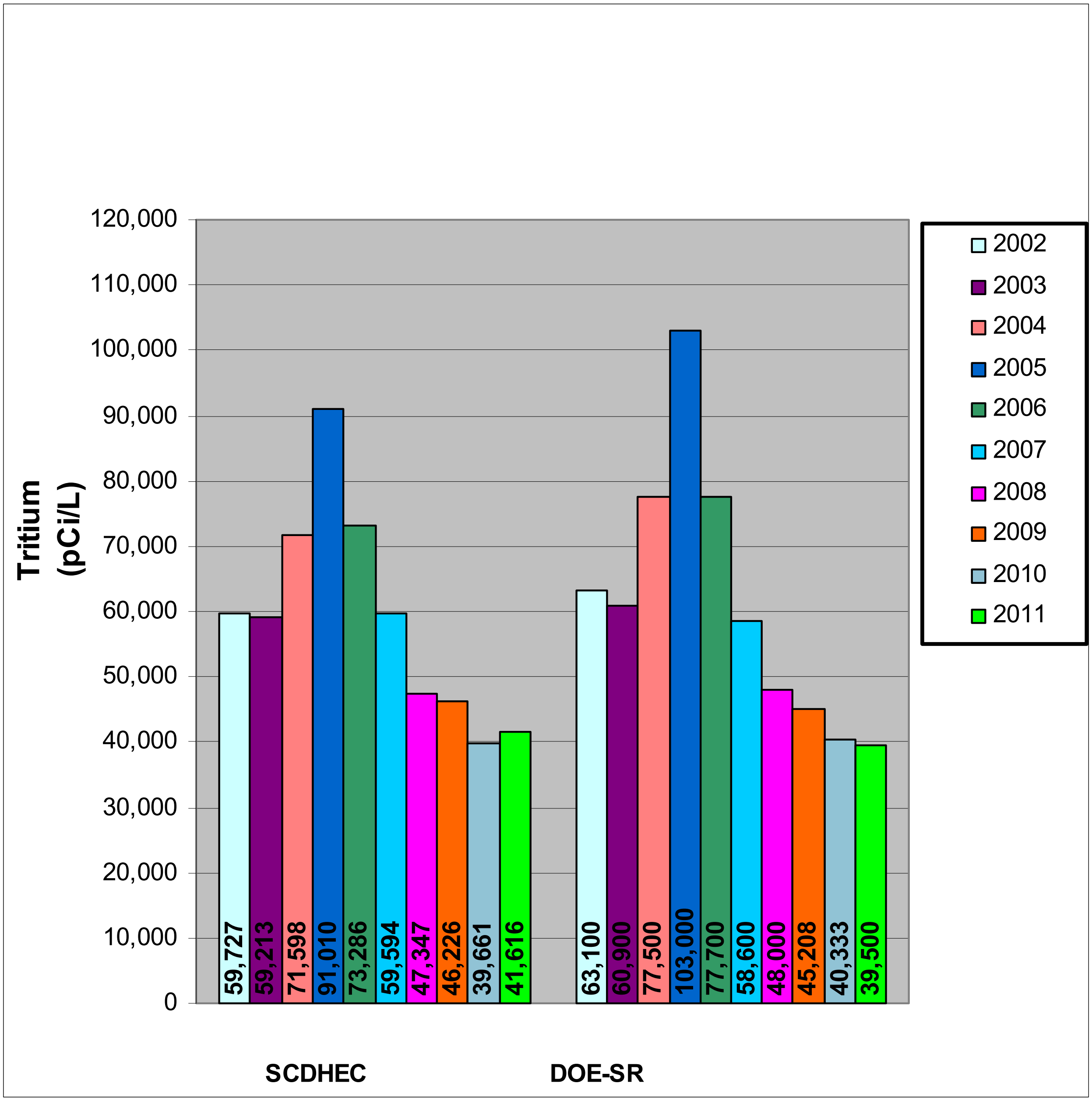
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 4. 2001-2011 Average Tritium Data Trends For SCDHEC and DOE-SR at Upper Three Runs Creek and SC Highway 125 (WSRC 2003-2008, SRNS 2009-2012, SCDHEC 2002-2011).



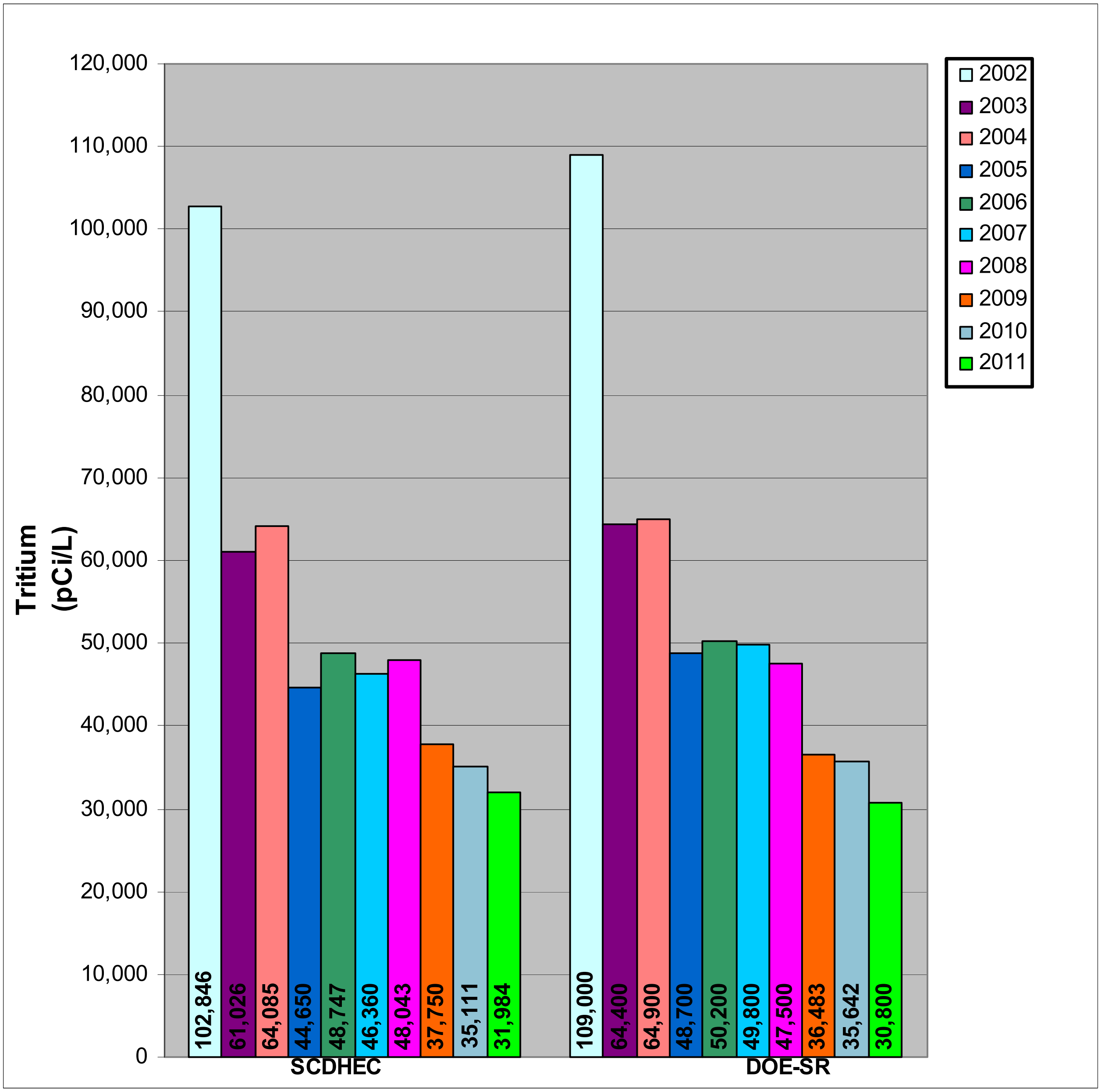
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 5. 2001-2011 Average Tritium Data Trends For SCDHEC and DOE-SR at Fourmile Branch and USFS Road 12.2 (WSRC 2003-2008, SRNS 2009-2012, SCDHEC 2002-2011).



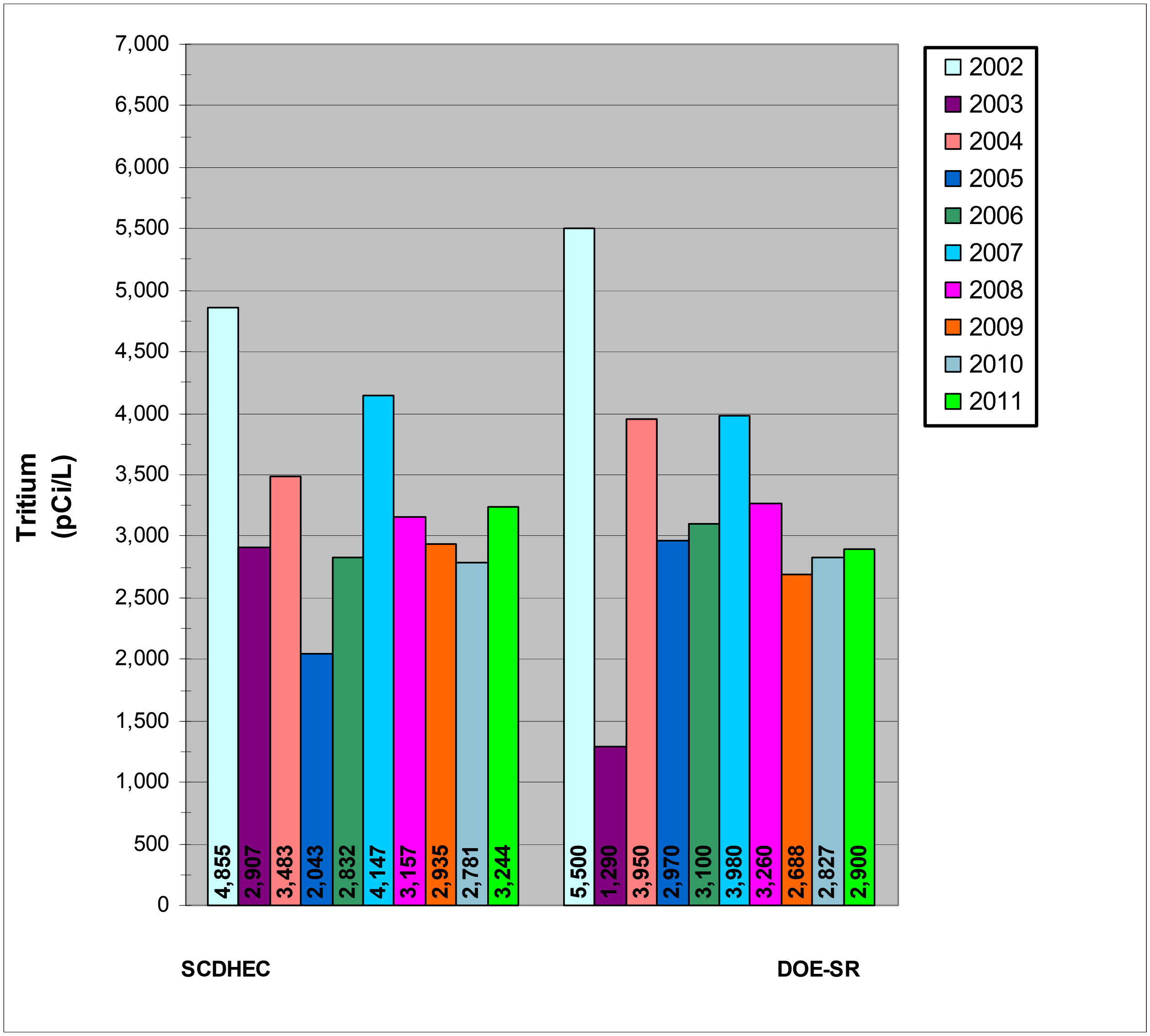
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 6. 2001-2011 Average Tritium Data Trends For SCDHEC and DOE-SR at Pen Branch and USFS Road 13.2 (WSRC 2003-2008, SRNS 2009-2012, SCDHEC 2002-2011).



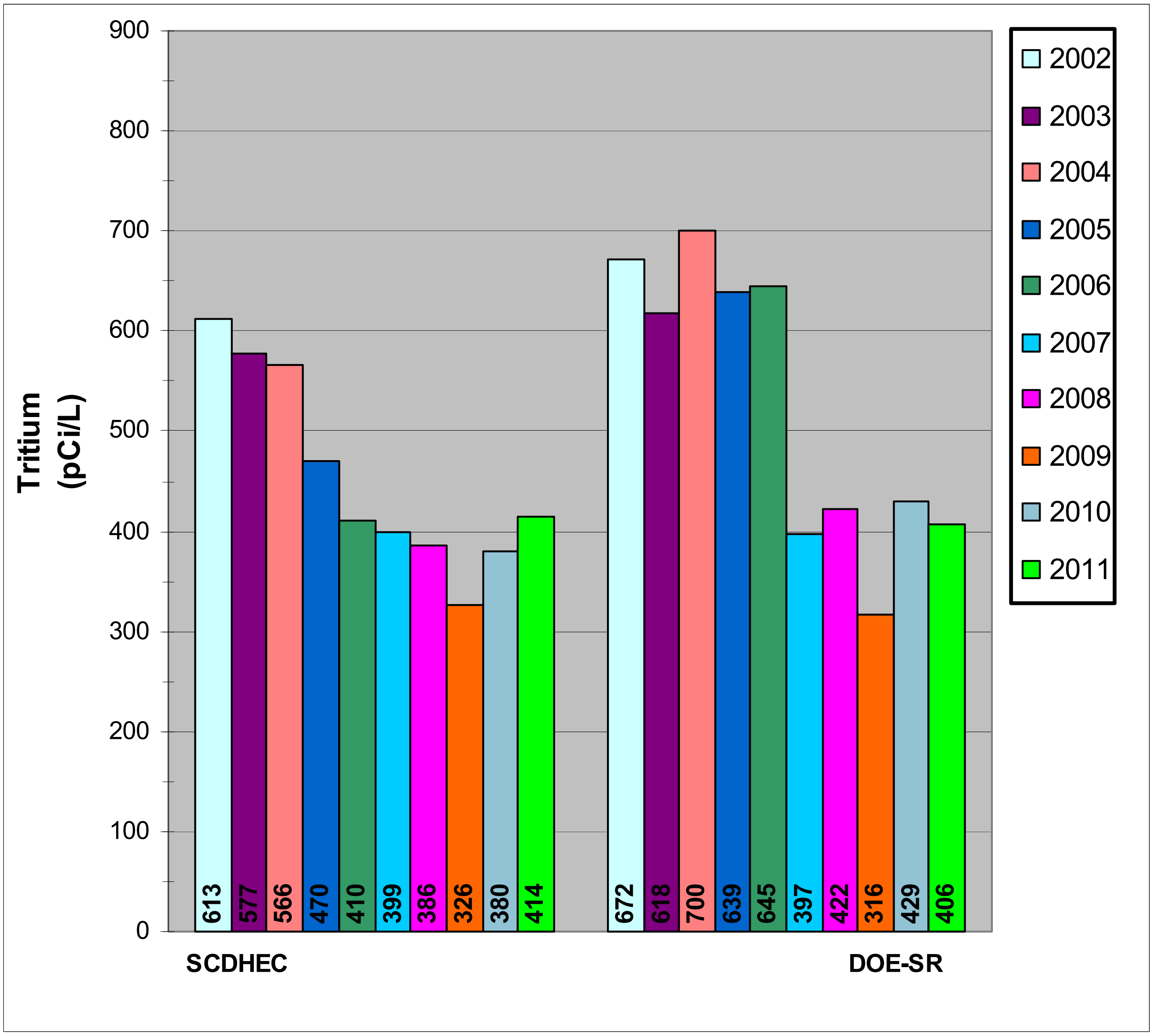
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 7. 2001-2011 Average Tritium Data Trends For SCDHEC and DOE-SR at Steel Creek and SC Highway 125 (WSRC 2003-2008, SRNS 2009-2012, SCDHEC 2002-2011).



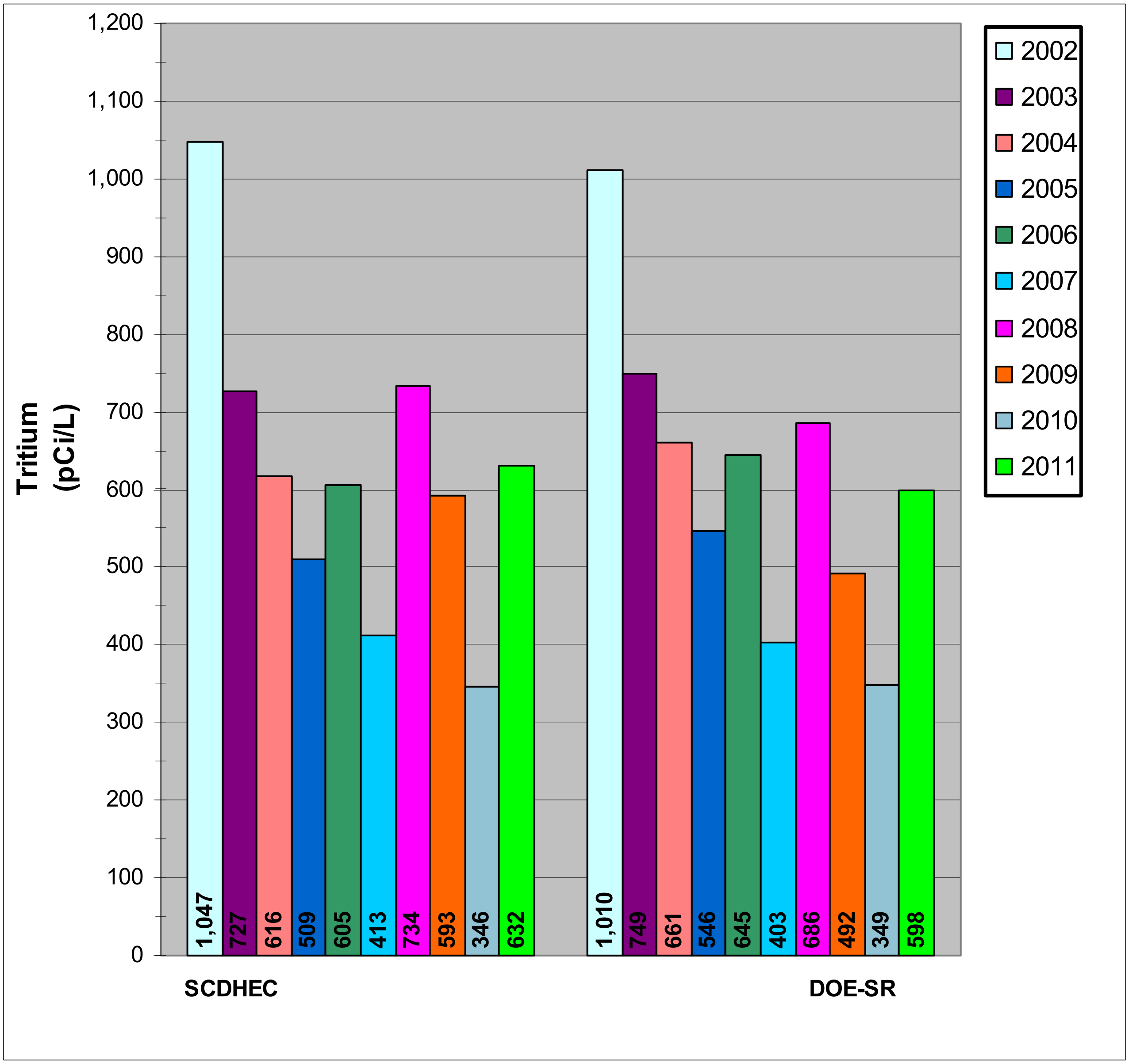
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 8. 2001-2011 Average Tritium Data Trends For SCDHEC and DOE-SR at Lower Three Runs Creek and SRS Road B (WSRC 2003-2008, SRNS 2009-2012, SCDHEC 2002-2011).



Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 9. 2001-2011 Average Tritium Data Trends For SCDHEC and DOE-SR at the Savannah River and US Highway 301 Bridge (WSRC 2003-2008, SRNS 2009-2012, SCDHEC 2002-2011).



6.0 Data
Radiological Monitoring of Surface Water On and Adjacent to the SRS

2011 Ambient Data **25**
2011 Creek Mouth Data **38**
2011 Iodine-129 and Technetium-99 Data **39**

Notes:
1. Concentration is in pCi/L
2. “MDA” is Minimum Detectable Activity
3. “NA” is Non applicable
4. “NS” is No Sample
5. “LLD” is Lower Limit of Detection

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2010 Jackson Boat Landing

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	<LLD	NA	215
	1/12/11	<LLD	NA	217
	1/19/11	<LLD	NA	217
	1/26/11	<LLD	NA	214
February	2/2/11	<LLD	NA	218
	2/9/11	306	103	213
	2/16/11	<LLD	NA	219
	2/23/11	<LLD	NA	209
March	3/2/11	<LLD	NA	219
	3/9/11	<LLD	NA	224
	3/16/11	<LLD	NA	202
	3/23/11	<LLD	NA	221
	3/30/11	<LLD	NA	221
April	4/6/11	<LLD	NA	221
	4/13/11	<LLD	NA	223
	4/20/11	<LLD	NA	231
	4/27/11	<LLD	NA	221
May	5/4/11	<LLD	NA	194
	5/11/11	<LLD	NA	217
	5/18/11	<LLD	NA	223
	5/25/11	<LLD	NA	219
June	6/1/11	<LLD	NA	219
	6/8/11	251	98	211
	6/15/11	218	96	208
	6/22/11	<LLD	NA	217
	6/29/11	<LLD	NA	216
July	7/6/11	<LLD	NA	217
	7/13/11	238	98	209
	7/20/11	<LLD	NA	239
	7/27/11	<LLD	NA	208
August	8/3/11	<LLD	NA	207
	8/10/11	<LLD	NA	213
	8/17/11	255	99	208
	8/24/11	<LLD	NA	214
	8/31/11	<LLD	NA	205
September	9/7/11	<LLD	NA	207
	9/14/11	223	99	212
	9/21/11	<LLD	NA	223
	9/28/11	<LLD	NA	220
October	10/5/11	<LLD	NA	206
	10/12/11	<LLD	NA	209
	10/19/11	287	107	228
	10/26/11	<LLD	NA	212
November	11/2/11	<LLD	NA	213
	11/9/11	<LLD	NA	220
	11/16/11	246	105	222
	11/23/11	<LLD	NA	207
	11/30/11	<LLD	NA	212
December	12/7/11	206	94	203
	12/14/11	<LLD	NA	214
	12/21/11	273	99	208
	12/28/11	<LLD	NA	214

SV-325 Upper Three Runs and SC Highway 125

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	648	117	215
	1/12/11	682	117	217
	1/19/11	1249	137	217
	1/26/11	1165	138	214
February	2/2/11	1039	128	218
	2/9/11	1052	128	213
	2/16/11	655	116	219
	2/23/11	939	122	209
March	3/2/11	697	118	219
	3/9/11	940	128	224
	3/16/11	1288	131	202
	3/23/11	1442	141	221
	3/30/11	934	130	221
April	4/6/11	1520	145	221
	4/13/11	631	118	223
	4/20/11	810	125	231
	4/27/11	928	127	221
May	5/4/11	663	107	194
	5/11/11	908	126	217
	5/18/11	1573	145	223
	5/25/11	1558	146	219
June	6/1/11	370	106	219
	6/8/11	1055	126	211
	6/15/11	894	122	208
	6/22/11	1331	136	217
	6/29/11	889	122	216
July	7/6/11	806	120	217
	7/13/11	1023	124	209
	7/20/11	819	125	239
	7/27/11	943	120	208
August	8/3/11	598	111	207
	8/10/11	960	123	213
	8/17/11	543	109	208
	8/24/11	1422	137	214
	8/31/11	2358	158	205
September	9/7/11	397	103	207
	9/14/11	1515	139	212
	9/21/11	1052	130	223
	9/28/11	464	112	220
October	10/5/11	1068	124	206
	10/12/11	1223	130	209
	10/19/11	1030	132	228
	10/26/11	845	120	212
November	11/2/11	828	119	213
	11/9/11	926	125	220
	11/16/11	528	115	222
	11/23/11	850	119	207
	11/30/11	469	107	212
December	12/7/11	748	115	203
	12/14/11	706	116	214
	12/21/11	796	115	208
	12/28/11	721	117	214

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2012 TNX Boat Landing D-Area SRS

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	<LLD	NA	215
	1/12/11	<LLD	NA	217
	1/19/11	<LLD	NA	217
	1/26/11	<LLD	NA	214
February	2/2/11	<LLD	NA	218
	2/9/11	356	105	213
	2/16/11	268	103	219
	2/23/11	256	99	209
March	3/2/11	284	104	219
	3/9/11	<LLD	NA	224
	3/16/11	215	95	202
	3/23/11	285	105	221
	3/30/11	<LLD	NA	221
April	4/6/11	<LLD	NA	221
	4/13/11	<LLD	NA	223
	4/20/11	<LLD	NA	231
	4/27/11	<LLD	NA	221
May	5/4/11	<LLD	NA	194
	5/11/11	<LLD	NA	217
	5/18/11	<LLD	NA	223
	5/25/11	<LLD	NA	219
June	6/1/11	<LLD	NA	219
	6/8/11	218	98	211
	6/15/11	<LLD	NA	208
	6/22/11	<LLD	NA	217
	6/29/11	<LLD	NA	216
July	7/6/11	<LLD	NA	217
	7/13/11	<LLD	NA	209
	7/20/11	<LLD	NA	239
	7/27/11	<LLD	NA	208
August	8/3/11	272	99	207
	8/10/11	<LLD	NA	213
	8/17/11	<LLD	NA	208
	8/24/11	289	102	214
	8/31/11	237	96	205
September	9/7/11	273	98	207
	9/14/11	<LLD	NA	212
	9/21/11	<LLD	NA	223
	9/28/11	<LLD	NA	220
October	10/5/11	<LLD	NA	206
	10/12/11	<LLD	NA	209
	10/19/11	<LLD	NA	228
	10/26/11	<LLD	NA	212
November	11/2/11	<LLD	NA	213
	11/9/11	<LLD	NA	220
	11/16/11	<LLD	NA	222
	11/23/11	250	97	207
	11/30/11	<LLD	NA	212
December	12/7/11	218	94	203
	12/14/11	<LLD	NA	214
	12/21/11	252	96	208
	12/28/11	332	103	214

SV-2040 Beaver Dam Creek D-Area

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	268	101	215
	1/12/11	<LLD	NA	217
	1/19/11	<LLD	NA	217
	1/26/11	2215	157	214
February	2/2/11	<LLD	NA	218
	2/9/11	291	102	213
	2/16/11	<LLD	NA	219
	2/23/11	<LLD	NA	209
March	3/2/11	<LLD	NA	219
	3/9/11	<LLD	NA	224
	3/16/11	212	94	202
	3/23/11	<LLD	NA	221
	3/30/11	<LLD	NA	221
April	4/6/11	<LLD	NA	221
	4/13/11	<LLD	NA	223
	4/20/11	<LLD	NA	231
	4/27/11	<LLD	NA	221
May	5/4/11	<LLD	NA	194
	5/11/11	<LLD	NA	217
	5/18/11	<LLD	NA	223
	5/25/11	<LLD	NA	219
June	6/1/11	<LLD	NA	219
	6/8/11	263	99	211
	6/15/11	351	101	208
	6/22/11	<LLD	NA	217
	6/29/11	<LLD	NA	216
July	7/6/11	<LLD	NA	217
	7/13/11	<LLD	NA	209
	7/20/11	<LLD	NA	239
	7/27/11	<LLD	NA	208
August	8/3/11	<LLD	NA	207
	8/10/11	<LLD	NA	213
	8/17/11	278	99	208
	8/24/11	253	101	214
	8/31/11	260	97	205
September	9/7/11	<LLD	NA	207
	9/14/11	234	99	212
	9/21/11	<LLD	NA	223
	9/28/11	<LLD	NA	220
October	10/5/11	<LLD	NA	206
	10/12/11	<LLD	NA	209
	10/19/11	389	111	228
	10/26/11	229	99	212
November	11/2/11	234	98	213
	11/9/11	<LLD	NA	220
	11/16/11	<LLD	NA	222
	11/23/11	257	97	207
	11/30/11	443	106	212
December	12/7/11	<LLD	NA	203
	12/14/11	<LLD	NA	214
	12/21/11	281	99	208
	12/28/11	<LLD	NA	214

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2039 Four Mile Creek at USFS Rd. 13.2

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	52849	635	215
	1/12/11	52095	633	217
	1/19/11	47959	618	217
	1/26/11	53046	641	214
February	2/2/11	52800	641	218
	2/9/11	36094	541	213
	2/16/11	43666	587	219
	2/23/11	34329	514	209
March	3/2/11	50023	633	219
	3/9/11	47359	622	224
	3/16/11	46314	591	202
	3/23/11	48484	628	221
	3/30/11	38635	557	221
April	4/6/11	36773	547	221
	4/13/11	38009	563	223
	4/20/11	47275	624	231
	4/27/11	45639	608	221
May	5/4/11	34742	502	194
	5/11/11	33367	485	217
	5/18/11	44704	596	223
	5/25/11	41919	578	219
June	6/1/11	44650	587	219
	6/8/11	40918	558	211
	6/15/11	NS	NS	NS
	6/22/11	37549	538	217
	6/29/11	40120	556	216
July	7/6/11	40694	560	217
	7/13/11	36430	536	209
	7/20/11	35825	530	239
	7/27/11	34237	501	208
August	8/3/11	34455	518	207
	8/10/11	35496	524	213
	8/17/11	33636	511	208
	8/24/11	36746	540	214
	8/31/11	34385	517	205
September	9/7/11	34698	520	207
	9/14/11	36764	535	212
	9/21/11	29555	484	223
	9/28/11	35403	524	220
October	10/5/11	35717	525	206
	10/12/11	40309	559	209
	10/19/11	41242	577	228
	10/26/11	41446	571	212
November	11/2/11	45744	597	213
	11/9/11	46224	598	220
	11/16/11	47519	606	222
	11/23/11	44549	591	207
	11/30/11	46985	610	212
December	12/7/11	39203	536	203
	12/14/11	47964	610	214
	12/21/11	49309	618	208
	12/28/11	48573	612	214

SV-2047 Pen Branch at USFS Rd. 13.2

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	38397	548	215
	1/12/11	32505	495	217
	1/19/11	5805	229	217
	1/26/11	34315	515	214
February	2/2/11	40642	567	218
	2/9/11	19763	403	213
	2/16/11	18291	390	219
	2/23/11	19082	387	209
March	3/2/11	5978	233	219
	3/9/11	5269	223	224
	3/16/11	5389	216	202
	3/23/11	20387	411	221
	3/30/11	25836	462	221
April	4/6/11	21250	418	221
	4/13/11	30314	494	223
	4/20/11	37711	570	231
	4/27/11	39863	566	221
May	5/4/11	27328	438	194
	5/11/11	39806	545	217
	5/18/11	40882	569	223
	5/25/11	27326	466	219
June	6/1/11	40556	550	219
	6/8/11	37357	531	211
	6/15/11	32639	489	208
	6/22/11	47901	605	217
	6/29/11	4537	206	216
July	7/6/11	24588	514	217
	7/13/11	44870	589	209
	7/20/11	37971	537	239
	7/27/11	31741	487	208
August	8/3/11	39604	550	207
	8/10/11	29064	472	213
	8/17/11	39436	548	208
	8/24/11	33577	513	214
	8/31/11	34666	514	205
September	9/7/11	32703	498	207
	9/14/11	35931	525	212
	9/21/11	40545	562	223
	9/28/11	36930	531	220
October	10/5/11	34393	511	206
	10/12/11	37480	537	209
	10/19/11	36009	538	228
	10/26/11	40786	564	212
November	11/2/11	41408	569	213
	11/9/11	44094	584	220
	11/16/11	37552	539	222
	11/23/11	16125	359	207
	11/30/11	40999	568	212
December	12/7/11	44117	588	203
	12/14/11	42980	575	214
	12/21/11	43945	583	208
	12/28/11	42545	571	214

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-327 Steel Creek at SC Highway 125

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	2302	160	215
	1/12/11	2258	160	217
	1/19/11	2401	164	217
	1/26/11	2304	160	214
February	2/2/11	2394	163	218
	2/9/11	1649	145	213
	2/16/11	1975	151	219
	2/23/11	1464	137	209
March	3/2/11	2457	166	219
	3/9/11	2401	165	224
	3/16/11	2570	162	202
	3/23/11	2860	177	221
	3/30/11	2326	166	221
April	4/6/11	2563	170	221
	4/13/11	3604	192	223
	4/20/11	3978	208	231
	4/27/11	4427	217	221
May	5/4/11	3140	167	194
	5/11/11	3900	192	217
	5/18/11	4135	201	223
	5/25/11	3332	184	219
June	6/1/11	4691	208	219
	6/8/11	4929	210	211
	6/15/11	NS	NS	NS
	6/22/11	4323	202	217
	6/29/11	<LLD	NA	216
July	7/6/11	4026	195	217
	7/13/11	4890	210	209
	7/20/11	4440	206	239
	7/27/11	4569	202	208
August	8/3/11	3435	182	207
	8/10/11	3716	189	213
	8/17/11	3401	181	208
	8/24/11	4038	198	214
	8/31/11	4241	197	205
September	9/7/11	4524	203	207
	9/14/11	4566	207	212
	9/21/11	2701	171	223
	9/28/11	4096	197	220
October	10/5/11	3370	180	206
	10/12/11	3412	183	209
	10/19/11	2817	177	228
	10/26/11	2873	173	212
November	11/2/11	2970	174	213
	11/9/11	3007	177	220
	11/16/11	2864	174	222
	11/23/11	2533	163	207
	11/30/11	2869	174	212
December	12/7/11	2834	170	203
	12/14/11	2433	162	214
	12/21/11	2852	172	208
	12/28/11	2346	161	214

SV-2018 Steel Creek Boat Landing

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	329	104	215
	1/12/11	452	109	217
	1/19/11	1008	127	217
	1/26/11	<LLD	NA	214
February	2/2/11	1708	146	218
	2/9/11	1290	135	213
	2/16/11	2590	167	219
	2/23/11	1123	128	209
March	3/2/11	1103	131	219
	3/9/11	1675	149	224
	3/16/11	1214	130	202
	3/23/11	886	126	221
	3/30/11	<LLD	NA	221
April	4/6/11	4343	210	221
	4/13/11	<LLD	NA	223
	4/20/11	248	106	231
	4/27/11	246	103	221
May	5/4/11	227	91	194
	5/11/11	<LLD	NA	217
	5/18/11	6365	241	223
	5/25/11	302	105	219
June	6/1/11	<LLD	NA	219
	6/8/11	<LLD	NA	211
	6/15/11	337	101	208
	6/22/11	<LLD	NA	217
	6/29/11	309	103	216
July	7/6/11	274	102	217
	7/13/11	293	99	209
	7/20/11	<LLD	NA	239
	7/27/11	304	100	208
August	8/3/11	309	100	207
	8/10/11	5827	226	213
	8/17/11	314	101	208
	8/24/11	246	97	214
	8/31/11	832	116	205
September	9/7/11	3765	189	207
	9/14/11	250	100	212
	9/21/11	391	108	223
	9/28/11	249	102	220
October	10/5/11	<LLD	NA	206
	10/12/11	<LLD	N	209
	10/19/11	338	110	228
	10/26/11	260	99	212
November	11/2/11	NS	NS	213
	11/9/11	292	104	220
	11/16/11	<LLD	NA	222
	11/23/11	418	103	207
	11/30/11	2115	156	212
December	12/7/11	379	101	203
	12/14/11	268	99	214
	12/21/11	395	103	208
	12/28/11	359	104	214

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2019 Little Hell Landing

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	345	103	215
	1/12/11	240	101	217
	1/19/11	353	106	217
	1/26/11	431	106	214
February	2/2/11	239	101	218
	2/9/11	366	104	213
	2/16/11	900	124	219
	2/23/11	304	100	209
March	3/2/11	588	114	219
	3/9/11	236	103	224
	3/16/11	371	100	202
	3/23/11	500	113	221
	3/30/11	<LLD	NA	221
April	4/6/11	1274	138	221
	4/13/11	<LLD	NA	223
	4/20/11	265	109	231
	4/27/11	333	107	221
May	5/4/11	<LLD	NA	194
	5/11/11	417	107	217
	5/18/11	<LLD	NA	223
	5/25/11	421	109	219
June	6/1/11	<LLD	NA	219
	6/8/11	<LLD	NA	211
	6/15/11	301	100	208
	6/22/11	<LLD	NA	217
	6/29/11	271	102	216
July	7/6/11	329	104	217
	7/13/11	667	113	209
	7/20/11	343	110	239
	7/27/11	385	103	208
August	8/3/11	364	102	207
	8/10/11	1118	128	213
	8/17/11	469	106	208
	8/24/11	<LLD	NA	214
	8/31/11	416	102	205
September	9/7/11	403	103	207
	9/14/11	724	116	212
	9/21/11	1522	142	223
	9/28/11	1323	136	220
October	10/5/11	882	118	206
	10/12/11	742	115	209
	10/19/11	335	110	228
	10/26/11	299	101	212
November	11/2/11	214	97	213
	11/9/11	<LLD	NA	220
	11/16/11	<LLD	NA	222
	11/23/11	<LLD	NA	207
	11/30/11	320	102	212
December	12/7/11	211	95	203
	12/14/11	<LLD	N	214
	12/21/11	224	97	208
	12/28/11	276	101	214

SV-118 US Highway 301 Bridge

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	296	102	215
	1/12/11	630	114	217
	1/19/11	987	126	217
	1/26/11	2760	170	214
February	2/2/11	481	110	218
	2/9/11	395	105	213
	2/16/11	340	106	219
	2/23/11	301	99	209
March	3/2/11	1782	150	219
	3/9/11	469	110	224
	3/16/11	1072	123	202
	3/23/11	841	123	221
	3/30/11	549	113	221
April	4/6/11	256	103	221
	4/13/11	<LLD	NA	223
	4/20/11	354	112	231
	4/27/11	<LLD	NA	221
May	5/4/11	<LLD	NA	194
	5/11/11	265	100	217
	5/18/11	283	105	223
	5/25/11	336	105	219
June	6/1/11	456	109	219
	6/8/11	400	105	211
	6/15/11	363	102	208
	6/22/11	<LLD	NA	217
	6/29/11	365	104	216
July	7/6/11	306	103	217
	7/13/11	643	112	209
	7/20/11	405	112	239
	7/27/11	628	111	208
August	8/3/11	330	101	207
	8/10/11	1547	140	213
	8/17/11	347	102	208
	8/24/11	309	100	214
	8/31/11	494	105	205
September	9/7/11	635	111	207
	9/14/11	977	124	212
	9/21/11	1048	129	223
	9/28/11	1532	141	220
October	10/5/11	2593	215	206
	10/12/11	488	107	209
	10/19/11	306	109	228
	10/26/11	<LLD	NA	212
November	11/2/11	240	98	213
	11/9/11	233	102	220
	11/16/11	<LLD	NA	222
	11/23/11	303	99	207
	11/30/11	<LLD	NA	212
December	12/7/11	331	100	203
	12/14/11	242	99	214
	12/21/11	266	98	208
	12/28/11	248	100	214

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-328 Lower Three Runs at Patterson Mill Rd.

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	3097	177	215
	1/12/11	2400	163	217
	1/19/11	2207	159	217
	1/26/11	465	108	214
February	2/2/11	1849	154	218
	2/9/11	1856	149	213
	2/16/11	1102	130	219
	2/23/11	1736	143	209
March	3/2/11	1857	152	219
	3/9/11	2132	159	224
	3/16/11	2273	154	202
	3/23/11	1848	152	221
	3/30/11	1333	139	221
April	4/6/11	1160	132	221
	4/13/11	2145	159	223
	4/20/11	2142	166	231
	4/27/11	2434	166	221
May	5/4/11	1892	139	194
	5/11/11	2567	163	217
	5/18/11	2804	174	223
	5/25/11	1765	149	219
June	6/1/11	3513	186	219
	6/8/11	3815	189	211
	6/15/11	3353	179	208
	6/22/11	3957	193	217
	6/29/11	3366	182	216
July	7/6/11	3958	193	217
	7/13/11	3713	189	209
	7/20/11	3576	190	239
	7/27/11	2967	169	208
August	8/3/11	3375	181	207
	8/10/11	3525	185	213
	8/17/11	3289	179	208
	8/24/11	3649	164	214
	8/31/11	3790	189	205
September	9/7/11	3002	173	207
	9/14/11	3493	186	212
	9/21/11	2162	157	223
	9/28/11	2878	173	220
October	10/5/11	3031	174	206
	10/12/11	2455	164	209
	10/19/11	2359	169	228
	10/26/11	3155	180	212
November	11/2/11	3076	176	213
	11/9/11	2793	172	220
	11/16/11	2554	167	222
	11/23/11	2736	169	207
	11/30/11	2059	154	212
December	12/7/11	2581	164	203
	12/14/11	2288	159	214
	12/21/11	2512	164	208
	12/28/11	1470	140	214

SV-2053 Lower Three Runs at SRS Rd. B

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	427	107	215
	1/12/11	283	101	217
	1/19/11	537	112	217
	1/26/11	249	100	214
February	2/2/11	494	110	218
	2/9/11	576	111	213
	2/16/11	495	111	219
	2/23/11	448	106	209
March	3/2/11	438	108	219
	3/9/11	446	112	224
	3/16/11	541	106	202
	3/23/11	524	112	221
	3/30/11	433	109	221
April	4/6/11	346	106	221
	4/13/11	300	105	223
	4/20/11	486	117	231
	4/27/11	366	107	221
May	5/4/11	345	94	194
	5/11/11	323	102	217
	5/18/11	341	107	223
	5/25/11	409	107	219
June	6/1/11	273	103	219
	6/8/11	339	101	211
	6/15/11	425	103	208
	6/22/11	400	106	217
	6/29/11	444	107	216
July	7/6/11	314	103	217
	7/13/11	520	109	209
	7/20/11	<LLD	NA	239
	7/27/11	456	108	208
August	8/3/11	422	104	207
	8/10/11	349	104	213
	8/17/11	336	101	208
	8/24/11	258	99	214
	8/31/11	501	106	205
September	9/7/11	<LLD	NA	207
	9/14/11	443	108	212
	9/21/11	408	110	223
	9/28/11	437	117	220
October	10/5/11	446	107	206
	10/12/11	410	106	209
	10/19/11	411	115	228
	10/26/11	510	113	212
November	11/2/11	496	108	213
	11/9/11	407	108	220
	11/16/11	312	105	222
	11/23/11	484	106	207
	11/30/11	491	108	212
December	12/7/11	496	105	203
	12/14/11	384	103	214
	12/21/11	426	104	208
	12/28/11	303	102	214

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2027 Upper Three Runs at USFS Rd. E-2

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/5/11	<LLD	NA	215
	1/12/11	<LLD	NA	217
	1/19/11	<LLD	NA	217
	1/26/11	249	163	214
February	2/2/11	282	104	218
	2/9/11	293	101	213
	2/16/11	<LLD	NA	219
	2/23/11	219	96	209
March	3/2/11	<LLD	NA	219
	3/9/11	<LLD	NA	224
	3/16/11	<LLD	NA	202
	3/23/11	<LLD	NA	221
	3/30/11	<LLD	NA	221
April	4/6/11	<LLD	NA	221
	4/13/11	<LLD	NA	223
	4/20/11	<LLD	NA	231
	4/27/11	<LLD	NA	221
May	5/4/11	<LLD	NA	194
	5/11/11	<LLD	NA	217
	5/18/11	<LLD	NA	223
	5/25/11	<LLD	NA	219
June	6/1/11	<LLD	NA	219
	6/8/11	<LLD	NA	211
	6/15/11	224	96	208
	6/22/11	<LLD	NA	217
	6/29/11	<LLD	NA	216
July	7/6/11	<LLD	NA	217
	7/13/11	233	97	209
	7/20/11	<LLD	NA	239
	7/27/11	285	99	208
August	8/3/11	240	97	207
	8/10/11	<LLD	NA	213
	8/17/11	254	98	208
	8/24/11	<LLD	NA	214
	8/31/11	278	97	205
September	9/7/11	438	105	207
	9/14/11	234	99	212
	9/21/11	<LLD	NA	223
	9/28/11	<LLD	NA	220
October	10/5/11	240	97	206
	10/12/11	<LLD	NA	209
	10/19/11	<LLD	NA	228
	10/26/11	<LLD	NA	212
November	11/2/11	230	98	213
	11/9/11	<LLD	NA	220
	11/16/11	<LLD	NA	222
	11/23/11	326	101	207
	11/30/11	<LLD	NA	212
December	12/7/11	343	100	203
	12/14/11	<LLD	NA	214
	12/21/11	238	98	208
	12/28/11	217	100	214

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Gamma Data

SV-2010 Jackson Boat Landing

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	9.04E-01	<MDA	NA	1.02E+00	<MDA	NA	1.03E+01
February	01/26/11	02/23/11	<MDA	NA	1.99E+00	<MDA	NA	2.65E+00	<MDA	NA	1.86E+01
March	02/23/11	03/30/11	<MDA	NA	3.31E+00	<MDA	NA	3.99E+00	<MDA	NA	7.81E+01
April	03/30/11	04/27/11	<MDA	NA	2.29E+00	<MDA	NA	2.62E+00	<MDA	NA	1.82E+01
May	04/27/11	06/01/11	<MDA	NA	2.28E+00	<MDA	NA	2.77E+00	<MDA	NA	2.01E+01
June	06/01/11	06/29/11	<MDA	NA	2.60E+00	<MDA	NA	2.82E+00	<MDA	NA	2.08E+01
July	06/29/11	07/27/11	<MDA	NA	2.35E+00	<MDA	NA	2.86E+00	<MDA	NA	2.08E+01
August	07/27/11	08/31/11	<MDA	NA	2.36E+00	<MDA	NA	2.82E+00	<MDA	NA	2.13E+01
September	08/31/11	09/28/11	<MDA	NA	2.24E+00	<MDA	NA	2.91E+00	<MDA	NA	2.13E+01
October	09/28/11	11/02/11	<MDA	NA	2.23E+00	<MDA	NA	2.89E+00	<MDA	NA	2.17E+01
November	11/02/11	11/30/11	<MDA	NA	2.41E+00	<MDA	NA	2.76E+00	<MDA	NA	2.16E+01
December	11/30/11	12/28/11	<MDA	NA	2.38E+00	<MDA	NA	3.01E+00	<MDA	NA	2.12E+01

SV-325 Upper Three Runs at SC Highway 125

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	2.11E+00	<MDA	NA	2.43E+00	<MDA	NA	2.46E+01
February	01/26/11	02/23/11	<MDA	NA	2.14E+00	<MDA	NA	2.69E+00	<MDA	NA	1.87E+01
March	02/23/11	03/30/11	<MDA	NA	3.31E+00	<MDA	NA	3.99E+00	<MDA	NA	7.88E+01
April	03/30/11	04/27/11	<MDA	NA	2.09E+00	<MDA	NA	2.55E+00	<MDA	NA	1.90E+01
May	04/27/11	06/01/11	<MDA	NA	2.36E+00	<MDA	NA	2.95E+00	<MDA	NA	2.11E+01
June	06/01/11	06/29/11	<MDA	NA	2.35E+00	<MDA	NA	2.99E+00	<MDA	NA	2.07E+01
July	06/29/11	07/27/11	<MDA	NA	2.41E+00	<MDA	NA	2.63E+00	<MDA	NA	2.16E+01
August	07/27/11	08/31/11	<MDA	NA	2.44E+00	<MDA	NA	3.02E+00	<MDA	NA	2.07E+01
September	08/31/11	09/28/11	<MDA	NA	2.46E+00	<MDA	NA	2.84E+00	<MDA	NA	2.19E+01
October	09/28/11	11/02/11	<MDA	NA	2.46E+00	<MDA	NA	2.84E+00	<MDA	NA	2.09E+01
November	11/02/11	11/30/11	<MDA	NA	2.54E+00	<MDA	NA	2.69E+00	<MDA	NA	2.10E+01
December	11/30/11	12/28/11	<MDA	NA	2.24E+00	<MDA	NA	2.93E+00	<MDA	NA	2.18E+01

SV-2040 Beaver Dam Creek

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	2.20E+00	<MDA	NA	2.43E+00	<MDA	NA	2.22E+01
February	01/26/11	02/23/11	<MDA	NA	2.32E+00	<MDA	NA	2.80E+00	<MDA	NA	1.84E+01
March	02/23/11	03/30/11	<MDA	NA	3.18E+00	<MDA	NA	3.99E+00	<MDA	NA	7.82E+01
April	03/30/11	04/27/11	<MDA	NA	2.04E+00	<MDA	NA	2.48E+00	<MDA	NA	1.88E+01
May	04/27/11	06/01/11	<MDA	NA	2.29E+00	<MDA	NA	2.78E+00	<MDA	NA	2.19E+01
June	06/01/11	06/29/11	<MDA	NA	2.39E+00	<MDA	NA	2.88E+00	<MDA	NA	2.06E+01
July	06/29/11	07/27/11	<MDA	NA	2.36E+00	<MDA	NA	2.86E+00	<MDA	NA	2.04E+01
August	07/27/11	08/31/11	<MDA	NA	2.49E+00	<MDA	NA	2.65E+00	<MDA	NA	2.06E+01
September	08/31/11	09/28/11	<MDA	NA	2.37E+00	<MDA	NA	3.03E+00	<MDA	NA	2.20E+01
October	09/28/11	11/02/11	<MDA	NA	2.06E+00	<MDA	NA	2.93E+00	<MDA	NA	2.09E+01
November	11/02/11	11/30/11	<MDA	NA	2.30E+00	<MDA	NA	2.87E+00	<MDA	NA	2.13E+01
December	11/30/11	12/28/11	<MDA	NA	2.36E+00	<MDA	NA	2.78E+00	<MDA	NA	2.06E+01

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Gamma Data

SV-2039 Four Mile Creek at USFS Rd. A-13

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	1.97E+00	<MDA	NA	2.78E+00	<MDA	NA	2.50E+01
February	01/26/11	02/23/11	<MDA	NA	2.00E+00	<MDA	NA	2.83E+00	<MDA	NA	1.88E+01
March	02/23/11	03/30/11	<MDA	NA	3.11E+00	<MDA	NA	3.99E+00	<MDA	NA	7.54E+01
April	03/30/11	04/27/11	<MDA	NA	2.11E+00	<MDA	NA	2.86E+00	<MDA	NA	1.89E+01
May	04/27/11	06/01/11	<MDA	NA	2.49E+00	<MDA	NA	3.31E+00	<MDA	NA	2.13E+01
June	06/01/11	06/29/11	<MDA	NA	2.44E+00	<MDA	NA	3.21E+00	<MDA	NA	2.15E+01
July	06/29/11	07/27/11	<MDA	NA	2.46E+00	<MDA	NA	3.22E+00	<MDA	NA	2.07E+01
August	07/27/11	08/31/11	<MDA	NA	2.31E+00	<MDA	NA	3.22E+00	<MDA	NA	2.17E+01
September	08/31/11	09/28/11	<MDA	NA	2.41E+00	<MDA	NA	3.17E+00	<MDA	NA	2.11E+01
October	09/28/11	11/02/11	<MDA	NA	2.13E+00	<MDA	NA	3.13E+00	<MDA	NA	2.13E+01
November	11/02/11	11/30/11	<MDA	NA	2.32E+00	<MDA	NA	3.33E+00	<MDA	NA	2.13E+01
December	11/30/11	12/28/11	<MDA	NA	2.48E+00	<MDA	NA	3.20E+00	<MDA	NA	2.20E+01

SV-2047 Pen Branch at USFS Rd. A-13

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	2.15E+00	<MDA	NA	2.19E+00	<MDA	NA	2.38E+01
February	01/26/11	02/23/11	<MDA	NA	2.09E+00	<MDA	NA	2.77E+00	<MDA	NA	1.85E+01
March	02/23/11	03/30/11	<MDA	NA	3.56E+00	<MDA	NA	3.90E+00	<MDA	NA	7.87E+01
April	03/30/11	04/27/11	<MDA	NA	1.97E+00	<MDA	NA	2.65E+00	<MDA	NA	1.85E+01
May	04/27/11	06/01/11	<MDA	NA	2.48E+00	<MDA	NA	3.05E+00	<MDA	NA	1.99E+01
June	06/01/11	06/29/11	<MDA	NA	2.48E+00	<MDA	NA	2.96E+00	<MDA	NA	2.21E+01
July	06/29/11	07/27/11	<MDA	NA	2.49E+00	<MDA	NA	3.00E+00	<MDA	NA	2.14E+01
August	07/27/11	08/31/11	<MDA	NA	2.49E+00	<MDA	NA	2.53E+00	<MDA	NA	2.05E+01
September	08/31/11	09/28/11	<MDA	NA	2.39E+00	<MDA	NA	3.01E+00	<MDA	NA	2.15E+01
October	09/28/11	11/02/11	<MDA	NA	2.42E+00	<MDA	NA	2.67E+00	<MDA	NA	2.09E+01
November	11/02/11	11/30/11	<MDA	NA	2.32E+00	<MDA	NA	3.33E+00	<MDA	NA	2.13E+01
December	11/30/11	12/28/11	<MDA	NA	2.40E+00	<MDA	NA	2.93E+00	<MDA	NA	2.13E+01

SV-327 Steel Creek at SC Highway 125

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	2.00E+00	<MDA	NA	2.34E+00	<MDA	NA	2.37E+01
February	01/26/11	02/23/11	<MDA	NA	1.89E+00	<MDA	NA	2.81E+00	<MDA	NA	1.82E+01
March	02/23/11	03/30/11	<MDA	NA	3.68E+00	<MDA	NA	3.94E+00	<MDA	NA	7.75E+01
April	03/30/11	04/27/11	<MDA	NA	2.07E+00	<MDA	NA	2.81E+00	<MDA	NA	1.87E+01
May	04/27/11	06/01/11	<MDA	NA	2.40E+00	<MDA	NA	2.96E+00	<MDA	NA	2.10E+01
June	06/01/11	06/29/11	<MDA	NA	2.13E+00	<MDA	NA	3.01E+00	<MDA	NA	2.07E+01
July	06/29/11	07/27/11	<MDA	NA	2.40E+00	<MDA	NA	3.00E+00	<MDA	NA	2.12E+01
August	07/27/11	08/31/11	<MDA	NA	2.43E+00	<MDA	NA	3.13E+00	<MDA	NA	2.12E+01
September	08/31/11	09/28/11	<MDA	NA	2.46E+00	<MDA	NA	3.29E+00	<MDA	NA	2.19E+01
October	09/28/11	11/02/11	<MDA	NA	2.23E+00	<MDA	NA	2.98E+00	<MDA	NA	2.15E+01
November	11/02/11	11/30/11	<MDA	NA	2.41E+00	<MDA	NA	3.08E+00	<MDA	NA	2.15E+01
December	11/30/11	12/28/11	<MDA	NA	2.51E+00	<MDA	NA	3.23E+00	<MDA	NA	2.19E+01

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Gamma Data

SV-2018 Steel Creek Boat Landing

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	2.14E+00	<MDA	NA	2.22E+00	<MDA	NA	2.51E+01
February	01/26/11	02/23/11	<MDA	NA	2.18E+00	<MDA	NA	2.41E+00	<MDA	NA	1.84E+01
March	02/23/11	03/30/11	<MDA	NA	3.53E+00	<MDA	NA	3.99E+00	<MDA	NA	7.95E+01
April	03/30/11	04/27/11	<MDA	NA	2.00E+00	<MDA	NA	2.69E+00	<MDA	NA	1.86E+01
May	04/27/11	06/01/11	<MDA	NA	2.21E+00	<MDA	NA	2.70E+00	<MDA	NA	2.08E+01
June	06/01/11	06/29/11	<MDA	NA	2.18E+00	<MDA	NA	2.91E+00	<MDA	NA	2.15E+01
July	06/29/11	07/27/11	<MDA	NA	2.35E+00	<MDA	NA	2.63E+00	<MDA	NA	2.09E+01
August	07/27/11	08/31/11	<MDA	NA	2.37E+00	<MDA	NA	2.98E+00	<MDA	NA	2.10E+01
September	08/31/11	09/28/11	<MDA	NA	2.53E+00	<MDA	NA	3.07E+00	<MDA	NA	2.18E+01
October	09/28/11	11/02/11	<MDA	NA	2.34E+00	<MDA	NA	3.04E+00	<MDA	NA	2.10E+01
November	11/02/11	11/30/11	<MDA	NA	2.44E+00	<MDA	NA	2.89E+00	<MDA	NA	2.15E+01
December	11/30/11	12/28/11	<MDA	NA	2.31E+00	<MDA	NA	3.00E+00	<MDA	NA	2.19E+01

SV-118 US Highway 301 at the Savannah River

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	2.05E+00	<MDA	NA	2.17E+00	<MDA	NA	2.40E+01
February	01/26/11	02/23/11	<MDA	NA	2.26E+00	<MDA	NA	2.67E+00	<MDA	NA	1.81E+01
March	02/23/11	03/30/11	<MDA	NA	3.52E+00	<MDA	NA	3.95E+00	<MDA	NA	8.23E+01
April	03/30/11	04/27/11	<MDA	NA	2.29E+00	<MDA	NA	2.73E+00	<MDA	NA	1.83E+01
May	04/27/11	06/01/11	<MDA	NA	1.95E+00	<MDA	NA	2.89E+00	<MDA	NA	2.14E+01
June	06/01/11	06/29/11	<MDA	NA	2.59E+00	<MDA	NA	2.86E+00	<MDA	NA	2.10E+01
July	06/29/11	07/27/11	<MDA	NA	2.48E+00	<MDA	NA	2.69E+00	<MDA	NA	2.02E+01
August	07/27/11	08/31/11	<MDA	NA	2.41E+00	<MDA	NA	2.58E+00	<MDA	NA	2.13E+01
September	08/31/11	09/28/11	<MDA	NA	2.29E+00	<MDA	NA	3.01E+00	<MDA	NA	2.14E+01
October	09/28/11	11/02/11	<MDA	NA	2.34E+00	<MDA	NA	2.97E+00	<MDA	NA	2.09E+01
November	11/02/11	11/30/11	<MDA	NA	2.55E+00	<MDA	NA	3.00E+00	<MDA	NA	2.24E+01
December	11/30/11	12/28/11	<MDA	NA	2.41E+00	<MDA	NA	2.71E+00	<MDA	NA	2.17E+01

SV-2053 Lower Three Runs at SRS Rd. B

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/29/10	01/26/11	<MDA	NA	1.98E+00	<MDA	NA	2.62E+00	<MDA	NA	2.50E+01
February	01/26/11	02/23/11	<MDA	NA	2.12E+00	<MDA	NA	2.69E+00	<MDA	NA	1.94E+01
March	02/23/11	03/30/11	<MDA	NA	3.46E+00	<MDA	NA	3.86E+00	<MDA	NA	8.13E+01
April	03/30/11	04/27/11	<MDA	NA	2.22E+00	<MDA	NA	2.86E+00	<MDA	NA	1.86E+01
May	04/27/11	06/01/11	<MDA	NA	2.43E+00	<MDA	NA	3.09E+00	<MDA	NA	2.14E+01
June	06/01/11	06/29/11	<MDA	NA	2.24E+00	<MDA	NA	2.98E+00	<MDA	NA	2.08E+01
July	06/29/11	07/27/11	<MDA	NA	2.25E+00	<MDA	NA	3.01E+00	<MDA	NA	2.13E+01
August	07/27/11	08/31/11	<MDA	NA	2.37E+00	<MDA	NA	3.10E+00	<MDA	NA	2.07E+01
September	08/31/11	09/28/11	<MDA	NA	2.31E+00	<MDA	NA	3.26E+00	<MDA	NA	2.10E+01
October	09/28/11	11/02/11	<MDA	NA	2.35E+00	<MDA	NA	3.01E+00	<MDA	NA	2.15E+01
November	11/02/11	11/30/11	<MDA	NA	2.30E+00	<MDA	NA	2.90E+00	<MDA	NA	2.06E+01
December	11/30/11	12/28/11	<MDA	NA	2.15E+00	<MDA	NA	2.76E+00	<MDA	NA	2.20E+01

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Alpha/Beta Data

SV-2010 Jackson Boat Landing

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	<LLD	NA	4.25	<LLD	NA	4.24
February	1/26/2011	2/23/2011	<LLD	NA	4.53	<LLD	NA	4.04
March	2/23/2011	3/30/2011	<LLD	NA	2.04	<LLD	NA	2.41
April	3/30/2011	4/27/2011	<LLD	NA	3.71	<LLD	NA	4.06
May	4/27/2011	6/1/2011	<LLD	NA	2.57	<LLD	NA	2.81
June	6/1/2011	6/29/2011	<LLD	NA	2.71	<LLD	NA	3.86
July	6/29/2011	7/27/2011	<LLD	NA	2.79	<LLD	NA	2.38
August	7/27/2011	8/31/2011	<LLD	NA	3.07	<LLD	NA	3.76
September	8/31/2011	9/28/2011	<LLD	NA	2.26	<LLD	NA	2.51
October	9/28/2011	10/2/2011	<LLD	NA	2.72	<LLD	NA	2.09
November	10/2/2011	11/30/2011	<LLD	NA	2.91	<LLD	NA	3.50
December	11/30/2011	12/28/2011	<LLD	NA	3.01	<LLD	NA	3.56

SV-325 Upper Three Runs and SC Highway 125

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	5.27	2.90	3.75	<LLD	NA	4.21
February	1/26/2011	2/23/2011	9.56	3.43	3.96	<LLD	NA	4.02
March	2/23/2011	3/30/2011	22.40	3.78	2.04	3.55	1.89	2.41
April	3/30/2011	4/27/2011	<LLD	NA	3.12	<LLD	NA	4.03
May	4/27/2011	6/1/2011	17.50	3.37	2.37	<LLD	NA	2.79
June	6/1/2011	6/29/2011	12.50	3.41	2.64	<LLD	NA	3.86
July	6/29/2011	7/27/2011	11.20	2.94	2.59	<LLD	NA	2.37
August	7/27/2011	8/31/2011	16.70	3.62	2.77	5.90	2.67	3.75
September	8/31/2011	9/28/2011	12.10	2.98	2.22	<LLD	NA	2.51
October	9/28/2011	10/2/2011	9.07	2.76	2.62	<LLD	NA	2.08
November	10/2/2011	11/30/2011	3.19	2.14	2.61	<LLD	NA	3.47
December	11/30/2011	12/28/2011	<LLD	NA	2.66	<LLD	NA	3.53

SV-2040 Beaver Dam Creek

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	<LLD	NA	4.33	<LLD	NA	4.24
February	1/26/2011	2/23/2011	<LLD	NA	4.52	<LLD	NA	4.04
March	2/23/2011	3/30/2011	<LLD	NA	2.07	<LLD	NA	2.41
April	3/30/2011	4/27/2011	<LLD	NA	3.75	<LLD	NA	4.06
May	4/27/2011	6/1/2011	<LLD	NA	2.59	<LLD	NA	2.81
June	6/1/2011	6/29/2011	<LLD	NA	2.82	<LLD	NA	3.86
July	6/29/2011	7/27/2011	<LLD	NA	2.81	<LLD	NA	2.38
August	7/27/2011	8/31/2011	<LLD	NA	3.09	<LLD	NA	3.77
September	8/31/2011	9/28/2011	<LLD	NA	2.32	<LLD	NA	2.52
October	9/28/2011	10/2/2011	<LLD	NA	2.81	<LLD	NA	2.09
November	10/2/2011	11/30/2011	<LLD	NA	3.01	<LLD	NA	3.51
December	11/30/2011	12/28/2011	<LLD	NA	3.07	<LLD	NA	3.57

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Alpha/Beta Data

SV-2039 Four Mile Creek at USFS Rd. A-13

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	<LLD	NA	3.93	<LLD	NA	4.22
February	1/26/2011	2/23/2011	<LLD	NA	4.02	4.03	2.62	4.02
March	2/23/2011	3/30/2011	2.55	1.70	1.94	3.78	1.74	2.40
April	3/30/2011	4/27/2011	<LLD	NA	3.39	<LLD	NA	4.04
May	4/27/2011	6/1/2011	<LLD	NA	2.46	<LLD	NA	2.80
June	6/1/2011	6/29/2011	<LLD	NA	2.95	4.16	2.56	3.87
July	6/29/2011	7/27/2011	<LLD	NA	2.72	3.10	1.72	2.38
August	7/27/2011	8/31/2011	<LLD	NA	2.87	7.03	2.62	3.75
September	8/31/2011	9/28/2011	<LLD	NA	2.16	3.66	1.80	2.50
October	9/28/2011	10/2/2011	<LLD	NA	2.70	<LLD	NA	2.08
November	10/2/2011	11/30/2011	<LLD	NA	2.79	9.53	2.61	3.49
December	11/30/2011	12/28/2011	<LLD	NA	2.85	5.83	2.44	3.55

SV-2047 Pen Branch at USFS Rd. A-13

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	<LLD	NA	4.18	<LLD	NA	4.23
February	1/26/2011	2/23/2011	<LLD	NA	4.31	<LLD	NA	4.03
March	2/23/2011	3/30/2011	<LLD	NA	2.05	<LLD	NA	2.41
April	3/30/2011	4/27/2011	<LLD	NA	3.64	<LLD	NA	4.05
May	4/27/2011	6/1/2011	<LLD	NA	2.63	<LLD	NA	2.82
June	6/1/2011	6/29/2011	<LLD	NA	2.83	<LLD	NA	3.86
July	6/29/2011	7/27/2011	<LLD	NA	2.97	<LLD	NA	2.39
August	7/27/2011	8/31/2011	<LLD	NA	3.22	<LLD	NA	3.77
September	8/31/2011	9/28/2011	<LLD	NA	2.44	<LLD	NA	2.53
October	9/28/2011	10/2/2011	<LLD	NA	2.92	<LLD	NA	2.10
November	10/2/2011	11/30/2011	<LLD	NA	3.04	<LLD	NA	3.51
December	11/30/2011	12/28/2011	<LLD	NA	2.95	<LLD	NA	3.56

SV-327 Steel Creek at SC Highway 125

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	<LLD	NA	4.27	<LLD	NA	4.24
February	1/26/2011	2/23/2011	<LLD	NA	4.78	<LLD	NA	4.05
March	2/23/2011	3/30/2011	4.85	2.33	2.38	3.15	1.74	2.44
April	3/30/2011	4/27/2011	<LLD	NA	4.13	<LLD	NA	4.08
May	4/27/2011	6/1/2011	<LLD	NA	2.70	<LLD	NA	2.82
June	6/1/2011	6/29/2011	<LLD	NA	2.90	<LLD	NA	3.87
July	6/29/2011	7/27/2011	12.00	3.43	3.16	<LLD	NA	2.41
August	7/27/2011	8/31/2011	<LLD	NA	3.81	<LLD	NA	3.80
September	8/31/2011	9/28/2011	4.65	2.44	2.68	<LLD	NA	2.55
October	9/28/2011	10/2/2011	<LLD	NA	2.76	<LLD	NA	2.09
November	10/2/2011	11/30/2011	<LLD	NA	2.95	<LLD	NA	3.50
December	11/30/2011	12/28/2011	<LLD	NA	3.02	<LLD	NA	3.56

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Alpha/Beta Data

SV-2018 Steel Creek Boat Landing

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	<LLD	NA	4.25	<LLD	NA	4.24
February	1/26/2011	2/23/2011	<LLD	NA	4.45	<LLD	NA	4.04
March	2/23/2011	3/30/2011	25.90	4.08	2.09	<LLD	NA	2.41
April	3/30/2011	4/27/2011	<LLD	NA	3.76	<LLD	NA	4.06
May	4/27/2011	6/1/2011	<LLD	NA	2.56	<LLD	NA	2.81
June	6/1/2011	6/29/2011	<LLD	NA	2.70	<LLD	NA	3.86
July	6/29/2011	7/27/2011	<LLD	NA	2.77	<LLD	NA	2.38
August	7/27/2011	8/31/2011	<LLD	NA	3.12	<LLD	NA	3.77
September	8/31/2011	9/28/2011	<LLD	NA	2.29	<LLD	NA	2.52
October	9/28/2011	10/2/2011	<LLD	NA	3.02	<LLD	NA	2.11
November	10/2/2011	11/30/2011	<LLD	NA	3.27	<LLD	NA	3.53
December	11/30/2011	12/28/2011	<LLD	NA	3.11	<LLD	NA	3.57

SV-118 US Highway 301 and Savannah River

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	<LLD	NA	4.32	<LLD	NA	4.24
February	1/26/2011	2/23/2011	<LLD	NA	4.60	<LLD	NA	4.04
March	2/23/2011	3/30/2011	<LLD	NA	2.13	3.40	1.71	2.42
April	3/30/2011	4/27/2011	<LLD	NA	3.88	<LLD	NA	4.07
May	4/27/2011	6/1/2011	<LLD	NA	2.63	<LLD	NA	2.82
June	6/1/2011	6/29/2011	<LLD	NA	2.81	<LLD	NA	3.86
July	6/29/2011	7/27/2011	<LLD	NA	2.84	<LLD	NA	2.39
August	7/27/2011	8/31/2011	<LLD	NA	3.14	6.19	2.58	3.77
September	8/31/2011	9/28/2011	<LLD	NA	2.68	<LLD	NA	2.55
October	9/28/2011	10/2/2011	<LLD	NA	2.75	<LLD	NA	2.09
November	10/2/2011	11/30/2011	<LLD	NA	2.76	<LLD	NA	3.48
December	11/30/2011	12/28/2011	<LLD	NA	2.82	<LLD	NA	3.55

SV-2053 Lower Three Runs and SRS Rd. B

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/29/2010	1/26/2011	<LLD	NA	4.19	<LLD	NA	4.23
February	1/26/2011	2/23/2011	<LLD	NA	4.43	<LLD	NA	4.04
March	2/23/2011	3/30/2011	<LLD	NA	2.09	<LLD	NA	2.41
April	3/30/2011	4/27/2011	<LLD	NA	3.74	<LLD	NA	4.06
May	4/27/2011	6/1/2011	3.93	2.07	2.39	<LLD	NA	2.79
June	6/1/2011	6/29/2011	<LLD	NA	2.55	<LLD	NA	3.85
July	6/29/2011	7/27/2011	<LLD	NA	2.73	<LLD	NA	2.38
August	7/27/2011	8/31/2011	<LLD	NA	2.84	<LLD	NA	3.75
September	8/31/2011	9/28/2011	<LLD	NA	2.22	<LLD	NA	2.51
October	9/28/2011	10/2/2011	<LLD	NA	3.14	<LLD	NA	2.11
November	10/2/2011	11/30/2011	<LLD	NA	2.76	<LLD	NA	3.48
December	11/30/2011	12/28/2011	<LLD	NA	3.15	4.79	2.41	3.58

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Creek Mouth Data

SV-2011 Upper Three Runs

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
3/11/2011	518	116	226
9/30/2011	453	107	210
12/15/2011	228	101	221

SV-2013 Beaver Dam

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
3/11/2011	<LLD	NA	226
9/30/2011	226	98	210
12/15/2011	<LLD	NA	221

SV-2015a Four Mile Creek (Creek Mouth)

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
3/11/2011	43008	592	226
9/30/2011	27569	469	210
12/15/2011	47992	610	221

SV-2015b Four Mile Creek (30')

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
3/11/2011	11402	314	226
9/30/2011	<LLD	NA	210
12/15/2011	3374	184	221

SV-2015c Four Mile Creek (150')

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
3/11/2011	<LLD	NA	226
9/30/2011	<LLD	NA	210
12/15/2011	<LLD	NA	221

SV-2017 Steel Creek

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
3/11/2011	6722	257	226
9/30/2011	287	100	210
12/15/2011	1149	131	221

SV-2020 Lower Three Runs Creek

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
3/11/2011	596	118	226
9/30/2011	918	123	210
12/15/2011	819	122	221

Quarterly Iodine-129 and Technetium-99 Data for Fourmile Branch (SV-2039).

Location Description	Collection Date	Iodine-129 Activity	Iodine-129 Confidence Interval	Iodine-129 MDA	Technetium-99 Activity	Technetium-99 Confidence Interval	Technetium-99 MDA
RWSV-2039	6/15/2011	<MDA	1.30E+00	2.45E+00	2.02E+00	2.38E+00	3.95E+00
RWSV-2039	7/11/2011	1.39E+00	1.51E+00	3.22E+00	4.10E+00	2.38E+00	3.95E+00
RWSV-2039	10/26/2011	1.76E+00	1.52E+00	3.15E+00	2.06E+00	2.37E+00	3.96E+00

7.0 Summary Statistics
Radiological Monitoring of Surface Water On and Adjacent to the SRS

2011 Tritium **41**
2011 Alpha **42**
2011 Beta **42**

Notes:
1) “pCi/L” is “picocuries per Liter”
2) “ND” is “No Detection”
3) “NA” is “Not Applicable”
4) “NS” is “No Sample”
5) “*” Denotes actual value and uncertainty (± 2sd) for one detection for sampling location

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Summary Statistics

Tritium Data for Ambient Monitoring Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Jackson Landing (SV-2010)	250	31	249	206	306	52	10
Upper Three Runs Creek (SV-325)	952	364	917	370	2,358	52	52
TNX Boat Landing (SV-2012)	267	40	268	215	356	52	15
Beaver Dam Creek (SV-2040)	404	487	266	212	2,215	52	16
Fourmile Branch (SV-2039)	41,616	6,229	40,918	29,555	53,046	51	51
Pen Branch (SV-2047)	31,984	11,581	35,970	4,537	47,901	52	52
Steel Creek (SV-327)	3,244	904	2,989	1,464	4,929	51	50
Steel Creek Boat Landing (SV-2018)	1,091	1,497	369	227	6,365	52	40
Little Hell Landing (SV-2019)	493	327	365	211	1,522	52	40
Highway 301 Bridge (SV-118)	632	579	395	233	2,760	52	45
Patterson Mill Rd. (SV-328)	2,606	812	2,561	465	3,958	52	52
Lower Three Runs Creek (SV-2053)	414	82	426	249	576	52	50
Upper Three Runs Creek (SV-2027)	268	56	245	217	438	52	18

Tritium Data for Creek Mouth Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Upper Three Runs Creek Creek Mouth (SV-2011)	400	152	453	228	518	3	3
Beaver Dam Creek Creek Mouth (SV-2013)	226*	98	226	226	226	3	1
Fourmile Branch Creek Mouth (SV-2015 a)	39,523	10,648	43,008	27,569	47,992	3	3
Fourmile Branch (SV-2015 b) 30' downstream from Creek Mouth	7,388	5,677	7,388	3,374	11,402	3	2
Fourmile Branch (SV-2015 c) 150' downstream from Creek Mouth	<LLD	NA	NA	<LLD	<LLD	3	0
Steel Creek Creek Mouth (SV-2017)	2,719	3,493	1,149	287	6,722	3	3
Lower Three Runs Creek Creek Mouth (SV-2020)	778	165	819	596	918	3	3

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Summary Statistics

Alpha Data for Ambient Monitoring Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Jackson Landing (SV-2010)	<LLD	NA	NA	<LLD	<LLD	12	0
Upper Three Runs Creek (SV-325)	11.95	5.76	11.65	3.19	22.4	12	10
Beaver Dam Creek (SV-2040)	<LLD	NA	NA	<LLD	<LLD	12	0
Fourmile Branch Creek (SV-2039)	2.55*	1.70	2.55	2.55	2.55	12	1
Pen Branch (SV-2047)	<LLD	NA	NA	<LLD	<LLD	12	0
Steel Creek (SV-327)	7.17	4.19	4.85	4.65	12.00	12	3
Steel Creek Boat Landing (SV-2018)	25.90*	4.08	25.90	25.90	25.90	12	1
Highway 301 Bridge (SV-118)	<LLD	NA	NA	<LLD	<LLD	12	0
Lower Three Runs Creek (SV-2053)	3.93*	2.07	3.93	3.93	3.93	12	1

Beta Data for Ambient Monitoring Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Jackson Landing (SV-2010)	<LLD	NA	NA	<LLD	<LLD	12	0
Upper Three Runs Creek (SV-325)	4.73	1.66	4.73	3.55	5.9	12	2
Beaver Dam Creek (SV-2040)	<LLD	NA	NA	<LLD	<LLD	12	0
Fourmile Branch (SV-2039)	5.14	2.19	4.10	3.10	9.5	12	8
Pen Branch (SV-2047)	<LLD	NA	NA	<LLD	<LLD	12	0
Steel Creek (SV-327)	3.15*	1.74	3.15	3.15	3.15	12	1
Steel Creek Boat Landing (SV-2018)	<LLD	NA	NA	<LLD	<LLD	12	0
Highway 301 Bridge (SV-118)	4.80	1.97	4.80	3.40	6.19	12	2
Lower Three Runs Creek (SV-2053)	4.79*	2.41	4.79	4.79	4.79	12	1

Acronyms

Am-241	Americium-241
CDC	Centers for Disease Control and Prevention
CO-60	Cobalt-60
Cs-137	Cesium-137
DOE-SR	Department of Energy - Savannah River
EPA	United States Environmental Protection Agency
ESOP	Environmental Surveillance and Oversight Program
ETF	Effluent Treatment Facility
EQC	Environmental Quality Control
H3	Tritium
I-129	Iodine-129
LLD	Lower Limit of Detection
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
NA	Not Applicable
ND	No Detection
NS	No Sample
REMD	Radiological Environmental Monitoring Division
RSW	Radiological Surface Water
SCDHEC	South Carolina Department of Health and Environmental Control
SD	Standard Deviation
SRS	Savannah River Site
SRNS	Savannah River Nuclear Solutions
Sr-90	Strontium-90
Tc-99	Technitium-99
U	Uranium
USEPA	United States Environmental Protection Agency
USFS	United States Forestry Service
WSRC	Washington Savannah River Company (formerly Westinghouse Savannah River Company)

Units of Measure

pCi/L	picocuries/liter
±	plus or minus one standard deviation
±2	plus or minus two standard deviations, represents uncertainty in single detects

References

Centers for Disease Control and Prevention (CDC). 2006. Phase III of the SRS Dose Reconstruction Project.

Savannah River Nuclear Solutions, LLC (SRNS). 2009. Savannah River Site Environmental Report for 2008. Savannah River Site Aiken, SC. SRNS-STI-2009-00190

SRNS. 2010. Savannah River Site Environmental Report for 2009. Savannah River Site Aiken, SC SRNS-STI-2011-00059.

SRNS. 2011. Savannah River Site Environmental Report for 2010. Savannah River Site Aiken, SC SRNS-STI-2011-00175.

SRNS. 2012. Savannah River Site Environmental Report for 2011. Savannah River Site Aiken, SC. SRNS–STI–2012-00564

Savannah River Site. 2008. Historical History Web Interface
URL: http://www.srs.gov/general/about/history1.htm

Savannah River Site. 2009. Savannah River Site Web Interface
URL: http://www.srs.gov/general/programs/solidification/index.htm

South Carolina Department of Health and Environmental Control (SCDHEC). 2000-2011. South Carolina Department of Health and Environmental Control Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, SC.

Till JE, et al. 2001. Savannah River Site Environmental Dose Reconstruction Project, Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval, Evaluation of Materials Released From the Savannah River Site. RAC Report No. 1-CDC-SRS-1999-Final. Risk Assessment Corporation (RAC).

United States Environmental Protection Agency (USEPA) 2002. "List of Drinking Water Contaminants & MCLs", EPA 816-F-02-013 (July 2002).

USEPA 2008a. USEPA website
URL: http://www.epa.gov/radiation/radionuclides/tritium.html#where

USEPA 2008b. USEPA website
URL: http://www.epa.gov/radiation/radionuclides/cesium.html

USEPA. 2010. USEPA website
URL: http://www.epa.gov/wastes/hazard/testmethods/sw846/pdfs/9310.pdf

Westinghouse Savannah River Company (WSRC). 2000. Savannah River Site Environmental Data for 1999, WSRC-TR-99-00301, Environmental Monitoring Section, Environmental Protection Department, Aiken, SC.

WSRC. 2001a. Savannah River Site Environmental Data for 2000, WSRC-TR-2000-00329, Environmental Monitoring Section, Environmental Protection Department, Aiken, SC.

WSRC. 2001b. Savannah River Site Environmental Report for 2000, WSRC-TR-2000-00328, Environmental Monitoring Section, Environmental Protection Department, Aiken, SC.

WSRC. 2002. Savannah River Site Environmental Report for 2001, CD, Environmental Monitoring Section, Environmental Protection Department, Aiken, SC.

WSRC. 2003. Savannah River Site Environmental Report for 2002, WSRC-TR-2003-00026/CD, Environmental Monitoring & Analysis, Environmental Services Section, Aiken, SC.

WSRC. 2004. Savannah River Site Environmental Report for 2003, WSRC-TR-2004-00015/CD, Environmental Monitoring & Analysis, Environmental Services Section, Aiken, SC.

WSRC. 2005. Savannah River Site Environmental Report for 2004, WSRC-TR-2005-00005/CD, Environmental Monitoring & Analysis, Environmental Services Section, Aiken, SC.

WSRC. 2006. Savannah River Site Environmental Report for 2005, WSRC-TR-2006-00007/CD, Environmental Monitoring & Analysis, Environmental Services Section, Aiken, SC.

WSRC. 2007. Savannah River Site Environmental Report for 2006, WSRC-TR-2007-00008/CD, Environmental Monitoring & Analysis, Environmental Services Section, Aiken, SC.

WSRC. 2008. Savannah River Site Environmental Report for 2007, WSRC-STI-2008-00057/CD, Environmental Monitoring & Analysis, Environmental Services Section, Aiken, SC.

Zeigler, C.C, I.B. Lawrimore, and W.E. O'Rear. 1985. Environmental Monitoring at the Savannah River Plant, Annual Report 1984. DPSPU-85-302. Health Protection Department, Savannah river Plant, Du Pont. SRS Phase II Database MJC1994051722.

This Page Intentionally Left Blank

2011 Nonradiological Monitoring of Ambient Surface Water at Savannah River Site

Environmental Surveillance Oversight Program

97NW004
Crystal L Robertson, Project Manager
January 1, 2011 – December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 1

PH RESULTS 1
DO AND BOD RESULTS 2
TEMPERATURE RESULTS 2
ALKALINITY RESULTS 2
TURBIDITY AND TSS RESULTS 3
FECAL COLIFORM RESULTS 3
NUTRIENT RESULTS 4
METALS RESULTS 4
VOC, PCB AND PESTICIDE RESULTS 6
SCDHEC AND DOE-SR DATA COMAPRISON 6

3.0 CONCLUSIONS/RECOMMENDATIONS 7

4.0 MAP 8

5.0 TABLES AND FIGURES 9

6.0 DATA 14

7.0 SUMMARY STATISTICS 24

LIST OF ACRONYMS AND UNITS OF MEASURE 30

REFERENCES 31

1.0 PROJECT SUMMARY

The streams located on the Savannah River Site (SRS) receive a wide variety of permitted point source discharges and nonpoint source run-off from on-site facilities and operations. These discharges specifically include, but are not limited to, industrial storm water, utility water, treated industrial and sanitary wastewater, and run-off from land disturbing activities. Data from SRS Environmental Reports and South Carolina Department of Health and Environmental Control's (SCDHEC) Environmental Surveillance Oversight Program (ESOP) is used to monitor the ambient water quality of streams on SRS.

ESOP assessed the surface water quality for nonradiological parameters in 2011 at SRS by sampling the on-site streams for inorganic and organic contaminants. The freshwater standard guidelines used are stated in SCDHEC's Water Classifications and Standards (Regulation 61-68). These guidelines give numeric criteria for specific parameters and narrative criteria that indicate conditions of biological integrity and water quality for aquatic life and human health (SCDHEC 2008). Nine ESOP sample locations were strategically chosen to monitor ambient surface water conditions and detect the nonradiological impact from the Department of Energy – Savannah River (DOE-SR) operations. See Section 4.0 for a map of ESOP sample locations.

Streams were tested for the following parameters on a monthly interval: pH, dissolved oxygen (DO), temperature, alkalinity, turbidity, biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, total Kjeldahl nitrogen (TKN), ammonia, nitrite/nitrate, total phosphorous, cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), and zinc (Zn). Volatile organic compounds (VOC), pesticides and polychlorinated biphenyls (PCB) were sampled biannually. These are standard parameters used to sample streams around South Carolina (SCDHEC 2011). In all, a total of 3309 different analyses were performed with 122 of these exceeding the state or United States Environmental Protection Agency (USEPA) standards or recommendations. Data from SCDHEC surface water locations were compared to DOE-SR data where sample points were co-located (SCDHEC 2011b). All surface water data can be found in Section 6.0, and surface water statistical analyses can be found in Section 7.0.

2.0 RESULTS AND DISCUSSION

pH Results

Many chemical and biological processes in surface waters can be affected by the pH, a measurement that indicates the alkalinity or acidity of a substance (USEPA 1997). The streams encountered at SRS are typical of southeastern streams characterized as blackwater. A blackwater stream is a stream with a deep, slow moving channel that flows through forested swamps and wetlands. Decaying vegetation in the water results in the leaching of tannins from the vegetation resulting in transparent, acidic water that is darkly stained resembling tea or coffee. Low pH is typical for blackwater streams such as those sampled at SRS (United States Geological Survey (USGS) 2000).

The freshwater pH standard for South Carolina is between 6.0 and 8.5 standard units (su) (SCDHEC 2008). ESOP personnel measured and recorded the pH at each sample location during the sampling event. There are seven individual measurements at three locations that are outside of the standard, however all sample location yearly averages meet this standard. See Section 5.0, Figure 1 for a comparison of ESOP and DOE-SR data for co-located samples; there are no notable differences (SRNS 2012).

DO and BOD Results

Oxygen is cycled through the environment and is both produced and consumed in streams. The amount of oxygen in its dissolved form in water is the DO. The BOD is the amount of oxygen consumed by microorganisms in stream water. Water quality is diminished when the BOD is high, which depletes the oxygen in the water. The low DO means less oxygen to sustain higher forms of aquatic life (USEPA 1997).

Dissolved oxygen was measured and recorded in the field as part of each ESOP sampling event, and samples were collected for BOD analysis. There is no numerical criteria in the South Carolina freshwater standards for a maximum BOD level, however all ESOP samples were near or below the lower limit of detection (LLD) of 2.0 milligrams per liter (mg/L). The South Carolina freshwater standard for DO is a daily average no less than 5.0 mg/L with a minimum of 4.0 mg/L (SCDHEC 2008). All individual analysis and yearly averages meet this requirement. See Section 5.0, Figure 2 for a DO comparison of ESOP and DOE-SR data for co-located samples; there are no notable differences (SRNS 2012). DOE-SR did not collect BOD samples in 2011; therefore no comparison is made for BOD.

Temperature Results

Temperature can affect biological and chemical processes in a stream. All aquatic organisms can be negatively impacted by temperature that varies from the natural occurring range (USEPA 1997). The South Carolina freshwater standards state that the temperature of free flowing freshwater shall not be increased more than 2.8°C above natural temperature conditions and shall not exceed a maximum of 32.2°C (SCDHEC 2008).

ESOP field personnel measured and recorded the temperature during every sampling event in 2011. All streams are below the maximum and are comparable to each other regarding the natural temperature, including samples upstream of SRS operations. The only exception is location NWSV-2040, which is a manmade stream used as cooling water. NWSV-2040 is below the maximum, but is typically warmer than the other streams. The temperature difference for this location is covered independent from ESOP under SCDHEC permit #SC0047431 which allows a greater change in temperature specified for this stream. No comparison is made between SCDHEC and DOE-SR results due to the high variability in temperature dependent on the day and the time of day samples are collected.

Alkalinity Results

Alkalinity is important for aquatic life in freshwater systems because it buffers pH changes that occur naturally or as a result of anthropogenic sources. Components of alkalinity, such as carbonate and bicarbonate, will incorporate some toxic heavy metals and reduce their toxicity (USEPA 1997). There is no numerical criteria in the South Carolina freshwater standards for alkalinity, however the National Technical Advisory Committee recommends a minimum alkalinity of 20 mg/L and that natural alkalinity not be reduced by more than 25 percent (National Academy of Sciences (NAS) 1974). Waters having insufficient alkalinity due to natural conditions do not have to be supplemented with artificially added materials to increase the alkalinity. Alkalinity resulting from naturally occurring materials, such as carbonate and bicarbonate, is not considered a health hazard in drinking water supplies, and naturally occurring maximum levels up to approximately 400 mg/L, as calcium carbonate, are not considered a problem to human health (NAS 1974).

ESOP sampled each location monthly in 2011 for alkalinity. Sixty individual samples and five yearly averages are below the recommended level: yearly averages NWSV-324 (4.9 (±1.9) mg/L), NWSV-325 (3.6 (±1.1) mg/L), NWSV-2027 (0.75 (±0.63) mg/L), NWSV-2039 (18 (±4.3) mg/L), and NWSV-2061 (5.9 (±2.0) mg/L). The low alkalinity in SRS streams may be due to the presence of naturally low buffering compounds in the streams. These conditions are consistent even in the samples upstream of most SRS operations, NWSV-2027 and NWSV-2061. DOE-SR did not sample for alkalinity in 2011, therefore no comparison is made.

Turbidity and TSS Results

Turbidity is a measure of water clarity, or the light that passes through the water. Turbidity is directly affected by the water's TSS, which refers to the amount of material suspended in the water (USEPA 1997). There is no freshwater quality standard for TSS, however turbidity in South Carolina streams is not to exceed 50 nephelometric turbidity units (NTU) provided existing uses are maintained (SCDHEC 2008). All ESOP monitored streams are below the standard for turbidity in 2011. DOE-SR did not sample for turbidity in 2011, therefore no comparison is made. DOE-SR did sample for TSS in 2011, and there are no notable differences when compared to ESOP co-located samples. See Section 5.0, Figure 3 for a TSS comparison of ESOP and DOE-SR data (SRNS 2012).

Fecal Coliform Results

Fecal coliform is generally not harmful itself, however it is an indicator of possible sewage contamination because it is common in human and animal feces. High fecal coliform results can indicate the possible presence of pathogenic bacteria, viruses, and protozoans (USEPA 1997). According to the South Carolina freshwater fecal coliform standard, five consecutive stream samples during any 30-day period shall not exceed a geometric mean of 200 colonies/100 milliliters (mL), nor shall more than ten percent of total samples during any 30-day period exceed 400 colonies/100 mL (SCDHEC 2008). Independent from the ESOP monitoring program, SCDHEC Bureau of Water has placed location NWSV-325 on the state Section 303(d) List of Impaired Waters due to fecal coliform bacteria (SCDHEC 2010).

ESOP field personnel collected surface water samples monthly for fecal coliform analysis at each location in 2011. ESOP results cannot be directly compared to the South Carolina freshwater standard due to a lack of multiple samples in a 30-day period. There are 9 individual samples that exceeded 400 colonies/100 mL, however no yearly average was above 400 colonies/100 mL. DOE-SR did not collect samples for fecal coliform in 2011, therefore no comparison is made.

Nutrient Results

Phosphorous and nitrogen are essential nutrients for the plants and animals that make up the aquatic food web, however in excess they can cause significant water quality problems. Phosphorous and nitrogen cycle through the environment in a variety of forms, and can indirectly impact DO and other water quality indicators (USEPA 1997). In 2011, ESOP sampled for total phosphorous and various forms of nitrogen, including TKN, ammonia and nitrite/nitrate. There are no numeric criteria in the South Carolina freshwater standard for any of these parameters.

ESOP uses the most conservative of the federally established drinking water standards for nitrate/nitrite levels to indicate ambient water quality in freshwater streams for nutrients. Drinking water standards are designed to protect the public from consumption and are a conservative measurement for freshwater streams. The USEPA drinking water standards for nitrate/nitrite levels are 10 mg/L and 1 mg/L, respectively (USEPA 2003). There are six individual samples that exceed 1 mg/L of nitrate/nitrite, however no location has a yearly average that exceeds this standard for 2011. Total phosphorous, TKN and ammonia are each below 1 mg/L for each parameter in every 2011 ESOP sample. DOE-SR did not sample for TKN or ammonia in 2011, therefore no comparison is made. Comparison of ESOP and DOE-SR data for co-located samples for total phosphorous and nitrate/nitrite can be found in Section 5.0, Figure 4 and Figure 5; respectfully. There are no notable differences (SRNS 2012).

Metals Results

Most metals are considered to be pollutants, including some that are toxic. In 2011, ESOP personnel collected samples monthly at each sample location for the following metals: cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc. All of these metals, except iron and manganese, have numeric criteria for the protection of human health and aquatic life in the South Carolina freshwater quality standards.

Iron and manganese are naturally occurring metals that do not have state freshwater standards. Iron has a recommended USEPA limit in freshwater streams of 1 mg/L (USEPA 2008). Seventeen individual ESOP samples at five locations have iron above this recommended level. One location has a yearly average above the recommended level, NWSV-324 (2.8 (±1.1) mg/L). Three DOE-SR locations have yearly averages above the recommended level for iron. See Section 5.0, Figure 6 and Figure 7 for an iron and manganese comparison of ESOP and DOE-SR data for co-located samples; there are no notable differences (SRNS 2012).

The freshwater quality standard for cadmium in South Carolina streams is not to exceed 0.0001 mg/L (SCDHEC 2008). Twelve individual ESOP samples have cadmium levels above the standard. Seven of the sample locations have yearly averages above the standard; NWSV-324 (0.00035 (±0.00027) mg/L), NWSV-327 (0.00026 mg/L (one detection)), NWSV-2027 (0.00032 (±0.00030) mg/L), NWSV-2039 (0.00038 (±0.00034) mg/L), NWSV-2040 (0.00012 (±0.000014) mg/L), NWSV-2047 (0.00013 (±0.000028) mg/L) and NWSV-2061 (0.00021 mg/L (one detection)). Data less than the LLD is not included in the yearly averages, therefore some yearly averages may be based on a single sample. These seven locations include streams upstream and downstream of most SRS operations. DOE-SR did not detect cadmium above the detection limit of 0.0005 mg/L in any samples for 2011 (SRNS 2012). Some of these samples are co-located with ESOP samples, however the cadmium detected by ESOP is at levels below the DOE-SR detection limit.

The freshwater quality standard for chromium in South Carolina streams is not to exceed 0.011 mg/L (SCDHEC 2008). Chromium is above the standard in four individual ESOP samples at four sample locations. Each of these sample locations has a yearly average above the standard based on a single sample; NWSV-324 (0.024 mg/L), NWSV-327 (0.017 mg/L), NWSV-328 (0.077 mg/L) and NWSV-2027 (0.18 mg/L). These four locations include streams upstream and downstream of most SRS operations. DOE-SR also detected chromium in four individual samples, however none of them had chromium levels above the freshwater standard including those co-located with ESOP samples (SRNS 2012).

The freshwater quality standard for copper in South Carolina streams is not to exceed 0.0029 mg/L (SCDHEC 2008). ESOP has a LLD higher than the standard at 0.010 mg/L; therefore any detection of copper is over the standard. One ESOP sample has copper that is above the standard. NWSV-2027 has a yearly average of 0.024 mg/L, based on one sample. This sample is upstream of most SRS operations, and is not co-located with any DOE-SR samples. DOE-SR has a LLD of 0.0010 mg/L and detected copper in at least one sample from all sixteen DOE-SR locations. Nine of these locations have at least one sample with copper concentrations over the standard, and two have yearly averages over the standard (SRNS 2012). Some of theses samples are co-located with ESOP samples, however the copper is detected at levels below ESOP detection limits.

The freshwater quality standard for lead in South Carolina streams is not to exceed 0.00054 mg/L (SCDHEC 2008). ESOP has a LLD higher than the standard at 0.0020 mg/L; therefore any detection of lead is over the standard. Lead is detected in four individual ESOP samples at four sample locations. Each of these sample locations has a yearly average above the standard based on a single sample: NWSV-325 (0.0021 mg/L), NWSV-328 (0.0031 mg/L), NWSV-2039 (0.0035 mg/L) and NWSV-2040 (0.0022 mg/L). These four samples are all downstream of various SRS operations. DOE-SR did not detect lead in any samples for 2011. The lead detected by ESOP is at concentrations below the DOE-SR detection limit of 0.0050 mg/L (SRNS 2012).

The freshwater quality standard for mercury in South Carolina streams is not to exceed 0.00091 mg/L (SCDHEC 2008). Mercury is not detected above the LLD of 0.00020 mg/L in any of the ESOP samples in 2011; therefore, all SCDHEC monitored streams meet the standard for this parameter. DOE-SR has a LLD of 0.00002 mg/L. DOE-SR detected mercury in at least one sample from ten of the sixteen locations. None of these detections were over the freshwater quality standard (SRNS 2012). Some of theses samples are co-located with ESOP samples, however the mercury is detected at levels below ESOP detection limits.

The freshwater quality standard for nickel in South Carolina streams is not to exceed 0.016 mg/L (SCDHEC 2008). ESOP has a LLD higher than the standard at 0.020 mg/L; therefore any detection of nickel is over the standard. Nickel is detected in two individual ESOP samples at two sample locations. Each of these sample locations has a yearly average above the standard based on a single sample; NWSV-328 (0.024 mg/L) and NWSV-2027 (0.067 mg/L). DOE-SR has a LLD of 0.0010 mg/L. DOE-SR detected nickel in at least one sample from all sixteen locations. None of these detections were over the freshwater quality standard, including samples co-located with ESOP samples (SRNS 2012). All of the DOE-SR nickel detections are at levels below ESOP detection limits.

The freshwater quality standard for zinc in South Carolina streams is not to exceed 0.037 mg/L (SCDHEC 2008). Zinc is detected above the LLD of 0.010 mg/L in at least one sample from all nine ESOP locations. All the ESOP detections of zinc for 2011 are below the standard for this parameter. DOE-SR also detected zinc above the detection limit of 0.001 mg/L in all sixteen locations. Five of the DOE-SR individual samples are above the standard, however no yearly average is above the standard. See Section 5.0, Figure 8 for a zinc comparison of ESOP and DOE-SR yearly averages for co-located samples; there are no notable differences (SRNS 2012).

VOC, PCB and Pesticide Results

Most VOC, PCB and pesticides are considered to be pollutants including some that are toxic, and most have numeric criteria for the protection of human health and aquatic life in the South Carolina freshwater quality standards. ESOP field personnel collected surface water samples for VOC, PCB and pesticides at each location biannually. None of the 59 individual parameters are detected above the LLD for any ESOP samples, which were collected in May and October of 2011. Statistical analysis was not done for these parameters due to the lack of numerical data. DOE-SR collects VOC, PCB and pesticides samples at the beginning of each quarter, and the results show Endosulfan II at one location in July 2011. Endosulfan II in this one sample is below the freshwater standard of 0.000056 mg/L (SCDHEC 2008). All other DOE-SR results are comparable to ESOP results with none of the other parameters being detected (SRNS 2012).

SCDHEC and DOE-SR Data Comparison

Seven of the nine SCDHEC sampling locations were co-located with DOE-SR sampling locations: NWSV-324, NWSV-325, NWSV- 327, NWSV-328, NWSV-2039, NWSV-2040 and NWSV-2047 (SRNS 2012). Section 5.0, Table 1 defines the geographic locations of the ESOP sampling locations and Section 5.0, Table 2 defines the sampling schedule for ESOP. Section 5.0, Table 3 defines the geographic locations of all the DOE-SR sampling locations. Comparisons are made for each parameter individually in the text above. Some comparisons include graphs located in Section 5 that show data from the seven co-located samples to see if there were any significant statistical differences in parameters: pH (Figure 1); DO (Figure 2); TSS (Figure 3); total phosphorous (Figure 4); nitrate/nitrite (Figure 5); iron (Figure 6); manganese (Figure 7); and zinc (Figure 8). Discrepancies in data between DOE-SR and SCDHEC may be attributed to differences in sample collection date and time, sample preservation, and lab analysis. Differences in statistical calculations, such as the yearly averages, may also attribute to dissimilarity. All data less than the lower limit of detections (<LLD) are left out of ESOP statistical calculations due to the lack of numerical data.

3.0 CONCLUSION/ RECOMMENDATIONS

The parameters identified that were above or below USEPA or SCDHEC standards or recommended levels for particular streams will continue to be monitored to establish trends that may warrant further investigation. ESOP will continue to sample on a monthly and biannual basis for routine parameters. ESOP will continue to evaluate water quality based on the independent nonradiological monitoring and surveillance of SRS surface water. Monitoring is required because of continued land disturbance from clean-up activities, new facility construction, logging, and new missions. The locations, numbers of samples, sample frequencies and monitoring parameters are reviewed annually and modified as needed to maximize available resources and address SRS mission changes.

4.0 MAP

Map 1. Nonradiological Surface Water (NRSW) Monitoring Sample Locations

5.0 TABLES AND FIGURES

Table 1. SCDHEC Surface Water Sample Locations

Sample Location	Location Description	Location Rationale
NWSV-2027	Upper Three Runs at Road 2-1	Upstream of most SRS Operations
NWSV-2061	Tinker Creek at Road 2-1	Upstream of most SRS Operations
NWSV-324	Tims Branch at Road C	Downstream from M- & A-Areas
NWSV-325	Upper Three Runs at Road A	Downstream from F-Area
NWSV-2040	Beaver Dam Creek	Downstream from D-Area
NWSV-2039	Fourmile Branch at Road A-13.2	Downstream from F- and H-Areas
NWSV-2047	Pen Branch at Road A-13.2	Downstream from K-Area
NWSV-327	Steel Creek at Road A	Downstream from L-Lake
NWSV-328	Lower Three Runs at Patterson Mill Road	Downstream from Par Pond

Table 2. Water Quality Parameter Analyses for SCDHEC

Laboratory	Frequency	Parameter
Aiken	Monthly	Turbidity, Alkalinity, Biochemical Oxygen Demand (BOD 5), Fecal Coliform, and Total Suspended Solids.
Columbia Lab	Monthly	Ammonia, Nitrate/Nitrite, Total Phosphorus, Total Kjeldahl Nitrogen (TKN), and Metals.
	Semi-annually	Volatile Organic Compounds (VOCs), Pesticide Scan and Polychlorinated Biphenyls (PCBs).
Field	Monthly	Temperature, pH, and Dissolved Oxygen (DO).

Table 3. DOE-SR Surface Water Sample Locations

SRS Stream Locations	Savannah River Locations
Tinker Creek near Northeast Site Boundary	River Mile 160
Tims Branch at Road C*	River Mile 150.4
Upper Three Runs at Road 1-A	River Mile 141.5
Upper Three Runs at Road A*	River Mile 129.1
Beaver Dam Creek at D-Area*	River Mile 118.8
Four Mile Creek at Road E	
Four Mile Creek at Road C	
Four Mile Creek adjacent to D-Area*	
Pen Branch at Road A-13.2*	
Steel Creek at Road A*	
Lower Three Runs at Patterson Mill Road*	

*Co-located with DHEC sample locations.

Tables and Figures

Figure 1. pH Comparison

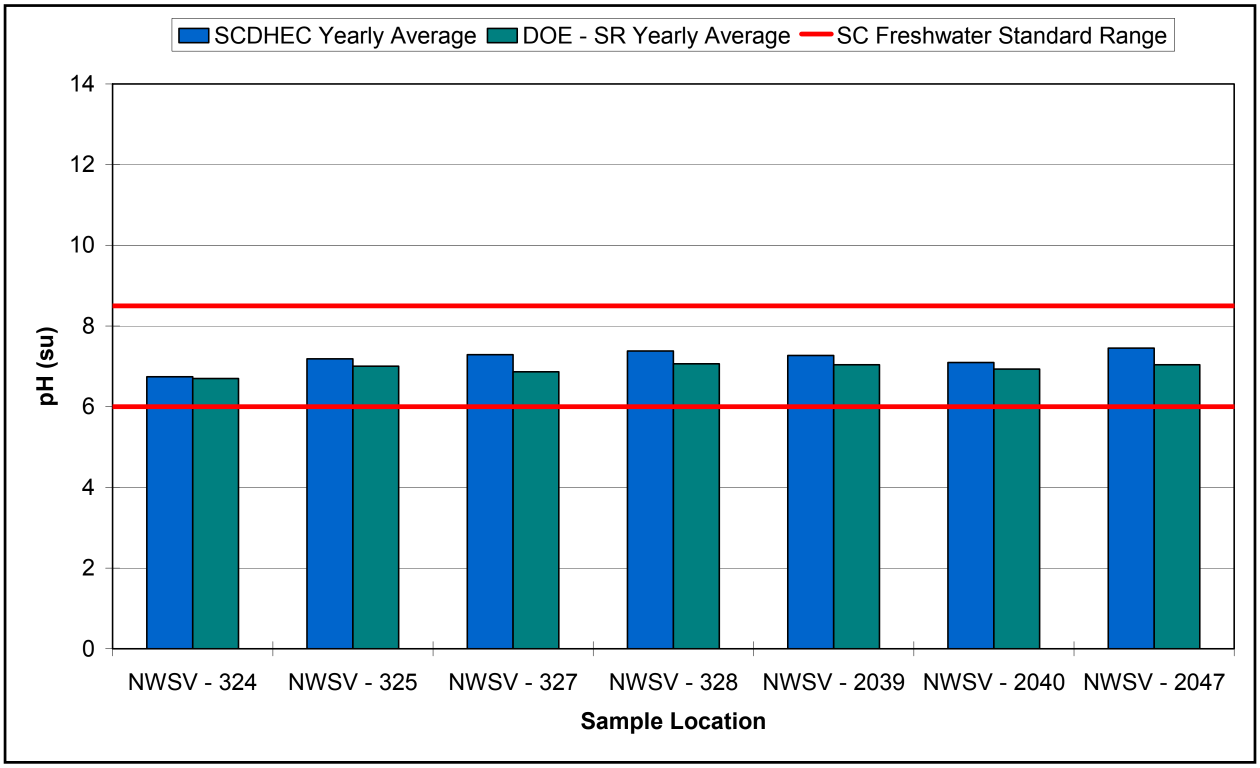
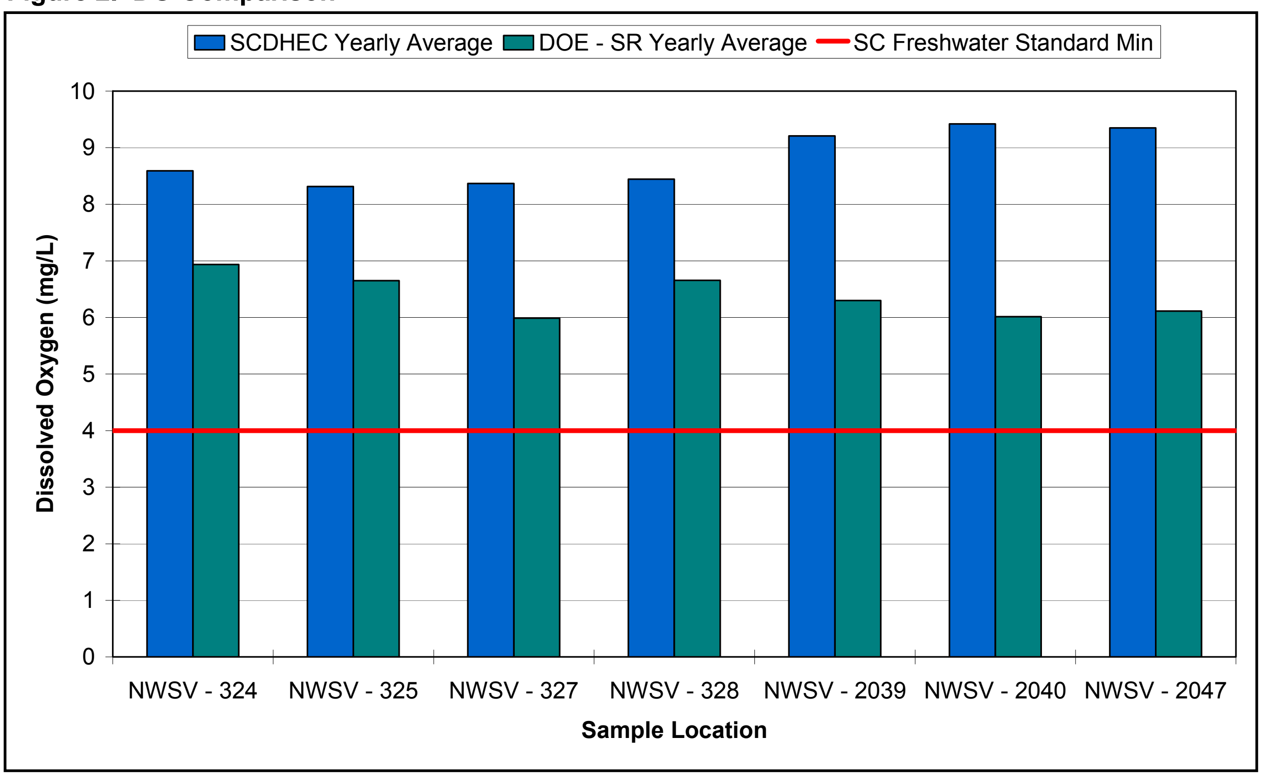


Figure 2. DO Comparison



Tables and Figures

Figure 3. TSS Comparison

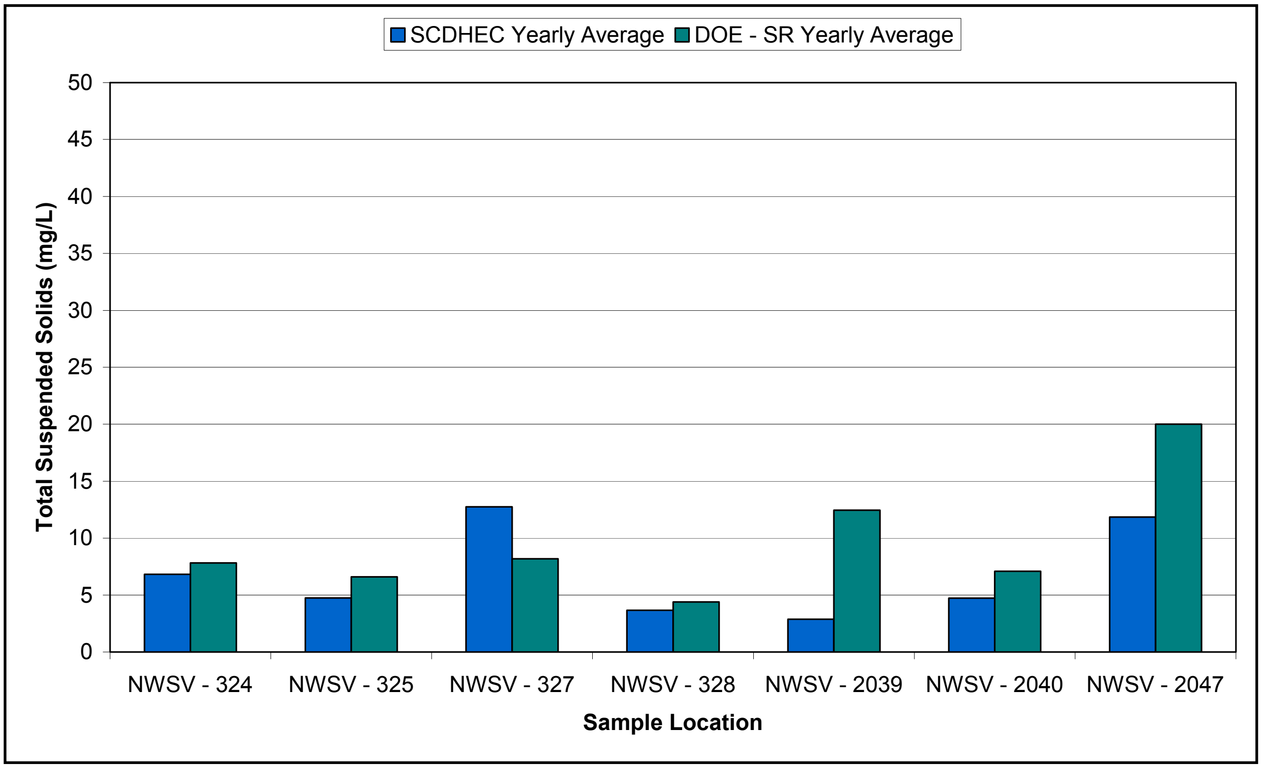
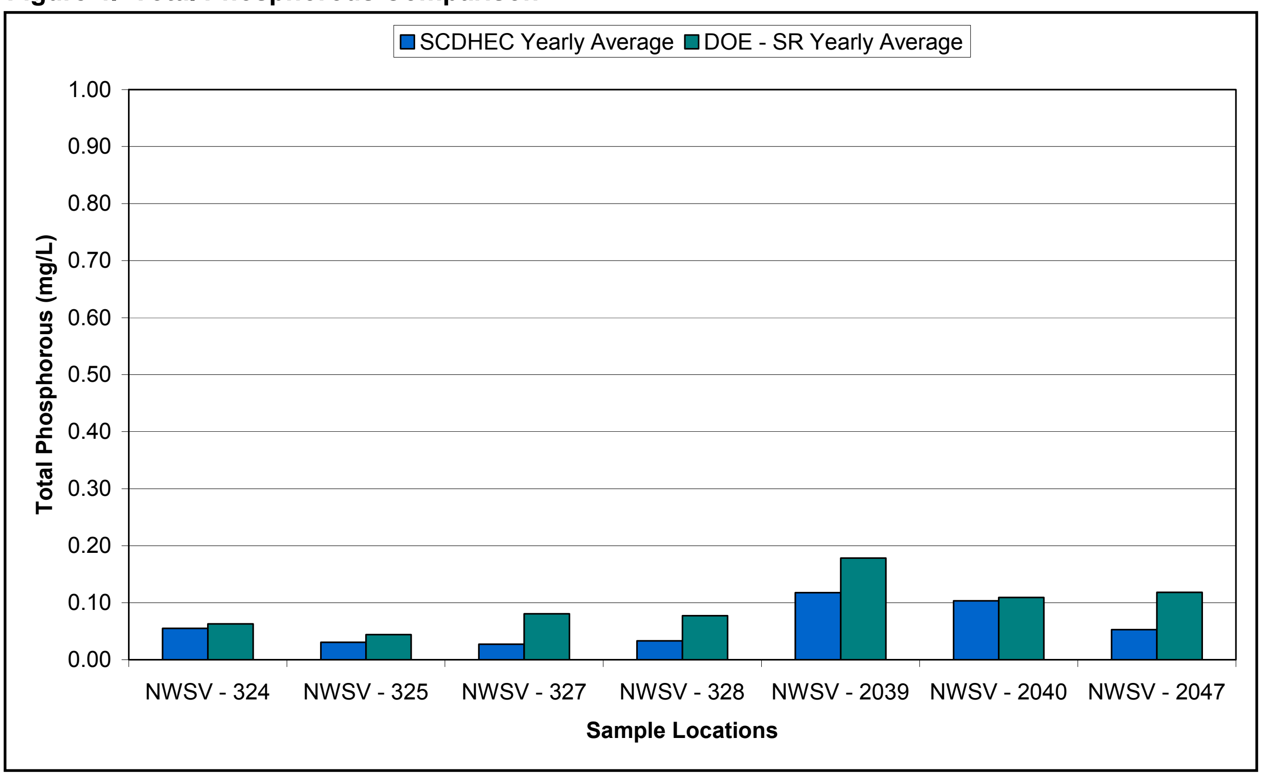


Figure 4. Total Phosphorous Comparison



Tables and Figures

Figure 5. Nitrate/Nitrite Comparison

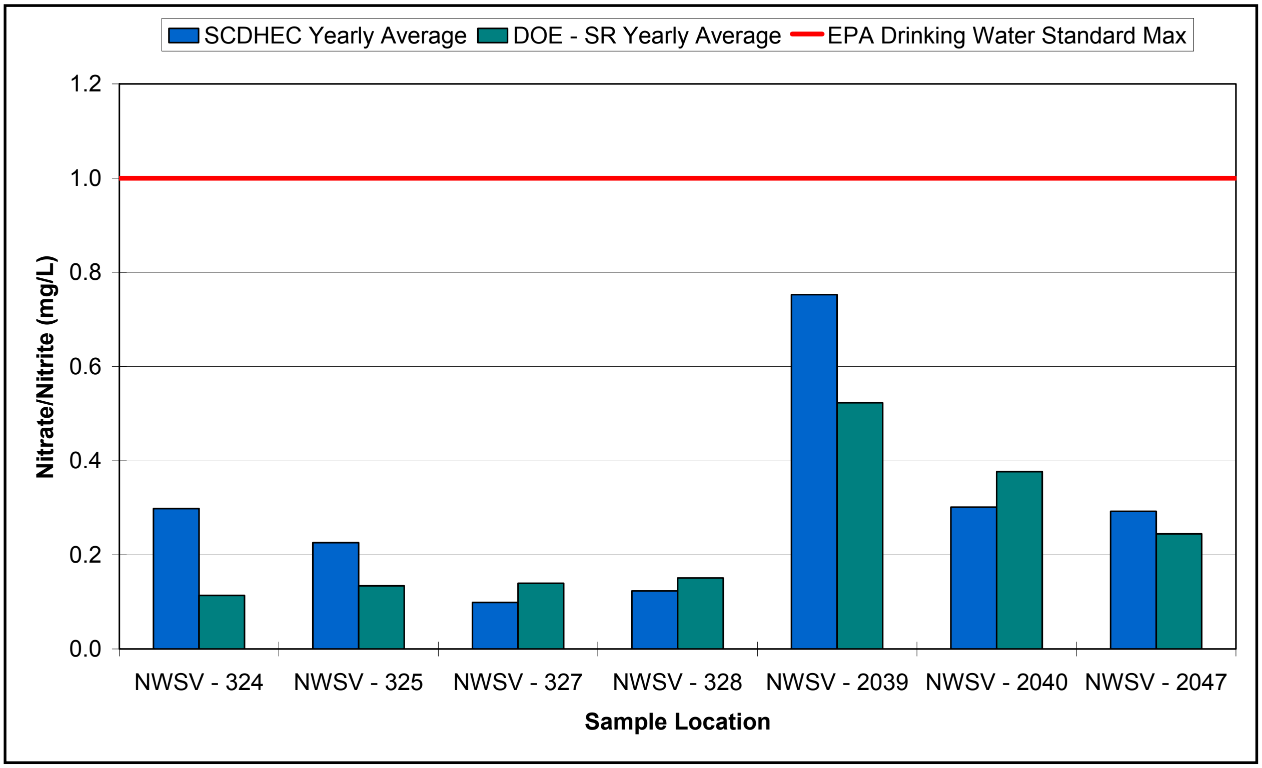
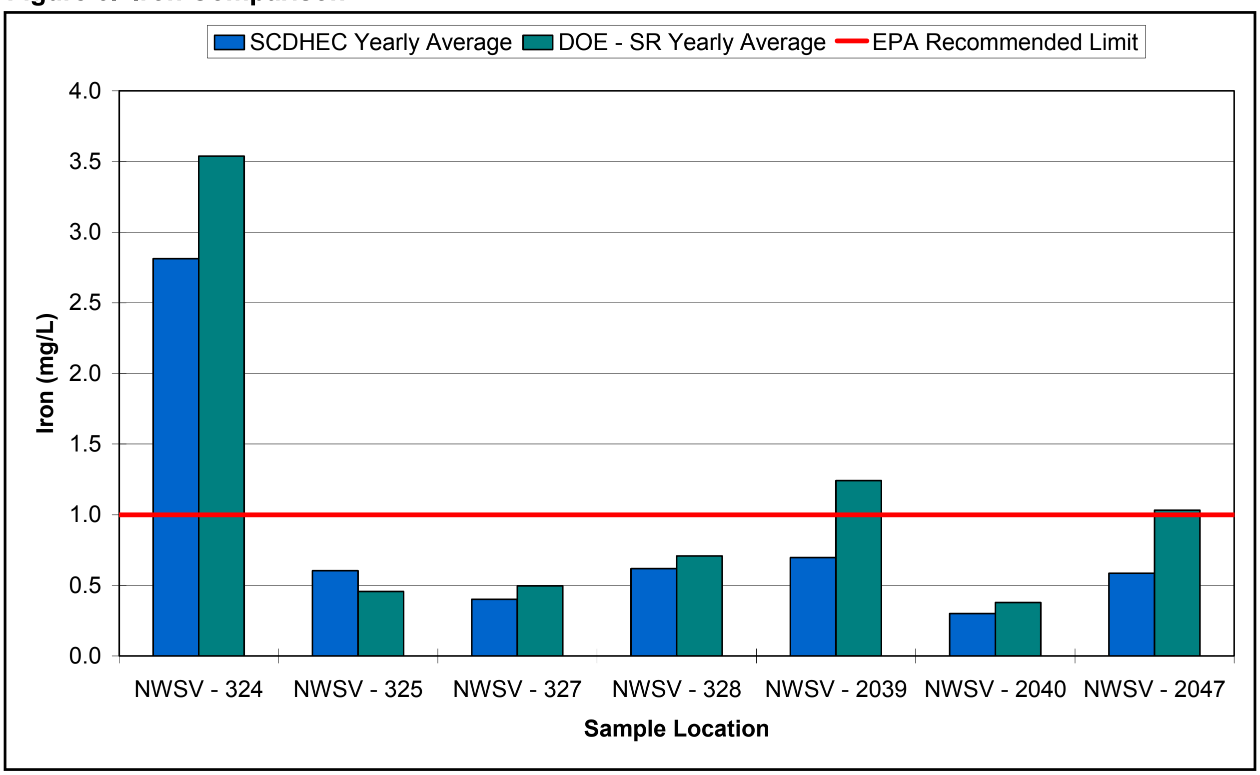


Figure 6. Iron Comparison



Tables and Figures

Figure 7. Manganese Comparison

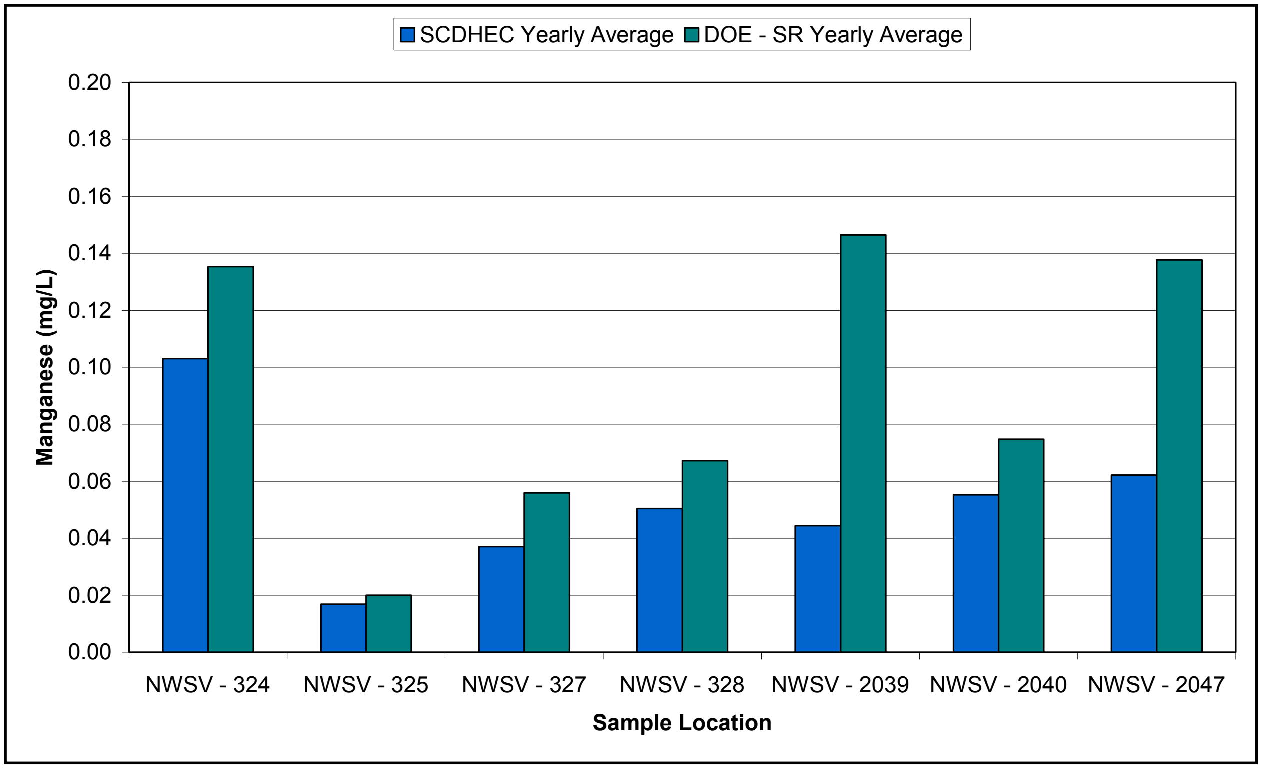
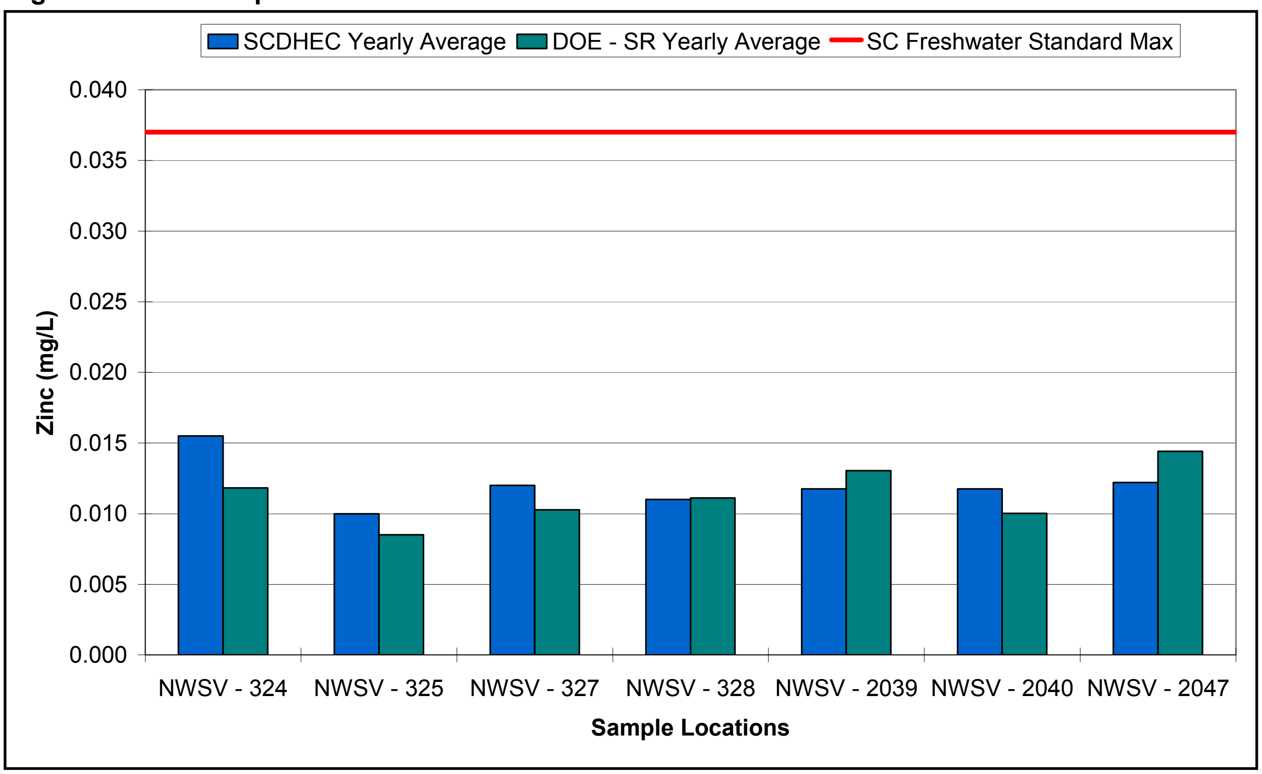


Figure 8. Zinc Comparison



6.0 DATA
Nonradiological Monitoring of Surface Water

DATA TABLES **15**

Notes:

1. NS = No sample available
2. AE = Analytical error
3. EST = Estimated amount

DATA TABLES

NWSV-324	Tims Branch at Road C					
	January	**February**	**March**	**April**	**May**	**June**
pH	8.05	7.59	6.94	6.60	6.73	6.84
DO	10.87	11.14	10.15	8.23	7.10	8.22
Water Temp	8.05	9.43	14.76	17.67	22.82	23.28
Alkalinity	**4.5**	**2.8**	**5.8**	**5.9**	**6.0**	**7.4**
Turbidity	4.6	6.0	7.4	6.7	8.5	9.0
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	2.9	5.6	6.8	6.9	6.6	17
Fecal Coliform	120	45 EST	62	45	43	37 EST
TKN	AE	0.21	0.52	AE	AE	AE
Ammonia	0.074	0.078	0.077	0.075	0.068	0.11
Nitrate/Nitrite	0.082	0.070	0.11	0.083	0.11	0.13
Total Phosphorus	0.041	0.038	0.050	0.064	0.068	0.071
Cadmium	**0.00021**	<0.00010	<0.00010	<0.00010	**0.00073**	<0.00010
Chromium	**0.024**	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	**1.7**	**1.9**	**2.7**	**3.9**	**3.8**	**4.1**
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.055	0.090	0.073	0.11	0.18	0.18
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	0.019
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-324	Tims Branch at Road C					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.35	**5.93**	NS	6.67	6.59	**5.91**
DO	7.22	7.46	NS	9.92	6.15	8.05
Water Temp	27.95	24.70	NS	18.56	16.99	15.12
Alkalinity	**6.9**	**1.6**	NS	**4.7**	**<1.0**	**3.4**
Turbidity	6.9	5.6	NS	8.5	3.8	4.5
BOD	<2.0	<2.0	NS	<2.0	<2.0	<2.0
TSS	3.9	5.3	NS	9.5	6.6	3.9
Fecal Coliform	100	53	NS	**>600**	23 EST	230
TKN	0.25	0.31	NS	0.78	0.69	0.59
Ammonia	0.092	0.060	NS	0.12	0.060	0.071
Nitrate/Nitrite	0.078	0.52	NS	0.041	**2.0**	0.053
Total Phosphorus	0.060	0.053	NS	0.069	0.041	0.05
Cadmium	0.00010	<0.00010	NS	**0.00035**	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	NS	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	NS	<0.010	<0.010	<0.010
Iron	**3.6**	**3.7**	NS	0.53	**2.4**	**2.6**
Lead	<0.0020	<0.0020	NS	<0.0020	<0.0020	<0.0020
Manganese	0.11	0.11	NS	0.11	0.042	0.074
Nickel	<0.020	<0.020	NS	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	NS	0.012	<0.010	<0.010
Mercury	<0.00020	<0.00020	NS	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

DATA TABLES

NWSV-325	Upper Three Runs at Road A					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.54	7.62	7.50	7.20	6.94	7.12
DO	9.70	10.76	9.58	9.05	7.87	8.53
Water Temp	9.77	10.17	14.27	16.38	21.20	22.08
Alkalinity	**2.7**	**3.3**	**3.4**	**3.5**	**3.4**	**1.3**
Turbidity	2.9	3.4	4.0	5.2	6.2	5.4
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	3.3	5.2	7.4	6.6	6.6	7.3
Fecal Coliform	120	66	100	97	100	110
TKN	AE	0.20	0.38	AE	AE	AE
Ammonia	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.21	0.16	0.18	0.18	0.24	0.83
Total Phosphorus	0.029	0.026	0.027	0.04	0.036	0.046
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	<0.00010
Chromium	0.0054	<0.0050	0.0072	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.30	0.36	0.40	0.62	0.48	0.38
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.021	0.023	0.017	0.026	0.016	0.013
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-325	Upper Three Runs at Road A					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.35	6.58	7.43	7.43	7.24	7.28
DO	7.01	6.43	7.10	9.47	6.77	7.51
Water Temp	24.49	22.10	20.66	18.42	16.87	15.95
Alkalinity	**3.8**	**3.8**	**2.9**	**3.7**	**4.9**	**6.0**
Turbidity	3.1	3.8	2.4	3.3	1.6	1.8
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	3.0	5.3	3.4	5.7	1.8	1.4
Fecal Coliform	190	210	230	**1100**	110	80 EST
TKN	<0.10	<0.10	<0.10	0.36	0.39	0.38
Ammonia	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.17	0.15	0.23	0.12	0.099	0.14
Total Phosphorus	0.036	0.026	0.023	0.027	0.023	0.028
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.33	0.35	0.24	**3.2**	0.27	0.32
Lead	**0.0021**	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.012	0.014	<0.010	0.013	<0.010	0.013
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

DATA TABLES

NWSV-327	Steel Creek at Road A					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.33	7.89	7.53	7.27	6.86	7.42
DO	10.60	11.83	9.73	9.03	7.73	8.07
Water Temp	8.65	8.12	13.94	16.98	23.92	24.90
Alkalinity	22	21	25	21	30	31
Turbidity	2.1	1.9	2.6	4.0	4.2	2.9
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	1.6	1.3	2.4	7.0	5.6	3.6
Fecal Coliform	120	190	330	**440**	80	40 EST
TKN	<0.10	0.12	0.40	AE	AE	AE
Ammonia	<0.050	<0.050	<0.050	<0.050	0.056	0.086
Nitrate/Nitrite	0.072	0.059	0.089	0.074	0.091	0.076
Total Phosphorus	0.022	<0.020	<0.020	0.03	0.029	0.031
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	**0.017**	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.29	0.26	0.52	0.65	0.43	0.31
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.031	0.029	0.045	0.067	0.035	0.028
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	0.014	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-327	Steel Creek at Road A					
	July	**August**	**September**	**October**	**November**	**December**
pH	7.08	6.95	7.26	7.31	7.37	7.24
DO	7.32	7.30	7.81	5.92	7.77	7.29
Water Temp	27.26	24.56	23.98	18.93	17.55	15.50
Alkalinity	25	30	30	22	29	28
Turbidity	2.9	16	6.6	6.1	1.6	1.4
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	3.2	88	13	13	1.4	<1.0
Fecal Coliform	110	190	220	**>1200**	86	40 EST
TKN	0.13	<0.10	0.47	0.70	0.62	0.52
Ammonia	0.070	<0.050	0.059	0.077	<0.050	<0.050
Nitrate/Nitrite	0.073	0.060	0.074	0.12	0.30	<0.020
Total Phosphorus	0.028	0.025	0.027	0.025	<0.020	<0.020
Cadmium	**0.00026**	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.27	0.22	0.55	0.76	0.26	0.29
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.027	0.015	0.065	0.061	0.017	0.025
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

DATA TABLES

NWSV-328	Lower Three Runs at Patterson Mill Road					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.34	7.75	7.44	7.50	7.04	7.38
DO	9.55	10.83	9.10	8.88	8.08	8.94
Water Temp	10.13	8.94	14.13	16.17	21.80	20.36
Alkalinity	48	49	46	32	56	48
Turbidity	1.6	1.8	1.5	2.2	2.8	1.8
BOD	<2.0	<2.0	2.5	<2.0	<2.0	<2.0
TSS	1.5	1.7	2.0	4.9	3.0	9.0
Fecal Coliform	160	220	180	160	120 EST	160
TKN	AE	0.17	0.49	AE	AE	AE
Ammonia	<0.050	0.051	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.10	0.089	0.040	0.072	0.35	0.13
Total Phosphorus	0.031	0.026	0.026	0.033	0.040	0.047
Cadmium	0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	**0.077**	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.26	0.67	0.30	0.38	0.40	0.38
Lead	<0.0020	<0.0020	<0.0020	<0.0020	**0.0031**	<0.0020
Manganese	0.045	0.047	0.045	0.056	0.050	0.033
Nickel	<0.020	**0.024**	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	0.010	<0.010	0.011	0.012
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-328	Lower Three Runs at Patterson Mill Road					
	July	**August**	**September**	**October**	**November**	**December**
pH	7.28	7.29	7.46	7.36	7.40	7.33
DO	7.99	8.00	8.04	7.70	6.78	7.44
Water Temp	22.51	20.43	19.63	18.20	18.24	16.23
Alkalinity	51	50	49	51	55	54
Turbidity	2.2	2.7	2.4	4.0	1.1	1.0
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	2.7	2.1	2.2	7.6	<1.0	<1.0
Fecal Coliform	130 EST	250	300 EST	**980**	100 EST	360
TKN	<0.10	<0.10	0.41	0.53	0.32	0.42
Ammonia	0.054	0.086	<0.050	0.069	<0.050	<0.050
Nitrate/Nitrite	0.12	0.12	0.11	0.098	0.22	0.028
Total Phosphorus	0.044	0.031	0.027	0.034	<0.020	0.025
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.58	**1.1**	**1.3**	**1.4**	0.32	0.32
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.051	0.035	0.032	0.12	0.042	0.049
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

DATA TABLES

NWSV-2027	Upper Three Runs at Road 2-1					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.74	6.74	7.11	6.53	7.14	6.23
DO	9.43	10.83	9.72	9.09	7.95	10.63
Water Temp	12.61	11.45	15.44	16.26	19.70	20.45
Alkalinity	**<1.0**	**0.0**	**<1.0**	**<1.0**	**0.0**	**1.3**
Turbidity	2.0	1.9	2.0	1.9	3.6	2.2
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	2.0	2.2	2.2	2.8	4.6	4.0
Fecal Coliform	83	120	180	100	100	77
TKN	AE	<0.10	AE	AE	AE	AE
Ammonia	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.37	**1.6**	0.94	0.28	0.29	0.26
Total Phosphorus	<0.020	<0.020	<0.020	<0.020	<0.020	0.023
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	<0.00010
Chromium	<0.0050	**0.18**	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	**0.024**	<0.010	<0.010	<0.010	<0.010
Iron	0.16	0.84	0.33	0.26	0.33	0.28
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	<0.010	0.018	<0.010	<0.010	<0.010	<0.010
Nickel	<0.020	**0.067**	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2027	Upper Three Runs at Road 2-1					
	July	**August**	**September**	**October**	**November**	**December**
pH	**5.88**	**5.25**	**5.89**	6.58	6.09	**5.94**
DO	8.47	8.08	8.34	9.63	6.02	7.80
Water Temp	22.48	20.87	20.06	18.30	17.75	16.95
Alkalinity	**1.3**	**1.0**	**<1.0**	**1.2**	**0.0**	**1.2**
Turbidity	1.5	2.5	1.2	1.7	2.4	1.1
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	2.5	2.5	2.4	4.2	2.6	1.3
Fecal Coliform	63	120	150	280	110	180
TKN	<0.10	0.48	0.30	0.52	0.43	0.37
Ammonia	<0.050	<0.050	<0.050	0.076	<0.050	<0.050
Nitrate/Nitrite	0.26	0.26	0.26	0.24	**4.1**	0.28
Total Phosphorus	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Cadmium	<0.00010	**0.00053**	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.25	0.23	0.21	0.29	0.28	0.23
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

DATA TABLES

NWSV-2039	Fourmile Branch at Road A-13.2					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.51	8.08	7.58	7.50	6.69	7.26
DO	10.69	11.27	9.83	9.37	8.32	9.01
Water Temp	8.55	8.61	14.28	15.49	22.37	22.48
Alkalinity	**14**	**14**	**16**	**15**	**16**	25
Turbidity	3.1	5.1	3.7	4.1	3.3	3.8
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	2.4	4.6	2.4	4.1	2.3	1.8
Fecal Coliform	69	150	120	220	180	66
TKN	AE	<0.10	0.50	AE	AE	AE
Ammonia	0.12	0.072	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.94	**1.1**	**1.1**	0.99	1.0	0.58
Total Phosphorus	0.084	0.093	0.10	0.13	0.11	0.14
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.63	0.64	0.86	**1.2**	0.64	0.84
Lead	<0.0020	**0.0035**	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.033	0.042	0.037	0.054	0.030	0.035
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	0.012	<0.010	<0.010	0.011	0.012
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2039	Fourmile Branch at Road A-13.2					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.90	6.87	6.99	7.45	7.32	7.10
DO	7.99	8.02	8.63	10.08	8.45	8.85
Water Temp	25.90	22.92	21.19	18.39	16.66	15.34
Alkalinity	27	21	20	**16**	**16**	**18**
Turbidity	6.8	2.9	1.7	4.2	2.0	1.4
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	1.4	3.3	1.4	5.6	2.4	<1.0
Fecal Coliform	88	270	320	**710**	80	140
TKN	0.14	0.14	0.28	0.36	0.63	0.48
Ammonia	0.061	<0.050	<0.050	0.057	<0.050	<0.050
Nitrate/Nitrite	0.12	0.29	0.22	0.83	0.86	1.0
Total Phosphorus	0.22	0.12	0.10	0.14	0.085	0.09
Cadmium	**0.00062**	<0.00010	<0.00010	**0.00014**	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	**1.6**	0.62	0.36	0.22	0.31	0.44
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.064	0.055	0.029	0.096	0.026	0.032
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	0.012	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

DATA TABLES

NWSV-2040	Beverdam Creek in D-Area					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.42	7.52	7.35	7.27	6.61	6.78
DO	10.08	12.03	13.97	8.80	7.98	8.60
Water Temp	13.45	12.77	15.20	21.97	27.52	28.04
Alkalinity	21	**14**	20	**17**	22	**18**
Turbidity	3.9	7.5	6.4	6.9	4.3	3.4
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	2.3
TSS	2.4	5.5	5.2	6.2	4.6	5.5
Fecal Coliform	<5	7 EST	14	6	9	2
TKN	AE	0.12	0.47	AE	AE	AE
Ammonia	0.061	0.10	0.057	<0.050	<0.050	0.074
Nitrate/Nitrite	0.42	0.32	0.30	0.26	0.38	0.29
Total Phosphorus	0.11	0.092	0.088	0.082	0.15	0.090
Cadmium	**0.00011**	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.21	0.46	0.40	0.46	0.38	0.24
Lead	<0.0020	<0.0020	<0.0020	**0.0022**	<0.0020	<0.0020
Manganese	0.050	0.066	0.066	0.095	0.060	0.051
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	0.012	<0.010	<0.010	0.011	0.013
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2040	Beverdam Creek in D-Area					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.68	6.58	7.03	7.19	7.75	6.92
DO	11.06	7.96	6.92	10.02	6.55	9.08
Water Temp	28.89	29.45	24.03	24.93	21.54	19.57
Alkalinity	AE	20	21	21	20	21
Turbidity	3.6	4.8	2.7	4.3	6.1	2.4
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	3.3	5.1	2.8	7.4	6.7	2.1
Fecal Coliform	7	75	12	42	12	10
TKN	0.17	0.13	0.44	0.69	0.43	0.40
Ammonia	0.062	<0.050	<0.050	0.054	0.070	0.064
Nitrate/Nitrite	0.31	0.26	0.23	0.25	0.38	0.22
Total Phosphorus	0.11	0.13	0.076	0.064	0.13	0.12
Cadmium	<0.00010	<0.00010	<0.00010	**0.00013**	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.26	0.20	0.18	0.35	0.26	0.19
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.043	0.043	0.039	0.048	0.062	0.040
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	0.011
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

DATA TABLES

NWSV-2047	Pen Branch at Road A-13.2					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.53	**8.62**	7.70	7.42	6.86	7.33
DO	10.98	11.71	10.33	9.75	8.82	8.67
Water Temp	8.72	8.69	13.18	14.71	22.64	22.60
Alkalinity	20	**17**	22	27	**2.3**	28
Turbidity	4.2	31	10	4.0	6.7	5.2
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	4.2	32	12	2.9	43	3.4
Fecal Coliform	83	60	51 EST	160	230	160
TKN	AE	0.14	0.44	AE	AE	AE
Ammonia	0.059	0.066	<0.050	<0.050	<0.050	0.057
Nitrate/Nitrite	0.22	0.27	0.26	0.20	**1.5**	0.18
Total Phosphorus	0.033	0.15	0.076	0.045	0.051	0.046
Cadmium	**0.00015**	<0.00010	<0.00010	<0.00010	**0.00011**	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.45	**1.3**	0.58	0.73	0.93	0.40
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.040	0.18	0.056	0.057	0.12	0.035
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	0.012	0.012	<0.010	<0.010	0.013	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2047	Pen Branch at Road A-13.2					
	July	**August**	**September**	**October**	**November**	**December**
pH	7.24	7.13	7.50	7.42	7.38	7.33
DO	8.33	8.29	8.68	8.79	8.49	9.34
Water Temp	25.84	22.87	21.98	18.64	17.29	15.70
Alkalinity	30	27	28	24	25	26
Turbidity	3.9	6.6	2.7	7.8	2.7	1.7
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	3.1	6.9	6.0	14	2.9	<1.0
Fecal Coliform	120	110	230	**>600**	50	140
TKN	<0.10	<0.10	0.25	0.61	0.47	0.46
Ammonia	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.15	0.14	0.17	0.18	0.12	0.12
Total Phosphorus	0.047	0.033	0.031	0.055	0.036	0.031
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.52	0.41	0.35	0.63	0.25	0.47
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.053	0.043	0.035	0.083	0.020	0.024
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	0.012	<0.010	<0.010	0.012	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

DATA TABLES

NWSV-2061	Tinker Creek at Road 2-1					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.31	6.90	7.14	6.85	7.43	6.61
DO	10.26	11.34	10.29	9.22	7.99	10.82
Water Temp	9.71	9.52	14.89	16.44	21.69	22.69
Alkalinity	**3.6**	**1.6**	**5.6**	**3.8**	**6.0**	**7.0**
Turbidity	4.1	4.1	5.3	3.8	5.0	4.0
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	5.2	5.8	5.4	5.8	6.6	6.4
Fecal Coliform	90 EST	120	140	160	**520**	120
TKN	AE	0.12	0.34	AE	AE	AE
Ammonia	<0.050	<0.050	0.055	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.077	0.068	0.065	0.056	0.085	0.085
Total Phosphorus	0.046	0.043	0.048	0.066	0.081	0.097
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	**0.00021**	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.30	0.32	0.44	0.63	0.65	0.60
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.029	0.024	0.025	0.026	0.019	0.019
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	0.011	0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2061	Tinker Creek at Road 2-1					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.69	6.20	6.92	6.75	6.75	6.73
DO	8.42	8.28	8.62	9.91	6.39	8.36
Water Temp	26.52	23.08	21.76	18.53	17.64	16.10
Alkalinity	**9.3**	**7.4**	**6.9**	**6.9**	**6.1**	**6.3**
Turbidity	3.0	2.7	2.5	4.9	1.5	2.5
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	4.5	3.6	3.9	8.0	1.9	3.2
Fecal Coliform	150	220	330	**840**	340	80
TKN	<0.10	0.71	0.25	0.66	0.45	0.47
Ammonia	0.055	<0.050	<0.050	0.059	<0.050	<0.050
Nitrate/Nitrite	0.080	0.057	0.038	0.033	0.25	0.022
Total Phosphorus	0.092	0.073	0.061	0.069	0.058	0.057
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.45	0.43	0.33	0.53	0.32	0.41
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Manganese	0.016	0.015	0.011	0.034	0.015	0.027
Nickel	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	0.013	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2011 samples above the LLD for volatile organic compounds, pesticides, or polychlorinated biphenyls.

7.0 SUMMARY STATISTICS

Summary Statistics for Nonradiological Monitoring of Ambient Surface Water at SRS

Summary Statistics **25**

Notes:

1. NA = Not Applicable
2. AVG = Average
3. STDEV = Standard Deviation
4. Min = Minimum
5. Max = Maximum
6. N = Number
7. All summary statistics are rounded to two significant figures.

SUMMARY STATISTICS

Sample Location	NWSV-324	Tims Branch at Road C					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	6.75	0.64	6.67	5.91	8.05	11
	DO	8.59	1.67	8.22	6.15	11.14	11
	Water Temp	18.12	6.23	17.67	8.05	27.95	11
Lab Parameters	Alkalinity	**4.9**	1.9	5.3	1.6	7.4	10
	Turbidity	6.5	1.8	6.7	3.8	9.0	11
	BOD	<2.0	NA	NA	NA	NA	0
	TSS	6.8	3.8	6.6	2.9	17	11
	Fecal Coliform	123	169	53	23	600	11
	TKN	0.48	0.22	0.52	0.21	0.78	7
	Ammonia	0.080	0.019	0.075	0.060	0.12	11
	Nitrate/Nitrite	0.30	0.58	0.083	0.041	2.0	11
	Total Phosphorus	0.055	0.012	0.053	0.038	0.071	11
	Cadmium	**0.00035**	0.00027	0.00028	0.00010	0.00073	4
	Chromium	**0.024**	NA	0.024	0.024	0.024	1
	Copper	<0.010	NA	NA	NA	NA	0
	Iron	**2.8**	1.1	2.7	0.53	4.1	11
	Lead	<0.0020	NA	NA	NA	NA	0
	Manganese	0.10	0.045	0.11	0.042	0.18	11
	Nickel	<0.020	NA	NA	NA	NA	0
	Zinc	0.016	0.0049	0.016	0.012	0.019	2
	Mercury	<0.00020	NA	NA	NA	NA	0

Sample Location	NWSV-325	Upper Three Runs at Road A					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.19	0.39	7.26	6.35	7.62	12
	DO	8.32	1.39	8.20	6.43	10.76	12
	Water Temp	17.70	4.70	17.65	9.77	24.49	12
Lab Parameters	Alkalinity	**3.6**	1.1	3.5	1.3	6.0	12
	Turbidity	3.6	1.4	3.4	1.6	6.2	12
	BOD	<2.0	NA	NA	NA	NA	0
	TSS	4.8	2.1	5.3	1.4	7.4	12
	Fecal Coliform	209	285	110	66	1100	12
	TKN	0.34	0.080	0.38	0.20	0.39	5
	Ammonia	<0.050	NA	NA	NA	NA	0
	Nitrate/Nitrite	0.23	0.19	0.18	0.099	0.83	12
	Total Phosphorus	0.031	0.0072	0.028	0.023	0.046	12
	Cadmium	0.00010	NA	0.00010	0.00010	0.00010	1
	Chromium	0.0063	0.0013	0.0063	0.0054	0.0072	2
	Copper	<0.010	NA	NA	NA	NA	0
	Iron	0.60	0.82	0.36	0.24	3.2	12
	Lead	**0.0021**	NA	0.0021	0.0021	0.0021	1
	Manganese	0.017	0.0049	0.015	0.012	0.026	10
	Nickel	<0.020	NA	NA	NA	NA	0
	Zinc	0.010	0.000	0.010	0.010	0.010	2
	Mercury	<0.00020	NA	NA	NA	NA	0

SUMMARY STATISTICS

Sample Location	NWSV-327	Steel Creek at Road A					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.29	0.27	7.29	6.86	7.89	12
	DO	8.37	1.65	7.79	5.92	11.83	12
	Water Temp	18.69	6.41	18.24	8.12	27.26	12
Lab Parameters	Alkalinity	26	3.9	27	21	31	12
	Turbidity	4.4	4.0	2.9	1.4	16	12
	BOD	<2.0	NA	NA	NA	NA	0
	TSS	13	25	3.6	1.3	88	11
	Fecal Coliform	254	321	155	40	1200	12
	TKN	0.42	0.23	0.47	0.12	0.70	7
	Ammonia	0.070	0.012	0.070	0.056	0.086	5
	Nitrate/Nitrite	0.099	0.069	0.074	0.059	0.30	11
	Total Phosphorus	0.027	0.0030	0.028	0.022	0.031	8
	Cadmium	**0.00026**	NA	0.00026	0.00026	0.00026	1
	Chromium	**0.017**	NA	0.017	0.017	0.017	1
	Copper	<0.010	NA	NA	NA	NA	0
	Iron	0.40	0.18	0.30	0.22	0.76	12
	Lead	<0.0020	NA	NA	NA	NA	0
	Manganese	0.037	0.018	0.030	0.015	0.067	12
	Nickel	<0.020	NA	NA	NA	NA	0
	Zinc	0.012	0.0028	0.012	0.010	0.014	2
	Mercury	<0.00020	NA	NA	NA	NA	0

Sample Location	NWSV-328	Lower Three Runs at Patterson Mill Road					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.38	0.17	7.37	7.04	7.75	12
	DO	8.44	1.08	8.06	6.78	10.83	12
	Water Temp	17.23	4.34	18.22	8.94	22.51	12
Lab Parameters	Alkalinity	49	6.2	50	32	56	12
	Turbidity	2.1	0.83	2.0	1.0	4.0	12
	BOD	2.5	NA	2.5	2.5	2.5	1
	TSS	3.7	2.6	2.5	1.5	9.0	10
	Fecal Coliform	260	239	170	100	980	12
	TKN	0.39	0.13	0.42	0.17	0.53	6
	Ammonia	0.065	0.016	0.062	0.051	0.086	4
	Nitrate/Nitrite	0.12	0.086	0.11	0.028	0.35	12
	Total Phosphorus	0.033	0.0076	0.031	0.025	0.047	11
	Cadmium	0.00010	NA	0.00010	0.00010	0.00010	1
	Chromium	**0.077**	NA	0.077	0.077	0.077	1
	Copper	<0.010	NA	NA	NA	NA	0
	Iron	0.62	0.41	0.39	0.26	1.4	12
	Lead	**0.0031**	NA	0.0031	0.0031	0.0031	1
	Manganese	0.050	0.023	0.046	0.032	0.12	12
	Nickel	**0.024**	NA	0.024	0.024	0.024	1
	Zinc	0.011	0.0010	0.011	0.010	0.012	3
	Mercury	<0.00020	NA	NA	NA	NA	0

SUMMARY STATISTICS

Sample Location	NWSV-2027	Upper Three Runs at Road 2-1					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	6.43	0.69	6.38	5.25	7.74	12
	DO	8.83	1.34	8.78	6.02	10.83	12
	Water Temp	17.69	3.35	18.03	11.45	22.48	12
Lab Parameters	Alkalinity	**0.75**	0.63	1.1	0.0	1.3	8
	Turbidity	2.0	0.66	2.0	1.1	3.6	12
	BOD	<2.0	NA	NA	NA	NA	0
	TSS	2.8	1.0	2.5	1.3	4.6	12
	Fecal Coliform	130	60	115	63	280	12
	TKN	0.42	0.087	0.43	0.30	0.52	5
	Ammonia	0.076	NA	0.076	0.076	0.076	1
	Nitrate/Nitrite	0.76	1.1	0.28	0.24	4.1	12
	Total Phosphorus	0.023	NA	0.023	0.023	0.023	1
	Cadmium	**0.00032**	0.00030	0.00032	0.00010	0.00053	2
	Chromium	**0.18**	NA	0.18	0.18	0.18	1
	Copper	**0.024**	NA	0.024	0.024	0.024	1
	Iron	0.31	0.17	0.27	0.16	0.84	12
	Lead	<0.0020	NA	NA	NA	NA	0
	Manganese	0.018	NA	0.018	0.018	0.018	1
	Nickel	**0.067**	NA	0.067	0.067	0.067	1
	Zinc	0.011	NA	0.011	0.011	0.011	1
	Mercury	<0.00020	NA	NA	NA	NA	0

Sample Location	NWSV-2039	Fourmile Branch at Road A-13.2					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.27	0.39	7.29	6.69	8.08	12
	DO	9.21	1.06	8.93	7.99	11.27	12
	Water Temp	17.68	5.57	17.53	8.55	25.90	12
Lab Parameters	Alkalinity	**18**	4.3	16	14	27	12
	Turbidity	3.5	1.5	3.5	1.4	6.8	12
	BOD	<2.0	NA	NA	NA	NA	0
	TSS	2.9	1.4	2.4	1.4	5.6	11
	Fecal Coliform	201	180	145	66	710	12
	TKN	0.36	0.19	0.36	0.14	0.63	7
	Ammonia	0.078	0.029	0.067	0.057	0.12	4
	Nitrate/Nitrite	0.75	0.36	0.90	0.12	1.1	12
	Total Phosphorus	0.12	0.038	0.11	0.084	0.22	12
	Cadmium	**0.00038**	0.00034	0.00038	0.00014	0.00062	2
	Chromium	<0.0050	NA	NA	NA	NA	0
	Copper	<0.010	NA	NA	NA	NA	0
	Iron	0.70	0.39	0.64	0.22	1.6	12
	Lead	**0.0035**	NA	0.0035	0.0035	0.0035	1
	Manganese	0.044	0.020	0.036	0.026	0.096	12
	Nickel	<0.020	NA	NA	NA	NA	0
	Zinc	0.012	0.00050	0.012	0.011	0.012	4
	Mercury	<0.00020	NA	NA	NA	NA	0

SUMMARY STATISTICS

Sample Location	NWSV-2040	Beverdam Creek in D-Area					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.09	0.38	7.11	6.58	7.75	12
	DO	9.42	2.15	8.94	6.55	13.97	12
	Water Temp	22.28	5.97	23.00	12.77	29.45	12
Lab Parameters	Alkalinity	20	2.3	20	14	22	11
	Turbidity	4.7	1.7	4.3	2.4	7.5	12
	BOD	2.3	NA	2.3	2.3	2.3	1
	TSS	4.7	1.7	5.2	2.1	7.4	12
	Fecal Coliform	18	22	10	2	75	11
	TKN	0.36	0.20	0.42	0.12	0.69	8
	Ammonia	0.068	0.015	0.063	0.054	0.10	8
	Nitrate/Nitrite	0.30	0.064	0.30	0.22	0.42	12
	Total Phosphorus	0.10	0.026	0.10	0.064	0.15	12
	Cadmium	**0.00012**	0.000014	0.00012	0.00011	0.00013	2
	Chromium	<0.0050	NA	NA	NA	NA	0
	Copper	<0.010	NA	NA	NA	NA	0
	Iron	0.30	0.11	0.26	0.18	0.46	12
	Lead	**0.0022**	NA	0.0022	0.0022	0.0022	1
	Manganese	0.055	0.016	0.051	0.039	0.095	12
	Nickel	<0.020	NA	NA	NA	NA	0
	Zinc	0.012	0.0010	0.012	0.011	0.013	4
	Mercury	<0.00020	NA	NA	NA	NA	0

Sample Location	NWSV-2047	Pen Branch at Road A-13.2					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.46	0.42	7.40	6.86	8.62	12
	DO	9.35	1.12	8.81	8.29	11.71	12
	Water Temp	17.74	5.69	17.97	8.69	25.84	12
Lab Parameters	Alkalinity	23	7.5	26	2.3	30	12
	Turbidity	7.2	7.9	4.7	1.7	31	12
	BOD	<2.0	NA	NA	NA	NA	0
	TSS	12	13	6.0	2.9	43	11
	Fecal Coliform	166	150	130	50	600	12
	TKN	0.40	0.17	0.45	0.14	0.61	6
	Ammonia	0.061	0.0047	0.059	0.057	0.066	3
	Nitrate/Nitrite	0.29	0.38	0.18	0.12	1.5	12
	Total Phosphorus	0.053	0.033	0.046	0.031	0.15	12
	Cadmium	**0.00013**	0.000028	0.00013	0.00011	0.00015	2
	Chromium	<0.0050	NA	NA	NA	NA	0
	Copper	<0.010	NA	NA	NA	NA	0
	Iron	0.59	0.29	0.50	0.25	1.3	12
	Lead	<0.0020	NA	NA	NA	NA	0
	Manganese	0.062	0.046	0.048	0.020	0.18	12
	Nickel	<0.020	NA	NA	NA	NA	0
	Zinc	0.012	0.00045	0.012	0.012	0.013	5
	Mercury	<0.00020	NA	NA	NA	NA	0

SUMMARY STATISTICS

Sample Location	NWSV-2061	Tinker Creek at Road 2-1					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	6.86	0.33	6.80	6.20	7.43	12
	DO	9.16	1.41	8.92	6.39	11.34	12
	Water Temp	18.21	5.26	18.09	9.52	26.52	12
Lab Parameters	Alkalinity	**5.9**	2.0	6.2	1.6	9.3	12
	Turbidity	3.6	1.2	3.9	1.5	5.3	12
	BOD	<2.0	NA	NA	NA	NA	0
	TSS	5.0	1.7	5.3	1.9	8.0	12
	Fecal Coliform	259	224	155	80	840	12
	TKN	0.43	0.21	0.45	0.12	0.71	7
	Ammonia	0.056	0.0023	0.055	0.055	0.059	3
	Nitrate/Nitrite	0.076	0.058	0.067	0.022	0.25	12
	Total Phosphorus	0.066	0.017	0.064	0.043	0.097	12
	Cadmium	**0.00021**	NA	0.00021	0.00021	0.00021	1
	Chromium	<0.0050	NA	NA	NA	NA	0
	Copper	<0.010	NA	NA	NA	NA	0
	Iron	0.45	0.13	0.44	0.30	0.65	12
	Lead	<0.0020	NA	NA	NA	NA	0
	Manganese	0.022	0.0069	0.022	0.011	0.034	12
	Nickel	<0.020	NA	NA	NA	NA	0
	Zinc	0.011	0.0015	0.011	0.010	0.013	3
	Mercury	<0.00020	NA	NA	NA	NA	0

List Of Acronyms

BOD	Biochemical Oxygen Demand
DO	Dissolved Oxygen
DOE-SR	Department of Energy - Savannah River
ESOP	Environmental Surveillance and Oversight Program
LLD	Lower Limit of Detection
NAS	National Academy of Sciences
NRSW	Nonradiological Surface Water
PCB	Polychlorinated Biphenyls
SCDHEC	South Carolina Department of Health and Environmental Control
STDEV	Standard Deviation
SRS	Savannah River Site
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solid
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compounds

Units Of Measure

C	temperature in Celsius
mg/L	milligrams per liter
mL	milliliter
NTU	Nephelometric Turbidity Unit
su	standard units
±	plus or minus one standard deviation unless otherwise noted

References

National Academy of Sciences (NAS), National Academy of Engineering, 1974. Water quality criteria, 1972. U.S. Government Printing Office, Washington, D.C.

South Carolina Department of Health and Environmental Control, 2008. *Water Classifications and Standards* (Regulation 61-68), Bureau of Water, Division of Water Quality Assessment and Enforcement, Columbia, South Carolina.

SCDHEC, 2010. *State of South Carolina Section 303(d) List for 2010*, Bureau of Water, Columbia, South Carolina.

SCDHEC, 2011. *State of South Carolina Monitoring Strategy*, Technical Report No. 01J-11, Bureau of Water, Water Quality Monitoring Section, Columbia, South Carolina.

SCDHEC, 2011b. *Nonradiological Ambient Surface Water Quality Monitoring Project Plan*, Bureau of Environmental Services - Environmental Surveillance and Oversight Program. Aiken, South Carolina.

Savannah River Nuclear Solutions, LLC (SRNS), 2012. *Savannah River Site Environmental Report for 2011*. Savannah River Site, Aiken, South Carolina. SRNS-STI-2012-00200.

United States Environmental Protection Agency (USEPA), 1997. *Monitoring Water Quality*, EPA 841-B-97-003. Office of Water, Washington DC.

USEPA, 2003. *National Primary Drinking Water Standards*, EPA-816-F-03-016. Office of Water, Washington DC.

USEPA, 2008. *National Recommended Water Quality Criteria,* EPA-Section 304(a) Clean Water Act.

United States Geological Survey (USGS), 2000. *Water Quality in the Santee River Basin and Coastal Drainages, North and South Carolina,* 1995-1998: U.S Geological Survey Circular 1206, 32p., http://pubs.water.usgs.gov/circ1206/.

This Page Intentionally Left Blank

2011 Radiological and Nonradiological Monitoring of Sediments

Environmental Surveillance and Oversight Program

06SM001
John Simpkins, Project Manager
January 01, 2011 – December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 4

RADIOLOGICAL PARAMETER RESULTS 4
NONRADIOLOGICAL PARAMETER RESULTS 5
SCDHEC AND DOE-SR DATA COMPARISON 7

3.0 CONCLUSIONS AND RECOMMENDATIONS 8

4.0 MAPS 10

5.0 TABLES AND FIGURES 12

6.0 DATA 18

RADIOLOGICAL DATA 19
NONRADIOLOGICAL DATA 30

7.0 SUMMARY STATISTICS 31

RADIOLOGICAL STATISTICS 32
NONRADIOLOGICAL STATISTICS 33

LIST OF ACRONYMS AND UNITS OF MEASURE 34

REFERENCES 35

1.0 PROJECT SUMMARY

The accumulation of radiological and nonradiological contaminants in sediment can have direct impacts on aquatic organisms that can result in human exposure. Point source and nonpoint source pollutants impact water bodies through direct discharge, atmospheric fallout, or through runoff. These accumulated contaminants may become resuspended in streams and rivers. Contaminants dispersed downstream potentially impact drinking water supplies and fish consumed by the public. The high mobility of sediments is a complicated issue as stream flow changes can redistribute contaminants or bury them as part of the natural sedimentation process. Patterns of sediment contamination are strongly affected by hydrologic factors and the physical and chemical characterization of the sediment (USEPA 1987).

The United States Atomic Energy Commission established the Savannah River Site (SRS) in 1950 to produce plutonium, tritium, and other materials for national defense and civilian purposes (Till et al. 2001). SRS streams receive surface water runoff and water from permitted discharges. Stormwater basins may receive runoff and atmospheric fallout from diffuse and fugitive sources (USDOE 1995). Cesium-137 (Cs-137) contamination due to accidental releases of nuclear materials from past operations occurs along the entire length of Lower Three Runs (LTR) and Steel Creek on SRS, and the private property of Creek Plantation. LTR and Steel Creek watersheds represent a possible pathway for release of contamination from SRS activities to both on-site and off-site receptors in the environment (WSRC 2002). Flooding and dam releases from Par Pond and L-Lake scour creek bottoms that may result in the resuspension of contaminated sediments. SRS is within the Savannah River watershed, with five major streams feeding into the Savannah River. Dispersal of any contaminants from these streams has the potential to impact the publically accessible Savannah River.

Cesium-137 is an artificially produced fission product. Atmospheric Cs-137 was released from the separation areas and was a key radionuclide released to water and air, mainly from F-Area and H-Area (CDC 2006). The liquid releases were also from the reactors as a result of leaking fuel elements in the 1950s and 1960s (WSRC 1998). The largest single source of Cs-137 was fallout from atmospheric nuclear weapons tests in the 1950s and 1960s, which dispersed and deposited Cs-137 world-wide. However, much of the Cs-137 from testing has now decayed. Due to its half-life of 30 years, Cs-137 has an impact on the SRS environment. Additionally, the biological behavior of Cs-137 is similar to potassium, which is essential to the function of living cells (USEPA 2009a). Therefore, the potential for Cs-137 uptake into humans is important considering the potential health effects.

Americium-241 (Am-241) is a man-made transuranic nuclide produced during the fission process. With a half-life of 432 years, this radionuclide may be a legacy of past nuclear fallout events. Previous studies indicate that Am-241 was released in significant quantities from the SRS (Till et. al. 2001). Along with Cs-137, Am-241 was released to the air from SRS (CDC 2006).

Alpha-emitting radionuclides were released to liquid effluent from M-Area, F-Area and H-Area, and the reactor areas. The primary stream affected by the M-Area releases was Tims Branch, which ultimately flows into Upper Three Runs Creek. Fourmile Branch is the stream most affected by releases coming from the separation areas. Releases from the reactor areas affected all streams with the exception of Upper Three Runs Creek (Till et al. 2001).

Beta-emitting radionuclides were released to liquid effluent from F-Area, H-Area, and the reactors. Fourmile Branch is the stream primarily affected by releases from the separations areas. Steel Creek, Pen Branch, and Lower Three Runs Creek were mainly affected by releases from the reactors. Strontium-90 (Sr-90) is a main contributor of beta activity and came primarily from the reactors (Till et al. 2001).

Plutonium releases at SRS occurred primarily through the discharge of liquid effluent. Plutonium was manufactured on SRS in H-Area for fuel rods and in F-Area for targets (Till et al. 2001). Iodine-129 (I-129) is a fission product of reactor fuel that has a very long (~16 million year) half-life. Most releases occurred during fuel processing (Till et al. 2001). Technetium-99 (Tc-99) was produced in SRS production reactors as a fission byproduct of uranium and plutonium. This radionuclide was released to the environment from the separation areas ventilation systems, the aqueous environment from liquid waste in waste tanks, and the Solid Waste Disposal Facility (WSRC 1993a). Technetium-99 has also been released to the environment from atmospheric weapons tests, nuclear reactor airborne emissions, nuclear fuel reprocessing plant airborne emissions, and facilities that treat or store radioactive waste (USEPA 2009b). Although historical fallout from weapons testing has been the most important man-made contributor to radioactive contamination of the global environment, there are other anthropogenic sources, such as SRS operations. Also, some radionuclides occur naturally in the environment. Separating radioactivity contributed by releases from the SRS from weapons fallout is difficult for some radioisotopes (Till et al. 2001)

Barium has been a constituent of the H-Area Hazardous Waste Management Facility (WSRC 1993b). Beryllium is a strong light weight metal used in nuclear weapons work (Till et al. 2001). Cadmium enters the atmosphere through fuel and coal combustion (Till et al. 2001). Chromium solutions were used at the SRS as corrosion inhibitors. Chromium was a part of wastewater solutions resulting from dissolving stainless steel. It was also used in cleaning solutions in the separation areas (Till et al. 2001). Copper, while naturally occurring, can also be released to the environment through the combustion of wood, coal, and oil (Alloway 1995). These mechanisms are possible sources of elevated copper in the sediments. Atmospheric emissions of lead from SRS occurred through coal and fuel combustion (Till et al. 2001). Lead can deposit in sediment, where it has a long residence time when compared to other pollutants (Alloway 1995). Manganese has been released in the separations area head end processes and discharged to liquid waste tanks. It is also a byproduct of coal burning (Till et al. 2001). Mercury in sediment may be attributed to atmospheric fallout. SRS facilities such as F-Area and H-Area, tritium facilities, waste tanks, and the coal-fired power plants have emitted mercury to the atmosphere (Till et al. 2001). Nickel was released to Tims Branch from M-Area processes (Till et al. 2001). Upper Three Runs creek is the receptor of effluent from Tims Branch. Zinc was released in relatively small amounts to the separations area seepage basins as well as the M-Area seepage basin (Till et al. 2001).

The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) provides independent evaluation of the Department of Energy-Savannah River (DOE-SR) environmental monitoring programs. ESOP personnel independently evaluated sediment samples for radionuclide and nonradionuclide contaminant concentrations in SRS streams, SRS stormwater basins, creek mouths along the boundary of SRS, the Savannah River, and publically accessible sites in the SRS vicinity. Background locations are sampled to compare ambient levels of radionuclides from offsite locations to determine potential impacts due to SRS operations. Sediment samples on SRS are routinely split with DOE-SR in order to compare results.

The ESOP ambient sediment monitoring project changed in 2007 to include more background sediments (those greater than 50 miles from the SRS center point) within the boundaries of the state of South Carolina. This sampling program was implemented to allow statistical comparisons of the SRS perimeter and South Carolina background contaminant levels in sediment. The United States Geological Survey 7.5' Quadrangle Coverage for South Carolina (USDOI 1992) was used to determine the ESOP random quadrant sampling areas.

ESOP sampled 17 locations at SRS in 2011 with the cooperation of DOE-SR personnel. SRS sediment sampling locations are illustrated in Section 4.0, Map 1. Split samples were collected from seven stream locations on SRS and from three stormwater basins. These locations are not publically accessible. Creek mouth sediment samples at five publicly accessible locations along the Savannah River were also co-sampled (Section 5.0, Table 1). ESOP independently sampled six random background sediments (Section 4.0, Map 2 and Section 5.0, Table 2).

All SRS split samples were analyzed for gross alpha, gross beta, and gamma. Additionally, SRS creek mouths, stormwater basins and publically accessible boat landings were analyzed for metals. All samples collected from random background locations were analyzed for gross alpha, gross beta, and gamma. Additionally, isotopic analysis was conducted on the five SRS creek mouths, three stormwater basins and two public boat landing locations. Evaluation of radiological and nonradiological contaminants in sediment is necessary to detect any impact from DOE-SR operations beyond historically impacted areas. Radionuclide detections in sediment are typically the result of accumulation over many years and do not represent yearly depositions.

The continuation of sediment sampling and analysis, along with trending of data, is necessary to closely monitor SRS sediments. The potential for contaminants to impact the environment of SRS along with the publicly accessible creek mouths and the Savannah River warrants these long-term monitoring efforts.

2.0 RESULTS AND DISCUSSION

Radiological Parameter Results

SCDHEC 2011 radiological data can be found in Section 6.0 and statistical data can be found in Section 7.0.

Sediments were evaluated for gross alpha and gross non-volatile beta as well as a suite of 24 gamma-emitting radionuclides. Selected samples were also analyzed for Plutonium-238 (Pu-238), Plutonium-239/240 (Pu-239/240), Uranium-234 (U-234), Uranium-235 (U-235) and Uranium-238 (U-238). A complete list of gamma-emitting radionuclides that SCDHEC analyzed for in 2011 can be found in Section 5.0, Table 3.

Gamma spectroscopy led to detections of man-made radionuclides. Cesium-137 activity trends highest at the SRS streams, followed by publicly accessible SRS creek mouths, boat landings and SRS stormwater basins. Figure 1 in Section 5.0 illustrates Cs-137 activity in sediment samples collected from SRS stormwater basins, SRS streams, SRS creek mouths and publicly accessible boat landings.

Samples collected from four of the five publicly accessible SRS creek mouths had Cs-137 detections averaging 0.70 (± 0.40) pCi/g and ranged from 0.32 pCi/g at Four Mile creek mouth (SMSV-2015) to 1.26 pCi/g at Steel creek mouth (SMSV-2017). Cesium-137 was detected at seven of the ten publicly accessible boat landing locations at an average of 0.16 (± 0.11) pCi/g and ranged from 0.05 pCi/g to 0.31 pCi/g.

Cesium-137 was detected at four of the five publicly accessible SRS creek mouth locations (Section 5.0, Figure 2). Cesium-137 was detected in five of seven on-site non-publicly accessible SRS stream sediment samples at an average of 0.97 (± 1.5) picocuries per gram (pCi/g) and ranged from 0.06 to 3.8 pCi/g. The highest detection was located at Four Mile Creek at Highway 125 (SMSV-2049). Two of the three SRS stormwater basins had detections of Cs-137 at an average of 0.11 (± .04) pCi/g.

Five out of six background samples had Cs-137 detections. The random random background sample detection average was 2.1 (±4.6) pCi/g. The random background samples had detections ranging from less than minimum detectable activity (MDA) to 10.3 pCi/g. Cesium-137, on average, was highest in the random background samples followed by non publicly accessible SRS streams.

There were detections of actinium-228, potassium-40, lead-212, lead-214, radium-226, and thorium-234. These Naturally Occurring Radioactive Material (NORM) decay products may account for these detections (Section 5, Table 3). All other gamma-emitting radionuclides had no detections above their respective MDA.

Gross alpha activity was detected in two of the seven on-site non-publicly accessible SRS stream samples locations averaging 36.1 (±31.6) pCi/g and ranging from 13.70 to 58.40 pCi/g. The highest detection was located at Upper Three Runs (SMSV-2073). Gross alpha activity was not detected in any of the three SRS basin sample locations, six background locations or ten publicly accessible boat landings. Gross alpha was detected in three of five SRS creek mouth samples averaging 17.5 (±11.3) pCi/g and ranging from 9.7 to 30.4 pCi/g (Section 5.0 Figure 3).

Gross non-volatile beta was detected in four of the six on-site SRS stream locations averaging 21.7 (±18.3) pCi/g. Activities ranged from 11.5 pCi/g to 49.0 pCi/g. The highest detection was located at Upper Three Runs (SMSV-2073). Four out of the five creek mouth locations had gross non-volatile beta detections averaging 23.0 (±9.3) pCi/g. Activities ranged from 16.5 pCi/g to 36.8 pCi/g. The highest detection was located at Upper Three Runs creek mouth (SMSV-2011). Gross non-volatile beta was detected at 15.90 pCi/g at the SRS E-005 basin (Section 5.0 Figure 3).
Gross-beta was detected in two of the background locations averaging of 13.1 pCi/g and ranged from 10.50 to 15.60 pCi/g. The highest activity was detected at SMB76 in Jasper county.

Isotopic analysis of Pu-238, Pu-239/240, U-234, and U-235 was performed on samples from the five SRS creek mouths, three stormwater basins and two public boat landing locations. Plutonium-238 was detected in two of the SRS creek mouth sampling location. Activities ranged from 0.002 pCi/g at SMSV-2017 to 0.013 pCi/g at SMSV-2011. Pu-238 was detected in only one public boat landing sampling location (SMSCL11) at 0.004 pCi/g. Pu-238 was detected in only one (SME-001) of the three stormwater basins at an activity of 0.034 pCi/g. Plutonium-239/240 was detected at two of the five SRS creek mouth locations. Activities ranged from 0.0161 pCi/g at SMSV-2011 to 0.003 pCi/g at SMSV-2020. Plutonium-239/240 was detected at both public boat landing locations. Activities ranged from 0.003 pCi/g at SMBFL11 to 0.006 pCi/g at SMSCL11 . Plutonium-239/240 was detected at two of the three SRS stormwater locations. Activities ranged from 0.005 pCi/g at SME-005 to 0.009 pCi/g at SME-001 . Uranium-234 was detected at all sample locations. Activities ranged from 0.459 pCi/g at SMSV-2015 to 1.75 pCi/g at SME-005. Uranium-235 was detected at all sample locations. Activities ranged from 0.043 pCi/g at SMSV-2015 to 0.206 pCi/g at SME-005. Uranium-238 was detected at all sample locations. Activities ranged from 0. 513 pCi/g at SMSV-2015 to 1.69 pCi/g at SME-005.

<u>Nonradiological Parameter Results</u>

A United States Environmental Protection Agency (USEPA) Target Analyte List of ten metals was analyzed in all of the SRS creek mouth locations and the public boat landing in 2011. Metals data can be found in Section 5.0, Figure 5. Comparisons were made to the Ecological Screening Value (ESV) for sediment which does not represent remediation goals or cleanup levels, but is used to identify constituents of potential concern (WSRC 2005). The South Carolina state averages are from “Elements in South Carolina Inferred Background Soil and Stream Sediment Samples” (Canova 1999).

Barium was detected above the South Carolina state average of 20 milligrams per kilogram (mg/kg) in all five SRS creek mouth locations collected. The SRS creek mouth average was 50.6 (±27.7) mg/kg with a minimum of 21 mg/kg at SMSV-2015 and SMSV2013 and a maximum of 80 mg/kg at SMSV-2017. The public boat landing average was 52.7(±28.6) mg/kg with a minimum of 24 mg/kg at Steven’s Creek boat landing (SMSC11) and a maximum of 110 mg/kg at Burton’s Ferry landing (SMBFL11).

All 2011 samples were below the ESV of 0.5 mg/kg for Beryllium. Beryllium was detected above the minimum detection level (MDL) at only one of the five SRS creek mouth locations at concentration of 0.33 mg/kg at SMSV-2011. Beryllium was detected above the MDL at three of the ten public boat landing locations averaging of 0.36 mg/kg and ranging from a minimum 0.32 mg/kg at SMRVP11 to a maximum of 0.41 mg/kg at SMFF11.

Cadmium was found above the South Carolina state average of 0.6 mg/kg in three of the five SRS creek mouth locations collected. The SRS creek mouth average was 1.3 mg/kg with a minimum of 1.1 at SMSV-2011 and SMSV-2020 mg/kg and a maximum of 1.7 mg/kg at SMSV-2017. The public boat landing average was 1.7(±0.3)mg/kg with a minimum of 1.2 mg/kg at Cohen's Bluff landing (SMCB11) and a maximum of 2.1 mg/kg at Fury's Ferry Boat Landing (SMFF11.

Chromium was detected in all of the SRS creek mouth locations and none were above the South Carolina state average of 36 mg/kg. The SRS creek mouth average was 9.7(±4.1)mg/kg with a minimum of 3.3 mg/kg at SMSV-2015 and a maximum of 14 mg/kg at SV-2017. The public boat landing average was 11.2(±5.5)mg/kg with a minimum of 4.9 mg/kg at Jackson Boat landing (SMJBL11) and a maximum of 18 mg/kg at Riverview Park Boat landing (SMRVP11).

All 2011 samples were below the ESV of 18.7 mg/kg for copper. The SRS creek mouth average was 5.1 (±2.2)mg/kg with a minimum of 3.1 mg/kg at SMSV-2013 and a maximum of 8.3 mg/kg at SMSV-2017. The public boat landing average was 5.5 (±3.1)mg/kg with a minimum of 2.2 mg/kg at Steven's Creek landing (SMSC11) and a maximum of 10 mg/kg at Burton's Ferry landing (SMBFL11).

Lead was detected in four of the five SRS creek mouth samples at an average of 6.2 (±1.0)mg/kg with a minimum of 5.1 mg/kg at SMSV-2020 and a maximum of 7.2 mg/kg at SMSV-2013. Seven of the ten public boat landings yielded detections for lead. The average was 9.0 (±2.9)mg/kg with a minimum of 6.1 mg/kg at Steel Creek boat landing (SMSCL11) and a maximum of 13.0 mg/kg at Riverview Park boat landing (SMRVP11).

Manganese was detected in all SRS creek mouth and public boat landing samples. SRS creek mouth samples had an average of 307 (±218)mg/kg with a minimum of 25 mg/kg at SMSV-2013 and a maximum of 500 mg/kg at SMSV-2020. The public boat landing average was 317 (±268)mg/kg with a minimum of 9.1 at Little Hell boat landing (SMLHL11) mg/kg and a maximum of 860 at Burton's Ferry landing (SMBFL11).

There was no mercury detected in any samples collected in 2011.

Nickel was detected in four of the five SRS creek mouth samples. The SRS creek mouth average was 3.9(±1.0) mg/kg with a minimum of 2.5 mg/kg at SMSV-2013 and a maximum of 4.8 mg/kg at SMSV-2017. The public boat landing average was 4.4 (±1.2)mg/kg with a minimum of 3.3 mg/kg at Cohen's Bluff boat landing (SMCB11) and a maximum of 6.2 mg/kg at Burton's Ferry landing (SMBFL11).

Zinc was detected in all of the SRS creek mouth samples. The SRS creek mouth average was 22.1 (±11.1)mg/kg with a minimum of 9.4 mg/kg at SMSV-2015 and a maximum of 34 mg/kg at SMSV-2017. The public boat landing average was 21.9(±15.7) mg/kg with a minimum of 2.4 mg/kg at Little Hell boat landing (SMLHL11) and maximum of 54 mg/kg at Cohen's Bluff boat landing (SMCB11).

SCDHEC nonradiological sediment data can be found in Section 6.0 and nonradiological statistical data can be found in Section 7.0.

SCDHEC and DOE-SR Data Comparison

Radiological data comparison of 2011 sediment samples from SCDHEC and DOE-SR resulted in similar findings. SCDHEC Cs-137 data from the SRS creek mouths were trended for 2007-2011 (Section 5.0, Figure 4). Average Cs-137 levels increased from 2007 to 2009. The 2011 average was only slightly lower than the previous year. Due to flooding disturbances in sediments and other media characteristics, variability in sediment samples can be anticipated.

DOE-SR and SCDHEC split eight SRS stream sediment and three stormwater basin sediment samples in 2011. All SCDHEC samples were analyzed for gross alpha- and gross beta-emitting particles and gamma-emitting radionuclides. Select samples were also analyzed for Pu-238, Pu-239/40 and U-234 and U-235.

Both agencies detected Cs-137 concentrations in SRS streams, SRS stormwater basins and Savannah River locations. DOE-SR highest Cs-137 concentration (64.1 ± 2.6 pCi/g) was detected in sediment from R-Canal (100-R Location) which is not accessible to the public. When averaging all the SRS on-site stream sediment samples, SCDHEC found 0.97 (± 1.5) pCi/g Cs-137 while DOE-SR found 10.2 (± 20.2) pCi/g. When the Cs-137 concentration at R-Canal (100-R Location) is removed from the SRS on site stream average, the mean Cs-137 SRS on site stream concentration decreases to 6.6 (± 14.6) pCi/g .The publically accessible Savannah River and SRS creek mouths averaged 0.70 (±.40) pCi/g in the SCDHEC data. DOE-SR detected Cs-137 above the minimum detectable concentration (MDC) at 5 locations along the Savanah River and creek mouths at an average of 0.51 (± .31) pCi/g. Cs-137 was only detected at two of the three basins sampled by SCDHEC averaging 0.11(± 0.04). The DOE-SR on site stormwater basins results ranged from less than MDC to a maximum Cs-137 concentration of 53.0(± 3.5) pCi/g at the Z-Area Basin.

SCDHEC had no detections of Am-241 in sediment samples collected in 2011. The on site DOE-SR stream sediments Am-241 detections ranged from less than MDC to 0.013 pCi/g at Pond 400. DOE-SR did not detected Am-241 in any of the Savannah River and SRS creek mouths samples above MDC. The average MDA for the 2011 SCDHEC sediment samples was 0.156 pCi/g, which is much higher than the DOE-SR MDC of 0.0039 pCi/g (SRNS 2012). Since DOE-SR has a much lower MDC, this may explain why the SCDHEC data does not report more detections above the MDA. Also, values less than the MDC are included in the DOE-SR data (SRNS 2012). Only detections are averaged from the SCDHEC data.

DOE-SR had two detections of Pu-238 above the MDC in the Savannah River sediment samples at an average of 0.005 pCi/g. SCDHEC detected Pu-238 at three Savannah River locations averaging 0.003 pCi/g. The average MDC for the 2011 SCDHEC sediment samples was 0.0157 pCi/g, which is higher than the DOE-SR representative MDC of 0.0029 pCi/g (SRNS 2012).

DOE-SR detected Pu-239 in one sample in the Savannah River above the MDC. SCDHEC detected Pu-239/240 at four Savannah River locations averaging 0.007 pCi/g. The MDC for the 2011 SCDHEC sediment samples was 0.0169 pCi/g, which is higher than the DOE-SR representative MDC of 0.0028 pCi/g (SRNS 2012).

3.0 CONCLUSIONS AND RECOMMENDATIONS

The creek mouths of SRS are a conduit for the dispersal of radionuclides into publically accessible water. Cesium-137 was found in the sediment within several creek mouths at the Savannah River.

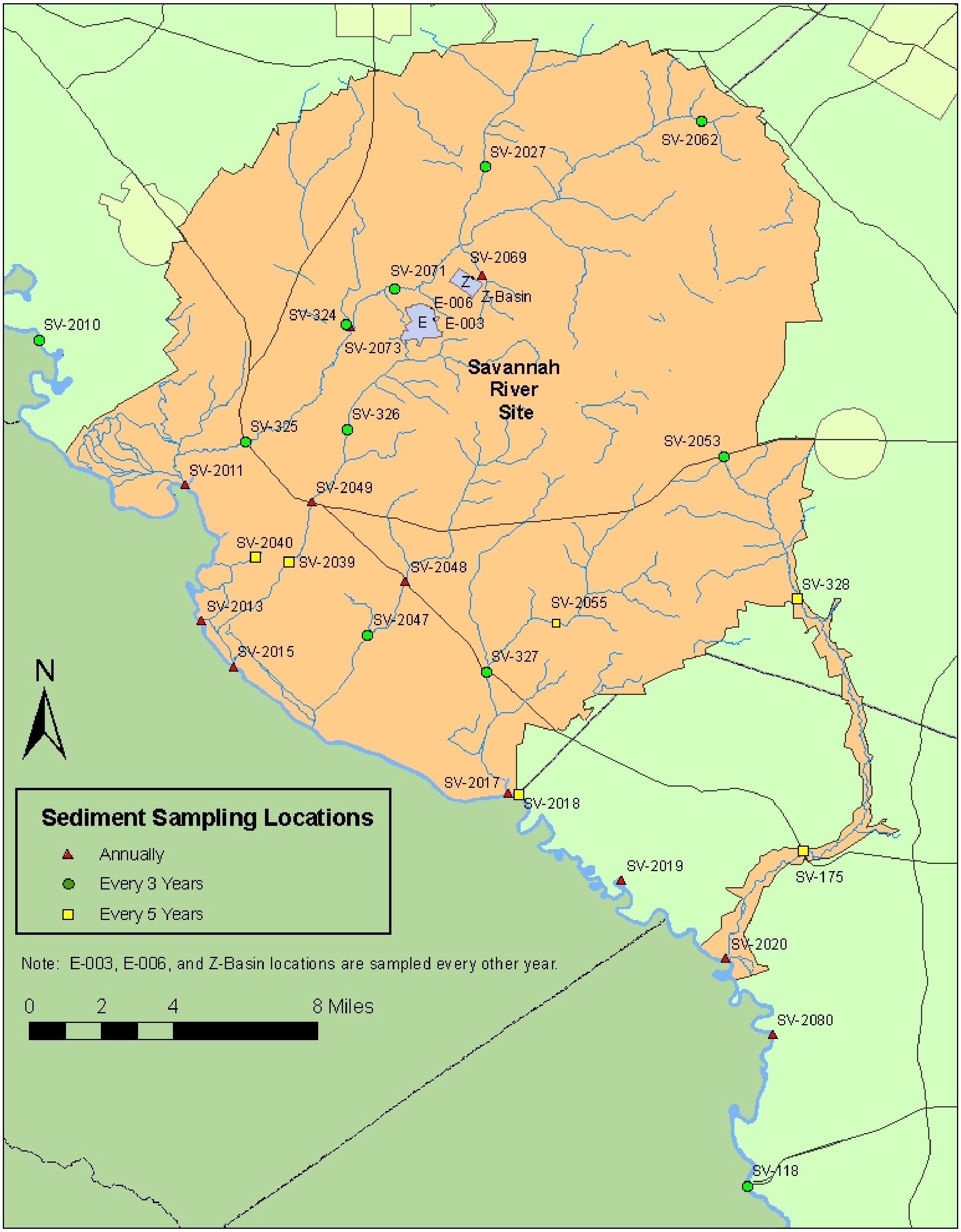
Cesium-137 is the most abundant anthropogenic radionuclide found in the sediment samples. Cesium-137 levels of 2011 from all the samples collected outside of SRS boundaries are within the expected range consistent with previous SCDHEC background data and may be attributed, in part, to fallout from past nuclear events in the 1950s and 1960s. The highest level of Cs-137 from all 2011 sediment samples occurred in background samples. Four of the publically accessible creek mouths of the SRS streams had Cs-137 activity, which was lower than average background levels. The publically accessible SRS creek mouths exhibited lower Cs-137 activity in 2011 than in 2010.

Metals in sediment can be naturally occurring or a result of man-made processes such as those used in SRS operations, which have released elevated amounts into streams on the SRS. Re-distribution of sediment from flooding can mobilize contaminants to downstream locations. Geological factors in the Savannah River basin contribute to the levels of metals through erosion and sediment deposition. All 2011 samples were below the ESV for beryllium, chromium, copper, mercury, nickel, zinc and lead.

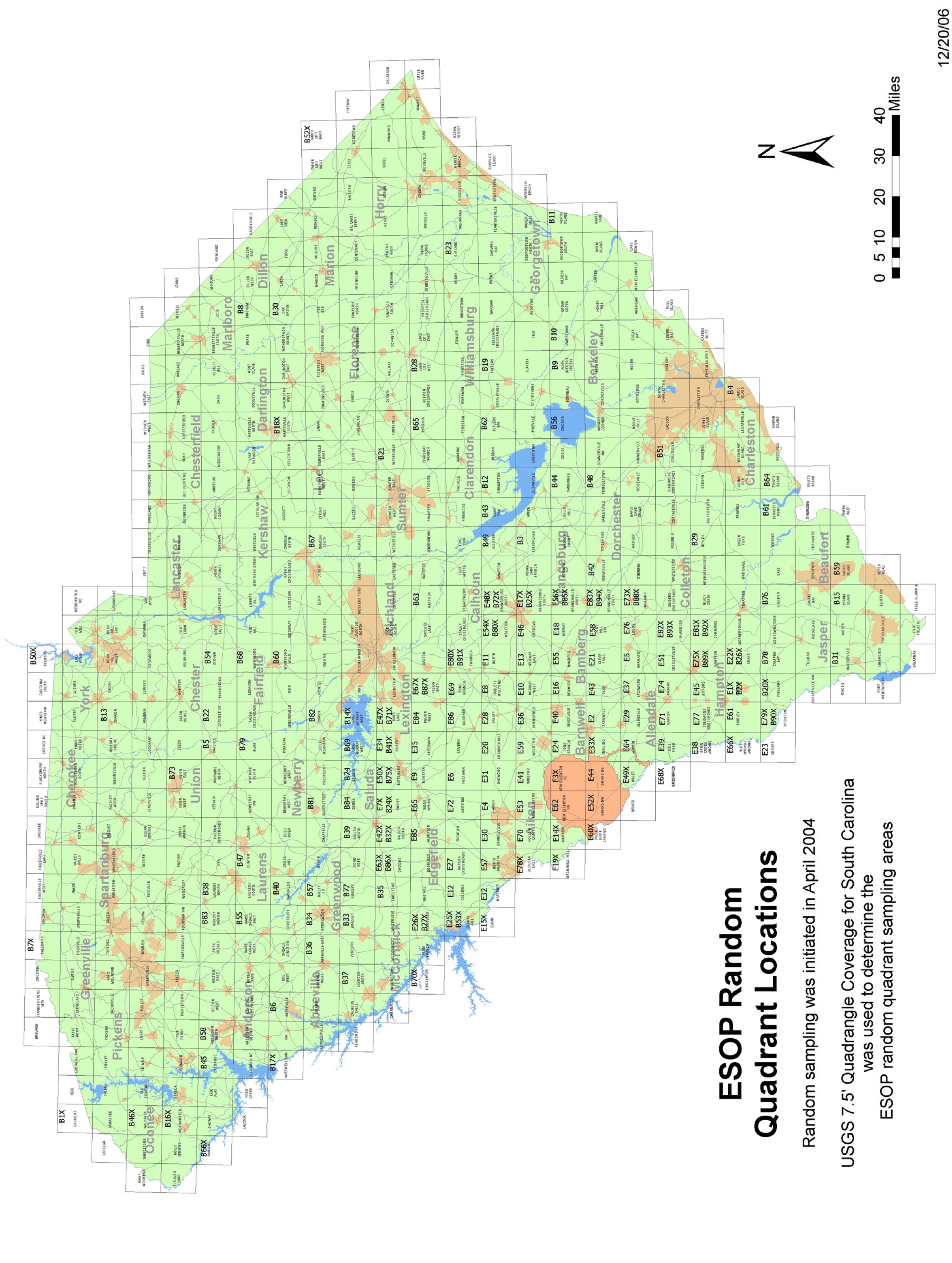
SRS sediments should continue to be monitored due to current releases and the potential for future discharges from SRS operations, legacy wastes, and clean up activities. Year to year data comparisons are difficult to interpret due to the nature of sediment. Differences among samples may be due to the fraction of clays that most effectively retain radionuclides. There is also difficulty in replicating the exact sampling point due to the movement of sediment. Monitoring of on-site sediments is of great importance as streams are a migration route for radionuclides to enter waters and sediment outside of the SRS boundary. ESOP will continue independent monitoring of SRS and Savannah River sediments and will periodically evaluate modification of the monitoring activities to better accomplish project goals and objectives. Continued monitoring will provide an improved understanding of radionuclide and non-radionuclide levels in SRS sediments and the Savannah River which will impart valuable information to human health exposure pathways. Trending of data over multiple years demonstrates whether radionuclide concentrations in the SRS area are declining due to radioactive decay or possibly increasing due to disturbances on SRS. The comparison of data results allows for independent data evaluation of DOE-SR monitoring activities. To compare the environmental monitoring programs of ESOP and DOE-SR, the sediment samples from SRS will be collected in cooperation with DOE-SR personnel. Each program will then independently analyze the samples for radiological and nonradiological parameters and results will be compared in the 2011 ESOP Data Report. Cooperation between DOE-SR and SCDHEC provides credibility and confidence in the information being provided to the public.

4.0 Radiological and Nonradiological Monitoring of Sediments

Map 1. SRS Sediment Sampling Locations



Radiological and Nonradiological Monitoring of Sediments
Map 2. ESOP Random Sample Locations



5.0 Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Table 1. Locations of SRS Sediment Samples

2011 ESOP Sediment Sample Locations on SRS		
Sample Location	**Location Description**	**Stream Abbr.**
SV-2011	Upper Three Runs Mouth @ RM 157.4	UTR
SV-2013	Upper Three Runs mouth @ RM 157.4	BDC
SV-2015	Fourmile Branch creek mouth @ RM 150.6	FMB
SV-2017	Steel Creek mouth @ RM 141.5	SC
SV-2020	Lower Three Runs mouth @ RM 129.1	LTR
SV-2040	Beaver Dam Creek	BDC
SV-327	Steel Creek @ SC 125 (SRS Road A)	SC
SV-2053	Lower Three Runs @ Road B	LTR
SV-2048	Pen Branch @ Road 125	PB
SV-2049	Fourmile Branch @ Road 125	FMB
SV-2018	Savannah River @ RM 141 (Steel Creek Landing)	
SV-2069	McQueen Branch off Monroe Owens Road.	McQ
SV-118	Savannah River @ RM 118.8 (Highway 301 Bridge)	
SV-2073	Upper Three Runs off Road C.	UTR
SME-001	E-001E Area stormwater basin	
SME-002	E-002 E Area stormwater basin	
SME-005	E-005 E Area stormwater basin	

2011 Publicly Accessable Boat Landing Sediment Sampling Locations		
Sample Name	**Abbr.**	**Location Description**
Upstream of SRS		
SMFF11	FF	Fury's Ferry Boat Landing
SMSC11	SC	Steven's Creek Landing
SMRVP11	RVP	North Augusta Riverview Park Boat Landing
SMJBL11	JBL	Jackson Boat Landing
Downstream of SRS		
SMSCL11	SCL	Steel Creek Landing, Barnwell County
SMLHL11	LHL	Little Hell Landing
SMJL11	JL	Johnson's Landing
SMBFL11	BFL	Burtons' Ferry Landing
SMCB11	CB	Cohen's Bluff Landing
SMSBL11	SBL	Stoke's Bluff Landing

Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Table 2. Random Quadrant Locations

2011 Random Surface Soil Sampling Locations Random Quadrants Outside the 50-mile SRS Perimeter or "B" Quadrants.			**Geological**
Quad	**7.5' Quad Name**	**Latitude by Lat and Longitude by Long**	**Region**
B71X	Barr Lake (50mi.)	3352.5 by 3400 and -8115 by -8122.5	UCP
B67	Camden South	3407.5 by 3415 and -8030 by -8037.5	UCP
B39	Saluda North	3400 by 3407.5 and -8145 by -8152.5	PM
B36	Abbeville East	3407.5 by 3415 and -8215 by -8222.5	PM
B30	Oak Grove	3415 by 3422.5 and -7930 by -7937.5	LCP

1. The randomly selected quadrants are from a United States Department of Interior 7.5 Minute Topographic Map Printed by the South Carolina Land Resources Commission, Rv 10/92.
2. "**X**" in any designated ID represents the presence of an **exclusion zone** of either a state border, 50 mi. limit bisector line that splits the quad area into an environmental side and a background side, or occurrence of background random pick area within 10 miles of a nuclear facility.
4. "**B**" means this is a South Carolina background pick outside of the 50 mile limit from SRS center point. Ten mile exclusion zone in "B" quads is used to reduce influence of any local reactor on SC background.
5. Parenthesis info by quad name identifies type of exclusion (NCX is North Carolina, GAX is Georgia, NRX is nuclear reactor, SRS is Savannah River Site exclusion zone border).
6. Purpose of random sampling is to compare public dose within 50 miles of SRS to a S. C. background.
7. Geological Regions are Blue Ridge (BR), Piedmont (PM), Upper & Lower Coastal Plain (U&LCP). Quadrants split by geological regions are assigned to the upper most region in the quadrant.

Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Table 3. Gamma Analytes

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Antimony-125	Sb-125
Berylium-7	Be-7
Cobalt-58	Co-58
Cobalt-60	Co-60
Cerium-144	Ce-144
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Lead-212	Pb-212
Lead-214	Pb-214
Manganese-54	Mn-54
Potassium-40	K-40
Radium-226	Ra-226
Ruthenium-103	Ru-103
Sodium-22	Na-22
Thorium-234	Th-234
Yttrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Note: Units are reported in pCi/g.

Table 4. Inorganic Metal Analytes

Analyte	Abbreviation	ESV
Barium	Ba	20
Beryllium	Be	0.5
Cadmium	Cd	0.6
Chromium	Cr	36
Copper	Cu	18.7
Lead	Pb	30.2
Manganese	Mn	630
Mercury	Hg	0.13
Nickel	Ni	15.9
Zinc	Zn	98

Note: Units are reported in mg/kg.

Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Figure 1. Comparisons of Cs-137 Activity Among Sample Groups

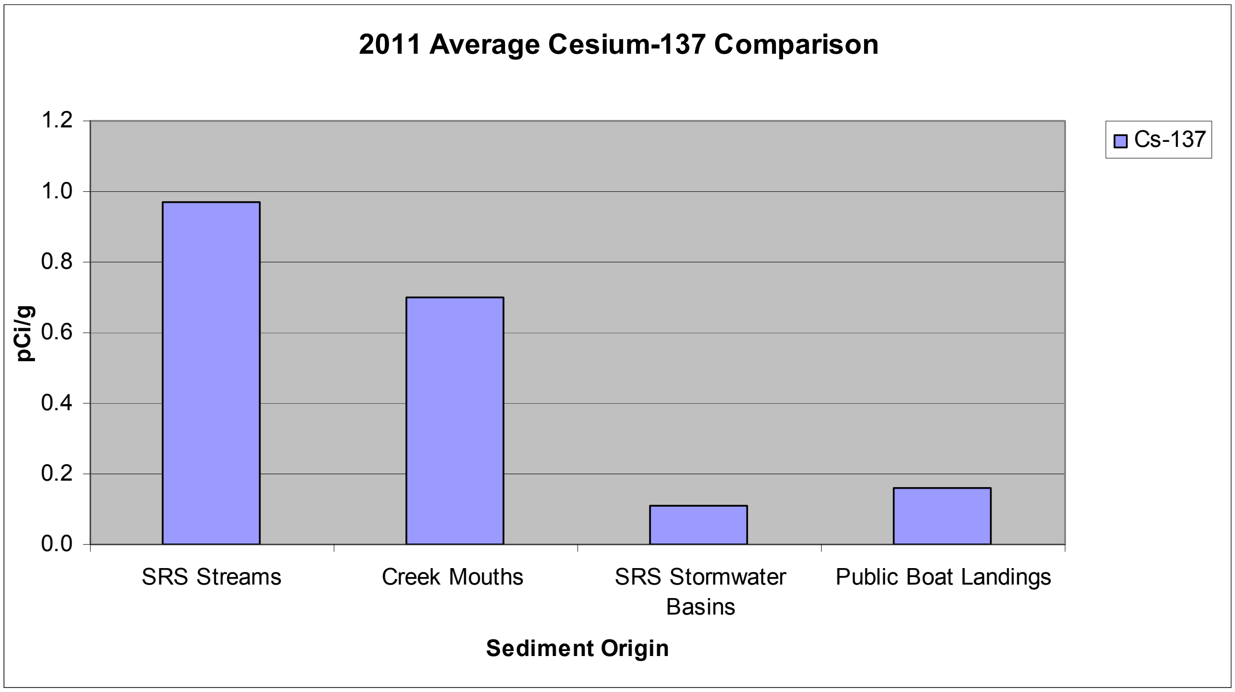
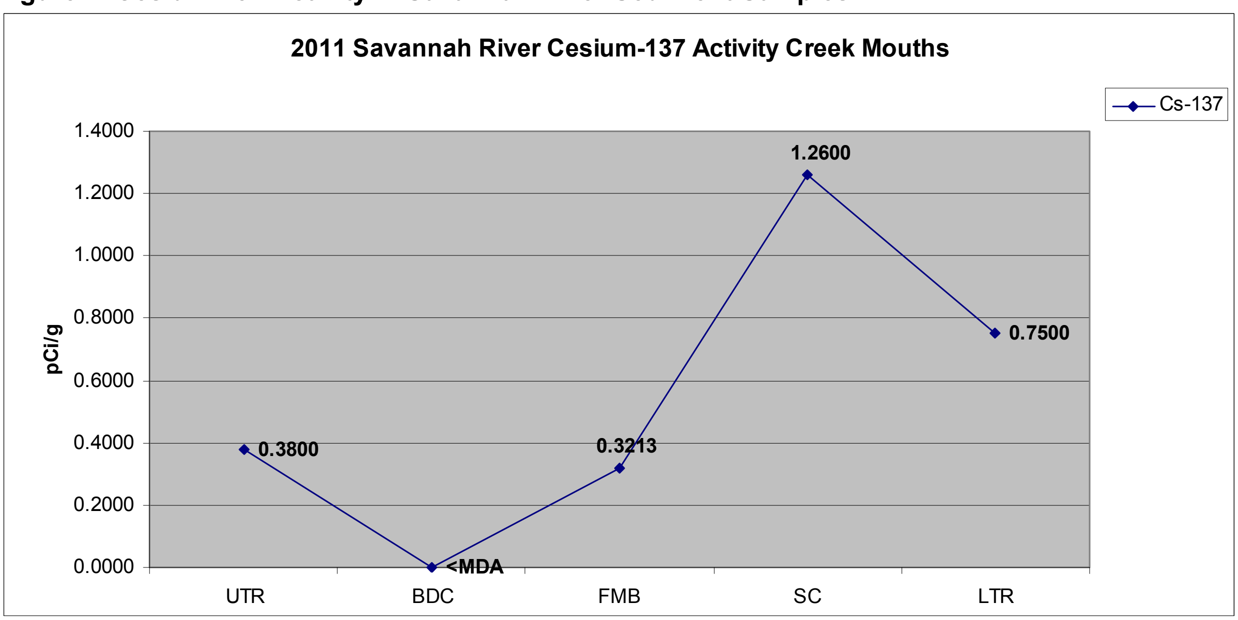


Figure 2. Cesium-137 Activity in Savannah River Sediment Samples



Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Figure 3. Comparisons of Gross-Alpha and Non-volatile Beta Activity Among Sample Groups

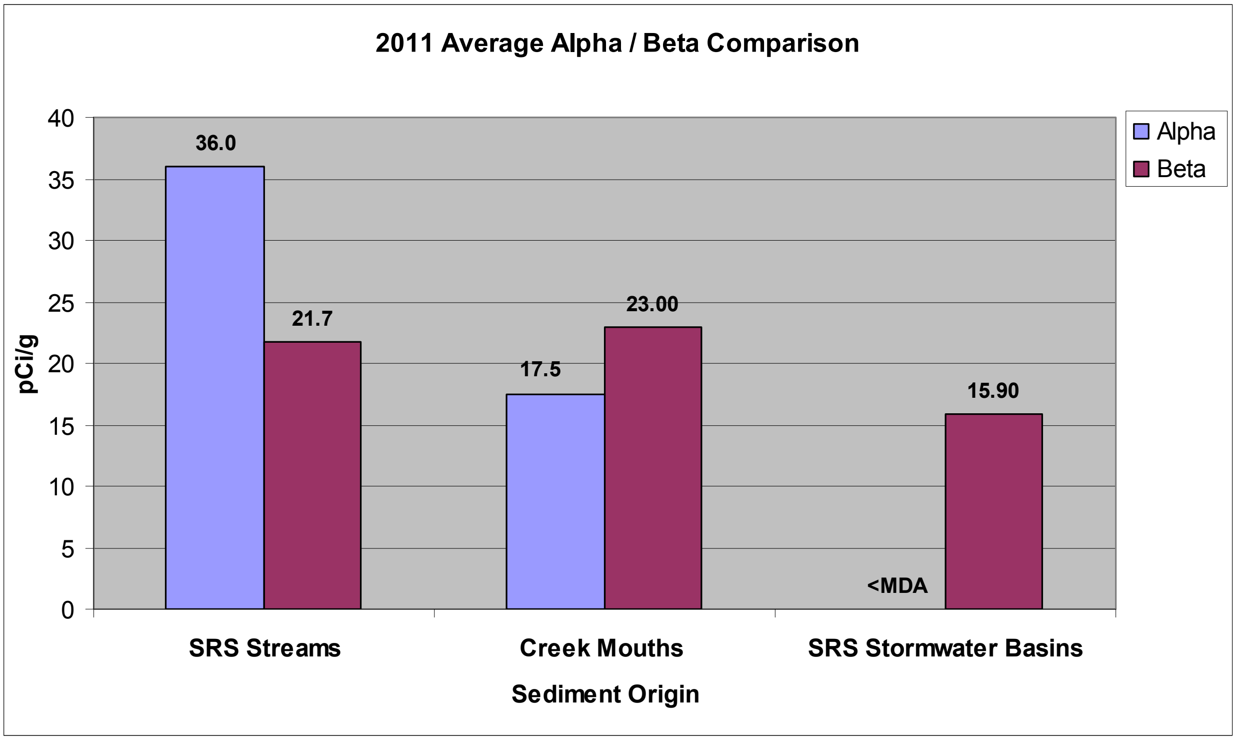
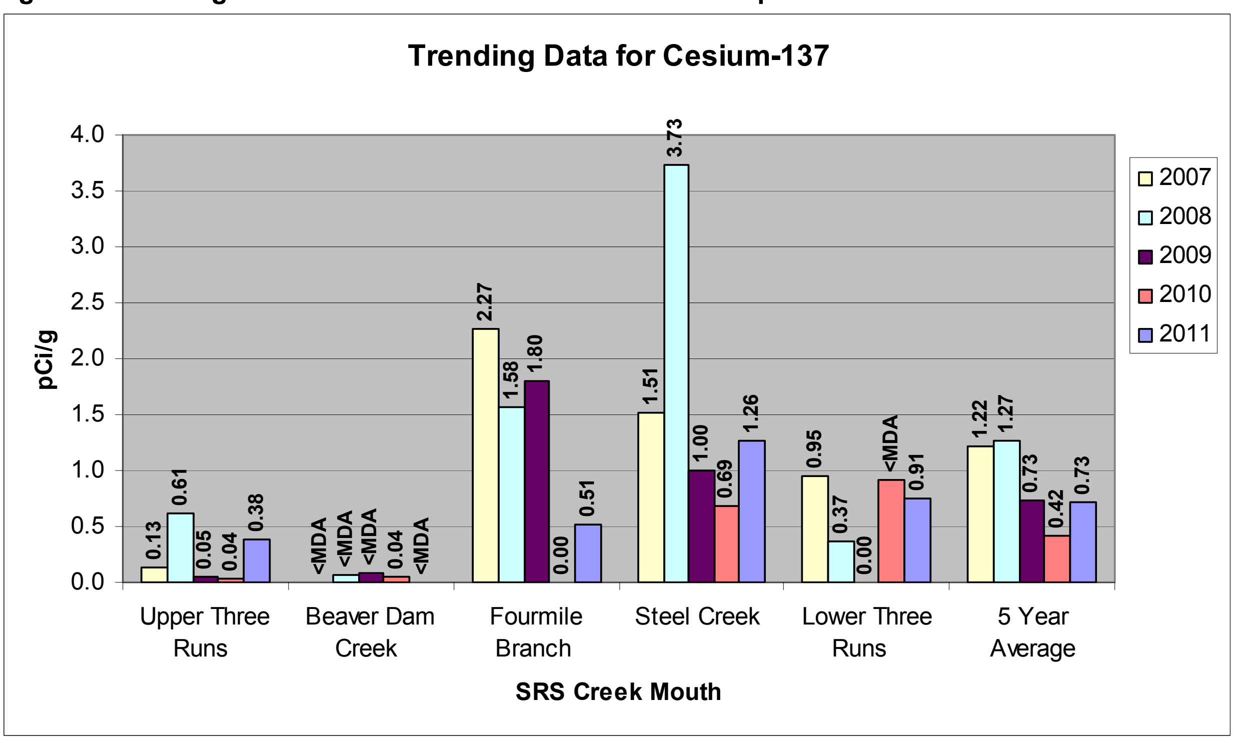


Figure 4. Trending Data for Cs-137 in SRS Creek Mouth Samples



Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Figure 5. Comparisons of Metal Concentrations Among Sample Groups

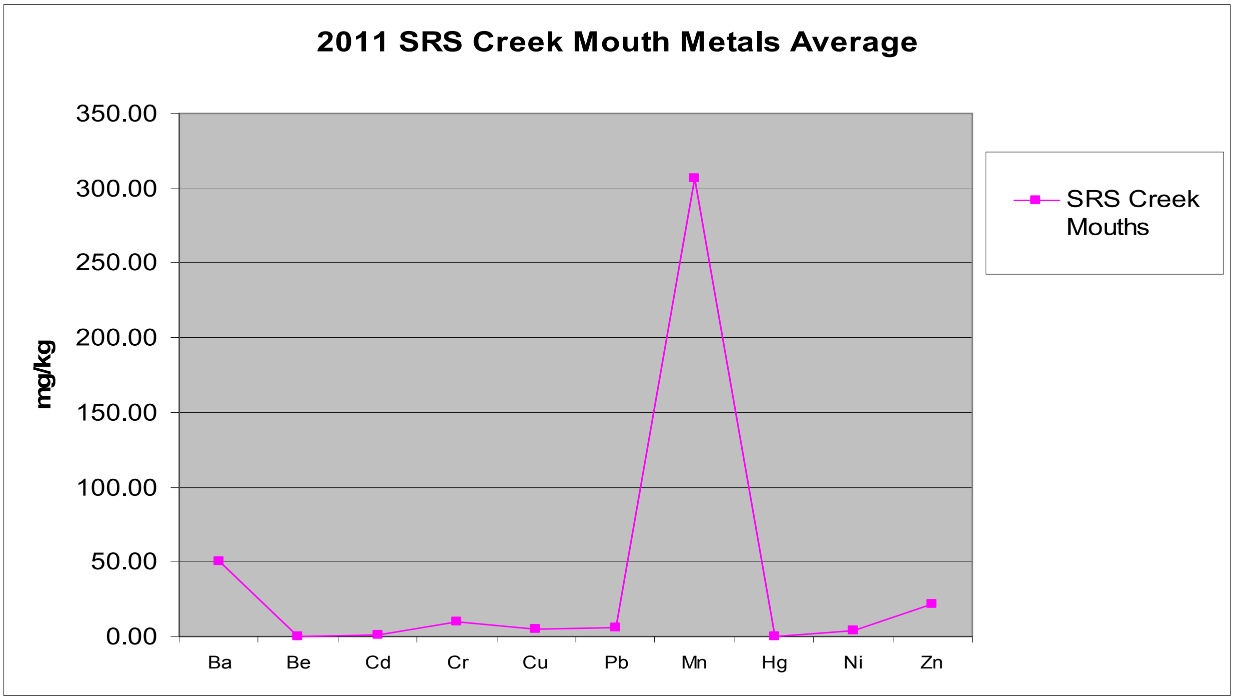
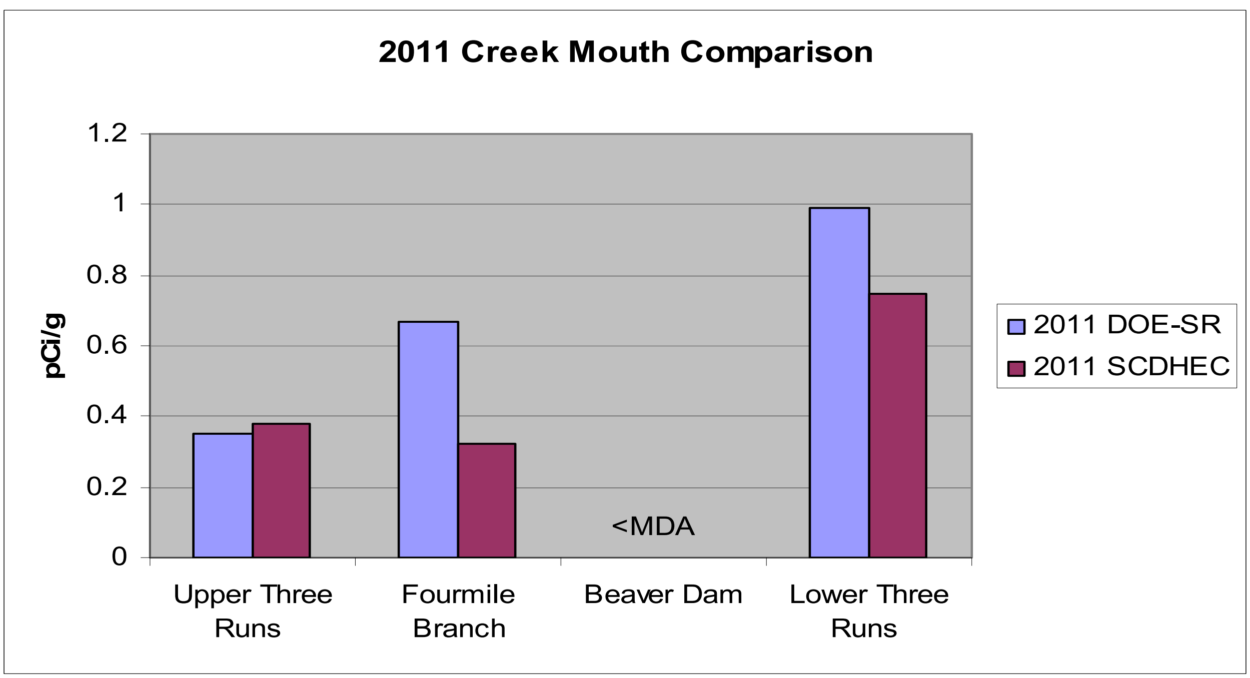


Figure 6. Cesium-137 in Savannah River Creek Mouths – SCDHEC Comparison to DOE-SR Data



6.0 Data

Radiological and Nonradiological Monitoring of Sediments

2011 RADIOLOGICAL DATA 19

2011 NONRADIOLOGICAL DATA 30

Notes:

1. Bold numbers denotes a detection.
2. A blank field following ±2 SIGMA occurs when the sample is <LLD.
3. LLD= Lower Limit of Detection
4. MDA= Minimum Detectable Activity

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Savannah River and Creek Mouths

Location Description	SMSV-2011	SMSV-2013	SMSV-2015	SMSV-2017	SMSV-2020
Collection Date	3/17/2011	3/17/2011	3/17/2011	3/17/2011	3/17/2011
Alpha Activity	30.4	<LLD	<LLD	12.30	9.74
Alpha Confidence Interval	12	NA	NA	8.83	8.52
Alpha LLD	8.39	8.73	8.54	8.57	8.84
Beta Activity	36.8	16.50	<LLD	18.30	20.40
Beta Confidence Interval	8.42	7.04	NA	7.15	7.41
Beta LLD	9.09	9.34	9.19	9.22	9.43
K-40 Activity	8.75	13.55	10.63	14.09	16.57
K-40 Confidence Interval	1.04	1.03	0.83	1.09	1.25
K-40 MDA	0.50	0.19	0.15	0.21	0.22
Cs-137 Activity	0.38	<MDA	0.32	1.26	0.75
Cs-137 Confidence Interval	0.05	NA	0.03	0.09	0.06
Cs-137 MDA	0.06	0.03	0.02	0.03	0.03
Pb-212 Activity	2.80	1.18	0.51	1.41	1.10
Pb-212 Confidence Interval	0.26	0.11	0.06	0.13	0.11
Pb-212 MDA	0.11	0.05	0.04	0.06	0.06
Pb-214 Activity	10.08	1.25	0.57	1.39	1.44
Pb-214 Confidence Interval	0.42	0.08	0.05	0.09	0.09
Pb-214 MDA	0.12	0.05	0.04	0.06	0.06
Ra-226 Activity	17.86	2.05	1.28	2.42	2.47
Ra-226 Confidence Interval	1.91	0.61	0.50	0.73	0.72
Ra-226 MDA	1.38	0.57	0.46	0.70	0.67
Ac-228 Activity	3.53	1.20	0.54	1.43	1.22
Ac-228 Confidence Interval	0.24	0.10	0.07	0.11	0.11
Ac-228 MDA	0.21	0.09	0.06	0.10	0.10

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Savannah River Site Streams That Are Not Publicly Accessible

Location Description Collection Date	SMSV-2048 3/15/2011	SMSV-2049 3/15/2011	SMSV-2069 3/16/2011	SM SV-2073 3/15/2011
Alpha Activity	<LLD	13.7	<LLD	58.4
Alpha Confidence Interval	NA	9.14	NA	16.1
Alpha LLD	8.62	8.69	9.0	8.81
Beta Activity	<LLD	14.0	<LLD	49.0
Beta Confidence Interval	NA	6.89	NA	9.51
Beta LLD	9.25	9.31	9.54	9.41
K-40 Activity	1.18	0.90	0.52	3.07
K-40 Confidence Interval	0.32	0.42	0.24	0.94
K-40 MDA	0.22	0.24	0.11	0.74
Cs-137 Activity	0.06	3.76	<MDA	0.30
Cs-137 Confidence Interval	0.02	0.24	NA	0.07
Cs-137 MDA	0.03	0.04	0.02	0.08
Pb-212 Activity	1.29	1.17	0.34	5.09
Pb-212 Confidence Interval	0.12	0.12	0.04	0.47
Pb-212 MDA	0.05	0.07	0.03	0.17
Pb-214 Activity	1.19	2.63	0.36	21.9
Pb-214 Confidence Interval	0.08	0.14	0.04	0.86
Pb-214 MDA	0.05	0.08	0.03	0.19
Ra-226 Activity	2.30	5.27	<MDA	40.1
Ra-226 Confidence Interval	0.68	1.07	NA	3.75
Ra-226 MDA	0.59	0.84	0.38	2.11
Ac-228 Activity	1.35	1.15	0.34	6.95
Ac-228 Confidence Interval	0.10	0.11	0.05	0.40
Ac-228 MDA	0.08	0.10	0.05	0.31

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Am-241, Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Savannah River Site Streams That Are Not Publicly Accessible

Location Description	SM SV-327	SM SV-2053	SM SV-2040
Collection Date	3/15/2011	3/15/2011	3/15/2011
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	8.33	8.94	8.80
Beta Activity	<LLD	11.5	12.2
Beta Confidence Interval	NA	6.76	6.72
Beta LLD	9.05	9.53	9.40
K-40 Activity	<MDA	0.75	6.31
K-40 Confidence Interval	NA	0.24	0.59
K-40 MDA	0.10	0.17	0.17
Cs-137 Activity	0.36	0.39	<MDA
Cs-137 Confidence Interval	0.03	0.04	NA
Cs-137 MDA	0.02	0.02	0.03
Pb-212 Activity	0.20	2.66	1.08
Pb-212 Confidence Interval	0.03	0.21	0.10
Pb-212 MDA	0.03	0.05	0.05
Pb-214 Activity	0.28	1.18	1.04
Pb-214 Confidence Interval	0.04	0.08	0.08
Pb-214 MDA	0.03	0.06	0.05
Ra-226 Activity	<MDA	1.89	2.35
Ra-226 Confidence Interval	NA	0.61	0.58
Ra-226 MDA	0.33	0.64	0.55
Ac-228 Activity	0.28	2.59	1.08
Ac-228 Confidence Interval	0.05	0.13	0.09
Ac-228 MDA	0.05	0.07	0.08

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Am-241, Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Savannah River Site Stormwater Basins

Location Description	SM E-005	SM E-001	SM E-002
Collection Date	**3/16/2011**	**3/16/2011**	**3/16/2011**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	12.20	12.20	12.30
Beta Activity	15.9	<LLD	<LLD
Beta Confidence Interval	7.0	NA	NA
Beta LLD	9.3	9.34	9.41
K-40 Activity	2.81	1.08	1.50
K-40 Confidence Interval	0.45	0.25	0.29
K-40 MDA	0.27	0.14	0.16
Cs-137 Activity	0.14	0.08	<MDA
Cs-137 Confidence Interval	0.03	0.02	NA
Cs-137 MDA	0.04	0.02	0.02
Pb-212 Activity	2.28	0.95	1.44
Pb-212 Confidence Interval	0.20	0.09	0.13
Pb-212 MDA	0.07	0.04	0.05
Pb-214 Activity	1.74	0.83	1.10
Pb-214 Confidence Interval	0.11	0.06	0.07
Pb-214 MDA	0.07	0.04	0.05
Ra-226 Activity	3.53	<MDA	2.01
Ra-226 Confidence Interval	0.84	NA	0.55
Ra-226 MDA	0.80	0.50	0.56
Ac-228 Activity	2.36	0.96	1.46
Ac-228 Confidence Interval	0.15	0.08	0.11
Ac-228 MDA	0.11	0.07	0.06

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Am-241, Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Publicly Accessible Boat Landings

	Fury's Ferry Boat Landing	Stevens Creek Boat Landing	Riverview Park Boat Landing
Location Description	**SM FF 11**	**SM SC 11**	**SM RVP 11**
Collection Date	**8/11/2011**	**8/11/2011**	**8/11/2011**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	11.6	11.2	11.0
Beta Activity	18.40	9.28	21.30
Beta Confidence Interval	6.83	5.91	6.86
Beta LLD	8.54	8.34	8.25
K-40 Activity	4.79	3.96	12.23
K-40 Confidence Interval	0.58	0.45	0.95
K-40 MDA	0.22	0.15	0.17
Cs-137 Activity	0.05	0.07	<MDA
Cs-137 Confidence Interval	0.02	0.02	NA
Cs-137 MDA	0.03	0.02	0.03
Pb-212 Activity	1.66	0.46	1.43
Pb-212 Confidence Interval	0.15	0.06	0.13
Pb-212 MDA	0.06	0.04	0.05
Pb-214 Activity	1.36	0.43	1.18
Pb-214 Confidence Interval	0.08	0.05	0.09
Pb-214 MDA	0.07	0.04	0.06
Ra-226 Activity	2.83	<MDA	2.18
Ra-226 Confidence Interval	0.74	NA	0.62
Ra-226 MDA	0.68	0.49	0.66
Ac-228 Activity	1.55	0.41	1.47
Ac-228 Confidence Interval	0.12	0.07	0.11
Ac-228 MDA	0.08	0.06	0.09

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Am-241, Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Publicly Accessible Boat Landings

	Jackson Boat Landing	Steel Creek Boat Landing	Little Hell Boat Landing	Johnson's Boat Landing
Location Description	**SM JBL 11**	**SMSV-2018**	**SM LHL 11**	**SM JL 11**
Collection Date	**8/9/2011**	**3/17/2011**	**8/9/2011**	**8/9/2011**
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	11.2	8.3	11.0	11.4
Beta Activity	11.40	22.10	<LLD	19.10
Beta Confidence Interval	6.03	7.26	NA	6.84
Beta LLD	8.30	9.02	8.23	8.45
K-40 Activity	11.14	16.08	0.87	11.58
K-40 Confidence Interval	0.88	1.23	0.20	0.90
K-40 MDA	0.18	0.21	0.09	0.17
Cs-137 Activity	<MDA	0.30	<MDA	0.05
Cs-137 Confidence Interval	NA	0.04	NA	0.02
Cs-137 MDA	0.02	0.03	0.01	0.02
Pb-212 Activity	1.72	1.32	0.42	1.47
Pb-212 Confidence Interval	0.15	0.13	0.04	0.13
Pb-212 MDA	0.05	0.06	0.03	0.05
Pb-214 Activity	1.13	1.58	0.31	1.08
Pb-214 Confidence Interval	0.08	0.10	0.03	0.07
Pb-214 MDA	0.06	0.06	0.03	0.05
Ra-226 Activity	2.35	3.04	<MDA	2.22
Ra-226 Confidence Interval	0.71	0.88	NA	0.62
Ra-226 MDA	0.64	0.68	0.35	0.59
Ac-228 Activity	1.83	1.33	0.44	1.44
Ac-228 Confidence Interval	0.12	0.12	0.05	0.11
Ac-228 MDA	0.08	0.10	0.05	0.08

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Am-241, Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Publicly Accessible Boat Landings

	Burton's Ferry Boat Landing	Cohen's Bluff Boat Landing	Stokes Bluff Boat Landing
Location Description	**SMSV-118**	**SM CB 11**	**SM SBL 11**
Collection Date	**3/17/2011**	**9/8/2011**	**9/8/2011**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	8.6	11.0	11.9
Beta Activity	35.30	21.30	<LLD
Beta Confidence Interval	8.25	6.85	NA
Beta LLD	9.20	8.24	8.47
K-40 Activity	18.08	13.57	4.74
K-40 Confidence Interval	1.40	1.05	0.54
K-40 MDA	0.28	0.19	0.23
Cs-137 Activity	0.31	0.20	0.15
Cs-137 Confidence Interval	0.04	0.04	0.03
Cs-137 MDA	0.04	0.03	0.03
Pb-212 Activity	1.51	1.09	2.87
Pb-212 Confidence Interval	0.15	0.11	0.24
Pb-212 MDA	0.07	0.05	0.06
Pb-214 Activity	2.10	1.19	1.76
Pb-214 Confidence Interval	0.12	0.09	0.11
Pb-214 MDA	0.07	0.06	0.06
Ra-226 Activity	4.28	2.52	3.55
Ra-226 Confidence Interval	0.92	0.63	0.86
Ra-226 MDA	0.80	0.66	0.75
Ac-228 Activity	1.46	0.99	2.87
Ac-228 Confidence Interval	0.13	0.09	0.16
Ac-228 MDA	0.12	0.09	0.09

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Am-241, Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Random Background "B" Samples > 50 miles from the SRS Center Point

Location Description	**SMB71**	**SMB67**	**SMB39**
Collection Date	**10/6/2011**	**10/11/2011**	**11/9/2011**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	13.10	13.00	12.60
Beta Activity	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA
Beta LLD	10.80	10.80	10.50
K-40 Activity	1.43	4.12	2.23
K-40 Confidence Interval	0.32	0.47	0.33
K-40 MDA	0.18	0.18	0.15
Cs-137 Activity	0.07	0.11	<MDA
Cs-137 Confidence Interval	0.02	0.02	NA
Cs-137 MDA	0.02	0.02	0.02
Pb-212 Activity	0.94	1.45	1.22
Pb-212 Confidence Interval	0.09	0.13	0.11
Pb-212 MDA	0.04	0.05	0.04
Pb-214 Activity	0.82	1.30	0.84
Pb-214 Confidence Interval	0.07	0.08	0.06
Pb-214 MDA	0.05	0.06	0.05
Ra-226 Activity	1.47	2.88	1.56
Ra-226 Confidence Interval	0.57	0.67	0.56
Ra-226 MDA	0.54	0.62	0.54
Ac-228 Activity	1.01	1.51	1.17
Ac-228 Confidence Interval	0.09	0.11	0.09
Ac-228 MDA	0.07	0.07	0.07

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Am-241, Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Data for Random Background "B" Samples > 50 miles from the SRS Center Point

Location Description	SMB76	SMB36	SMB30
Collection Date	**11/22/2011**	**12/2/2011**	**12/7/2011**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	13.10	12.40	13.10
Beta Activity	15.60	10.50	<LLD
Beta Confidence Interval	7.69	7.05	NA
Beta LLD	10.80	10.30	10.80
K-40 Activity	7.01	2.17	5.53
K-40 Confidence Interval	0.68	0.41	0.52
K-40 MDA	0.22	0.19	0.15
Cs-137 Activity	10.28	0.14	0.06
Cs-137 Confidence Interval	0.68	0.03	0.03
Cs-137 MDA	0.04	0.03	0.02
Pb-212 Activity	1.36	1.56	1.02
Pb-212 Confidence Interval	0.13	0.14	0.09
Pb-212 MDA	0.07	0.05	0.04
Pb-214 Activity	1.50	1.25	0.71
Pb-214 Confidence Interval	0.11	0.09	0.06
Pb-214 MDA	0.09	0.06	0.04
Ra-226 Activity	3.01	3.33	1.38
Ra-226 Confidence Interval	0.87	0.75	0.51
Ra-226 MDA	0.93	0.63	0.49
Ac-228 Activity	1.29	1.64	1.10
Ac-228 Confidence Interval	0.12	0.11	0.08
Ac-228 MDA	0.09	0.09	0.06

Note: Units are in pCi/g. There were no detections in any 2011 sediment sample above the MDA for: Am-241, Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Isotopic Data for SRS Creek Mouths and Boat Landings

Location Description	SMSV-2011	SMSV-2013	SMSV-2015	SMSV-2017
Collection Date	3/17/2011	3/17/2011	3/17/2011	3/17/2011
Pu-238 Activity	0.013	0.002	<MDA	0.002
Pu-238 Confidence Interval	0.012	0.004	NA	0.003
Pu-238 LLD	0.006	0.004	0.004	0.002
Pu-239/40 Activity	0.0164	<MDA	<MDA	<MDA
Pu-239/40 Confidence Interval	0.0123	NA	NA	NA
Pu-239/40 LLD	0.00495	0.004	0.004	0.002
U-234 Activity	1.29	0.900	0.459	0.991
U-234 Confidence Interval	0.34	0.024	0.095	0.283
U-234MDA	0.01	0.013	0.016	0.020
U-235 Activity	0.18	0.067	0.043	0.079
U-235 Confidence Interval	0.10	0.050	0.025	0.065
U-235 MDA	0.01	0.013	0.019	0.017
U-238 Activity	1.26	0.806	0.513	0.814
U-238 Confidence Interval	0.34	0.217	0.103	0.242
U-238 MDA	0.01	0.013	0.009	0.012

Note: Units are in pCi/g

2011 Radiological Isotopic Data for SRS Creek Mouths and Boat Landings

Location Description	SMSV-2020	SMSV-118	SMSV-2018
Collection Date	3/17/2011	3/17/2011	3/17/2011
Pu-238 Activity	<MDA	<MDA	0.004
Pu-238 Confidence Interval	NA	NA	0.004
Pu-238 LLD	0.005	0.002	0.002
Pu-239/40 Activity	0.003	0.003	0.006
Pu-239/40 Confidence Interval	0.004	0.004	0.006
Pu-239/40 LLD	0.002	0.002	0.002
U-234 Activity	0.806	1.180	0.929
U-234 Confidence Interval	0.254	0.208	0.184
U-234MDA	0.017	0.011	0.015
U-235 Activity	0.082	0.065	0.075
U-235 Confidence Interval	0.068	0.032	0.039
U-235 MDA	0.015	0.011	0.014
U-238 Activity	0.837	1.120	0.853
U-238 Confidence Interval	0.261	0.199	0.172
U-238 MDA	0.013	0.013	0.014

Radiological and Nonradiological Monitoring of Sediments Data

2011 Radiological Isotopic Data for SRS Storwater Basins

Location Description	SME-002	SME-001	SME-005
Collection Date	3/17/2011	3/17/2011	3/17/2011
Pu-238 Activity	<MDA	0.034	0.002
Pu-238 Confidence Interval	NA	0.014	0.005
Pu-238 LLD	0.005	0.004	0.005
Pu-239/40 Activity	<MDA	0.009	0.005
Pu-239/40 Confidence Interval	NA	0.007	0.006
Pu-239/40 LLD	0.002	0.004	0.005
U-234 Activity	1.270	1.170	1.750
U-234 Confidence Interval	0.373	0.252	0.460
U-234MDA	0.017	0.019	0.019
U-235 Activity	0.116	0.078	0.206
U-235 Confidence Interval	0.085	0.045	0.110
U-235 MDA	0.014	0.008	0.015
U-238 Activity	1.200	1.160	1.690
U-238 Confidence Interval	0.357	0.249	0.445
U-238 MDA	0.024	0.012	0.012

Note: Units are in pCi/g

Radiological and Nonradiological Monitoring of Sediments Data

2011 Nonradiological Data for Savannah River Site Creek Mouths

Location Description	SMSV-2011	SMSV-2013	SMSV-2015	SVSV-2017	SMSV-2020
Collection Date	3/17/2011	3/17/2011	3/17/2011	3/17/2011	3/17/2011
Barium in Sediment	67	21	21	80	64
Beryllium in Sediment	0.33	<0.30	<0.30	<0.30	<0.30
Cadmium in Sediment	1.1	<1.0	<1.0	1.7	1.1
Chromium in Sediment	11	8.3	3.3	14	12
Copper in Sediment	4.6	3.1	<1.0	8.3	4.4
Mercury in Sediment	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese in Sediment	440	25	120	450	500
Nickel in Sediment	4.3	2.5	<2.0	4.8	3.9
Lead in Sediment	5.6	7.2	<5.0	6.9	5.1
Zinc in Sediment	28	11	9.4	34	28

Note: Units are in mg/kg.

2011 Nonradiological Data for Publicly Accessible Boat Landings

Location Description	SMFF11	SMSC11	SMRVP11	SMJBL11	SMLHL11
Collection Date	8/11/2011	8/11/2011	8/11/2011	8/9/2011	8/9/2011
Barium in Sediment	48	24	66	34	<5.0
Beryllium in Sediment	0.41	<0.30	0.32	<0.30	<0.30
Cadmium in Sediment	2.1	1.9	1.8	<1.0	<1.0
Chromium in Sediment	17	7.4	18	4.9	<1.0
Copper in Sediment	4.5	2.2	9.7	2.4	4.4
Mercury in Sediment	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese in Sediment	18	220	150	440	9.1
Nickel in Sediment	<2.0	<2.0	4.0	<2.0	<2.0
Lead in Sediment	13	6.8	13	<5.0	<5.0
Zinc in Sediment	10	9.3	21	16	2.4

Note: Units are in mg/kg.

2011 Nonradiological Data for Publicly Accessible Boat Landings

Location Description	SMJL11	SMCB11	SMSBL11	SMSCL11	SMBFL11
Collection Date	8/9/2011	9/8/2011	9/8/2011	3/17/2011	3/17/2011
Barium in Sediment	27	66	27	72	110
Beryllium in Sediment	<0.30	<0.30	<0.30	<0.30	0.36
Cadmium in Sediment	<1.0	1.2	<1.0	1.2	1.7
Chromium in Sediment	5.2	12	6.0	12	18
Copper in Sediment	2.3	8.7	4.0	6.4	10
Mercury in Sediment	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese in Sediment	200	530	210	530	860
Nickel in Sediment	<2.0	3.3	<2.0	4.2	6.2
Lead in Sediment	<5.0	8.2	7.4	6.1	8.2
Zinc in Sediment	15	54	20	30	41

Note: Units are in mg/kg.

7.0 Summary Statistics

Radiological and Nonradiological Monitoring of Sediments

2011 RADIOLOGICAL STATISTICS 32

2011 NONRADIOLOGICAL STATISTICS 33

Notes:

1. N/A = Not Applicable
2. Min. = Minimum
3. Max. = Maximum
4. AVG = Average
5. SD = Standard Deviation
6. MED = Median

Radiological and Nonradiological Monitoring of Sediments Data

2011 Summary Statistics – SCDHEC Radiological Data
SRS Creek Mouths

	AVG:	SD:	MED:	MIN:	MAX:	Total Number of Samples	Number of Detections
Alpha	17.5	11.3	12.3	9.7	30.4	5	3
Beta	23	9.3	19.4	16.5	36.8	5	4
K-40	12.7	3.1	13.6	8.7	16.6	5	5
Cs-137	0.7	0.4	0.6	0.3	1.3	5	4
Pb-212	1.4	0.9	1.2	0.5	2.8	5	5
Pb-214	2.9	4	1.4	0.6	10.1	5	5
Ra-226	5.2	7.1	2.4	1.3	17.9	5	5
Ac-228	1.6	1.1	1.2	0.5	3.5	5	5

2011 Summary Statistics – SCDHEC Radiological Data
Non Publicly Accessible SRS Streams

	AVG:	SD:	MED:	MIN:	MAX:	Total Number of Samples	Number of Detections
Alpha	36.1	31.6	36	13.7	58.4	7	2
Beta	21.7	18.3	13.1	11.5	49	7	4
K-40	2.1	2.3	1	0.52	6.3	7	6
Cs-137	0.97	1.5	0.36	0.06	3.8	7	5
Pb-212	1.69	1.7	1.17	0.2	5.09	7	7
Pb-214	4.08	7.9	1.18	0.28	21.9	7	7
Ra-226	10.4	16.6	2.35	1.89	40	7	5
Ac-228	1.96	2.33	1.15	0.28	6.95	7	7

2011 Summary Statistics – SCDHEC Radiological Data
Publicly Accessible Boat Landings

	AVG:	SD:	MED:	MIN:	MAX:	Total Number of Samples	Number of Detections
Alpha	N/A	N/A	N/A	N/A	N/A	10	0
Beta	19.77	7.87	20.2	9.28	35.3	10	8
K-40	9.7	5.75	11.36	0.87	18.08	10	10
Cs-137	0.16	0.11	0.15	0.05	0.31	10	7
Pb-212	1.39	0.69	1.45	0.42	2.87	10	10
Pb-214	1.21	0.55	1.19	0.31	2.1	10	10
Ra-226	2.87	0.74	2.67	2.18	4.28	10	8
Ac-228	1.38	0.7	1.45	0.41	2.87	10	10

Note: Units are in pCi/g.

2011 Summary Statistics – SCDHEC Radiological Data
Non-Publicly Accessible SRS Stormwater Basins

	AVG:	SD:	MED:	MIN:	MAX:	Total Number of Samples	Number of Detections
Alpha	N/A	N/A	N/A	N/A	N/A	3	0
Beta	15.9	N/A	15.9	15.9	15.9	3	1
K-40	1.8	0.9	1.5	1.08	2.81	3	3
Cs-137	0.11	0.04	0.11	0.08	0.14	3	2
Pb-212	1.56	0.68	1.44	0.95	2.28	3	3
Pb-214	1.22	0.47	1.1	0.83	1.74	3	3
Ra-226	2.77	1.07	2.77	2.01	3.53	3	2
Ac-228	1.59	0.71	1.46	0.96	2.36	3	3

Note: Units are in pCi/g. There were no detections in any 2009 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Ru-103, Sb-125, I-131, Cs-134, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2011 Summary Statistics – SCDHEC Radiological Data
Nonrandom Background Samples

	AVG:	SD:	MED:	MIN:	MAX:	Total Number of Samples	Number of Detections
Alpha	N/A	N/A	N/A	N/A	N/A	6	0
Beta	13.1	3.6	13.1	10.5	15.6	6	2
K-40	3.8	2.2	3.2	1.4	7	6	6
Cs-137	2.1	4.6	0.11	0.06	10.3	6	5
Pb-212	1.26	0.24	1.29	0.94	1.56	6	6
Pb-214	1.07	0.32	1.04	0.71	1.5	6	6
Ra-226	2.27	0.89	2.22	1.38	3.33	6	6
Ac-228	1.29	0.25	1.23	1.01	1.64	6	6

Note: Units are in pCi/g. There were no detections in any 2010 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Ru-103, Sb-125, I-131, Cs-134, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

2011 Summary Statistics – SCDHEC Sediment Metals Data
SRS Streams Creek Mouths

	AVG:	SD:	MED:	MIN:	MAX:	Total Number of Samples	Number of Detections
Barium	50.6	27.7	64	21	80	5	5
Beryllium	0.3	N/A	0.3	0.3	0.3	5	1
Cadmium	1.3	0.3	1.1	1.1	1.7	5	3
Chromium	9.7	4.1	11	3.3	14	5	5
Copper	5.1	2.2	4.5	3.1	8.3	5	4
Mercury	N/A	N/A	N/A	N/A	N/A	5	0
Manganese	307	217.9	440	25	500	5	5
Nickel	3.9	1	4.1	2.5	4.8	5	4
Lead	6.2	1	6.3	5.1	7.2	5	4
Zinc	22.1	11.1	28	9.4	34	5	5

Note: Units are in mg/kg.

2011 Summary Statistics – SCDHEC Sediment Metals Data
Publically Accessible Boat Landings

	AVG:	SD:	MED:	MIN:	MAX:	Total Number of Samples	Number of Detections
Barium	52.7	28.6	48	24	110	10	9
Beryllium	0.4	0	0.4	0.3	0.4	10	3
Cadmium	1.7	0.4	1.8	1.2	2.1	10	6
Chromium	11.2	5.5	12	4.9	18	10	9
Copper	5.5	3.1	4.5	2.2	10	10	10
Mercury	N/A	N/A	N/A	N/A	N/A	10	0
Manganese	316.7	268.2	215	9.1	860	10	10
Nickel	4.4	1.2	4.1	3.3	6.2	10	4
Lead	9	2.9	8.2	6.1	13	10	7
Zinc	21.9	15.7	18	2.4	54	10	10

Note: Units are in mg/kg

List Of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control
DOE-SR	Department of Energy – Savannah River
ESOP	Environmental Surveillance and Oversight Program
ESV	Ecological Screening Value
LLD	Lower Limit of Detection
LTR	Lower Three Runs
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
SCDHEC	South Carolina Department of Health and Environmental Control
SMSV	Sediment from Savannah River Study area
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
USDOE	United States Department of Energy
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
WSRC	Washington Savannah River Company, formerly Westinghouse Savannah River Company

Units Of Measure

mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
±	plus or minus. Refers to one standard deviation unless otherwise stated

References

Alloway, B.J. 1995. *Heavy Metals in Soils*. Great Britain, St Edmundsbury Press, Suffolk.

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. ToxFaqs TM for Di-n-octylphthalate (DNOP). ATSDR Division of Toxicology, Atlanta, GA. http://www.atsdr.cdc.gov/tfacts95.html.

Canova, J.L. 1999. Elements in South Carolina Inferred Background Soil and Stream Sediment Samples. South Carolina Geology, 1999, v.41, p.11-25.

Centers for Disease Control (CDC). 2006. Phase III of the SRS dose reconstruction project. Available from URL http://www.cdc.gov/nceh/radiation/Savannah/docs/TOCs.pdf.

Savannah River Nuclear Solutions, LLC (SRNS). 2012. Savannah River Site Environmental Report for 2011. Savannah River Site, Aiken, South Carolina. SRNS-STI-2012-00200

Savannah River Nuclear Solutions, LLC (SRNS). 2009. Savannah River Site Environmental Report for 2008. Savannah River Site Aiken, SC. SRNS-STI-2009-00190.

Till, J.E., et al. 2001. Savannah River Site Environmental Dose Reconstruction Project, Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval, Evaluation of Materials Released from the Savannah River Site. RAC Report No. 1-CDC-SRS-1999-Final. Risk Assessment Corporation (RAC).

United States Department of Energy (USDOE). 1995. SRS Waste Management Final Environmental Impact Statement. Doc. No. DOE/EIS-0217 http://www.eh.doe.gov/nepa/eis/eis0217/eis0217_toc.html.

United States Department of Interior (USDOI). 1992. 7.5 Minute Topographic Geologic Survey Map of South Carolina. South Carolina Land Resources Commission RV 10/92.

United States Environmental Protection Agency (USEPA). 1987. An Overview of Sediment Quality in the United States, EPA-905/9-88-002, Office of Water Regulations and Standards, Washington, DC and Region 5, Chicago, IL.

USEPA. 2009a. *EPA Facts about Cesium*. http://www.epa.gov/rpdweb00/radionuclides/cesium.html.

USEPA. 2009b. *EPA Facts about Technetium-99*. http://www.epa.gov/rpdweb00/radionuclides/technetium.html.

Westinghouse Savannah River Company (WSRC). 1993a. Assessment of Technetium In the Savannah River Site Environment. Carlton, W.H., Denham, M., Evans, A.G., Aiken, South Carolina. WSRC-TR-93-217.

WSRC. 1993b. Final Record of Decision Remedial Alternative Selection for H-Area Hazardous Waste Management Facility. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-RP-93-1043.

WSRC. 1998. Assessment of Radionuclides in The Savannah River Site Environment-Summary (U), Environmental Protection Department, Environmental Monitoring Section, Aiken, South Carolina. WSRC-TR-98-00162.

WSRC. 2002. Viability of Sodium Iodide Detector Field Measurements and X-Ray Florescence Measurements for Recognition of Benchmark Exceedances in the Steel Creek Integrator Operable Unit. Westinghouse Savannah River Company, Aiken, South Carolina.

WSRC. 2003. Radiological False Positives in Environmental Soil and Groundwater Data from Commercial Laboratories. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-MS-2003-00565.

WSRC. 2005. Ecological Screening Values for Surface Water, Sediment, and Soil: 2005 Update, Friday, G.P., Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina.WSRC-TR-2004-00227.

WSRC. 2008. Savannah River Site Environmental Report for 2007. Washington Savannah River Company, Savannah River Site, Aiken, SC. WSRC-STI-2008-00057.

This Page Intentionally Left Blank

Section 3 2011 Terrestrial Monitoring

Chapter 7 Surface Soil Monitoring Adjacent to SRS

Chapter 8 Radiological Vegetation Monitoring Associated with the Savannah River Site

Chapter 9 Radiological Monitoring of Edible Vegetation

Chapter 10 Radiological Monitoring of Dairy Milk

2011 Surface Soil Monitoring Adjacent to SRS

Environmental Surveillance and Oversight Program

97SS006
John Simpkins, Project Manager
January 01, 2011 - December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 2
RADIOLOGICAL PARAMETER RESULTS 2
NONRADIOLOGICAL PARAMETER RESULTS 3
SCDHEC AND DOE-SR DATA COMPARISON 5

3.0 CONCLUSIONS AND RECOMMENDATIONS 6

4.0 MAPS 7

5.0 TABLES AND FIGURES 9

6.0 DATA 18

2011 RADIOLOGICAL DATA 19
2011 NONRADIOLOGICAL (METALS) DATA 29

7.0 SUMMARY STATISTICS 32

2011 NONRADIOLOGICAL (METALS) STATISTICS 33
2011 RADIOLOGICAL STATISTICS 34

LIST OF ACRONYMS AND UNITS OF MEASURE 35

REFERENCES 36

1.0 PROJECT SUMMARY

Surface soil is an important medium that can be contaminated by radionuclides and metals, and transported to other ecological systems. Plants absorb contaminants from soil that in turn introduce contaminants to the food chain. Radionuclides and metals in soil can leach into groundwater and possibly emerge into surface water, thus potentially contaminating aquatic systems (Corey 1980). Air and water are subject to much greater mixing than soil; therefore, dilution of metal load does not occur in soil as in air or water. As a result, the accumulation of metals in surface soils is often more intense on both local and global scales than in the other components of the biosphere (Alloway 1995). The re-suspension and subsequent airborne contamination of materials, due to cleanup processes and prescribed burns, facilitates the movement of contaminants to areas potentially outside of the Savannah River Site (SRS) boundary.

The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) provides independent evaluation of the Department of Energy – Savannah River (DOE-SR) environmental monitoring programs. ESOP personnel independently evaluated surface soils from ground surface to a 12 inch depth for gross alpha, gross non-volatile beta, select gamma-emitting radionuclides, as well as specific metals of concern at SRS. These soil samples were collected to determine if SRS activities might have impacted areas outside of the site boundary. Radionuclide detections in soil are the result of accumulation over many years and do not likely represent yearly depositions.

The ESOP surface soil monitoring project changed in 2004 to include more random coverage background soils (those greater than 50 miles from the SRS center point) within the boundaries of the state of South Carolina. This sampling program was implemented to allow statistical comparisons of the SRS perimeter and South Carolina background contaminant levels in soils. The United States Geological Survey (USGS) 7.5' Quadrangle Coverage for South Carolina (USDOI 1992) was used to determine the ESOP random quadrant sampling areas. Refer to Section 5.0, Table 1 and Section 4.0, Map 1 for random sampling locations. ESOP initiated the random sampling system to determine if elevated levels of contaminants are attributable to SRS activities. Perimeter and background averages were used to determine if SCDHEC data were comparable to radiological data from DOE-SR. Since DOE-SR environmental monitoring division does not report metals data for surface soil, no direct data comparisons can be made. Assessment of radiological and nonradiological contaminants in surface soil is necessary to detect any impact from DOE-SR operations beyond the historically impacted areas within the SRS boundaries. In addition to samples collected near the perimeter of SRS, publicly accessible boat landings were included in the sampling regime in 2007 to exemplify areas where direct contact to surface soil by the public often occurs.

ESOP collected samples in 2011 from six random background sites outside of the 50-mile SRS center point radius. Nineteen nonrandom samples were collected from SRS perimeter locations. Ten riverbank samples were collected from publicly accessible boat landings. Nonrandom SRS perimeter sampling locations are depicted on Map 2 of Section 4.0. A list of all nonrandom sampling locations is in Section 5.0, Table 2. The majority of all the samples had detectable amounts of cesium-137 (Cs-137), an anthropogenic radionuclide, that were consistent with levels attributed to atmospheric fallout from past nuclear weapons testing. The background average was higher than the other locations collected around SRS. Cesium-137 activity in 2011 coincides with levels detected by ESOP in the past. There were no surface soil samples collected in 2011 that were above the United States Environmental Protection Agency (USEPA) Preliminary Remediation Goals (PRGs) or the USEPA Regional Screening Levels (RSLs) (USEPA 2009). There were no riverbank soil samples in 2011 that exceeded the radiological USEPA Soil Screening Levels (SSLs). SSLs are more conservative screening values that are utilized when soil is in close proximity to groundwater (e.g. near rivers and sometimes near surface water bodies). USEPA PRGs are generic/default screening values for radioactive contamination in soil. USEPA RSLs are generic/default values for the toxicity of chemical contaminants in soil. The PRGs, RSLs and SSLs of select radionuclides and metals sampled by SCDHEC are listed in Section 5.0, Tables 6, 7 and 8.

There were no gross alpha-emitting radionuclides detected in any of the samples collected in 2011. Gross non-volatile beta was detected among all sample types.

Results for all metal analytes were below the USEPA RSLs. Metals data has been trended over time, and the samples collected near the SRS perimeter are similar to those collected randomly throughout South Carolina (SC).

Data comparison of 2011 surface soil data from SCDHEC and DOE-SR resulted in similar findings. Both data sets report average Cs-137 levels higher outside the 50 mile radius of SRS than within the SRS perimeter. SCDHEC data from 2011 perimeter samples show a slight decrease in the average level of Cs-137 from the 2010 data. DOE-SR reports in 2011 that Cs-137 concentrations are consistent with historical results. Metals data could not be compared to SCDHEC results since the DOE-SR environmental monitoring division does not analyze nonradiological contaminants.

2.0 RESULTS AND DISCUSSION

<u>Radiological Parameter Results</u>

All radiological data can be found in Section 6.0 and statistical data can be found in Section 7.0.

Surface soils were evaluated for gross alpha and gross non-volatile beta as well as a suite of 24 gamma-emitting radionuclides. Radioisotopes were detected not only in samples collected on SRS, but in background samples as well. The USEPA PRGs are used as a screening tool that corresponds to certain levels of human health risk in regards to radioactivity in soil (USEPA 2010). The conservative PRGs, correspond to a risk for chronic soil ingestion for a residential scenario and a one in one million (1E-06) increased cancer risk. In 2011, ESOP analyzed for all of the radioisotopes listed in Section 5.0, Table 4.

Cesium-137 is a man-made fission product. Atmospheric Cs-137 was released from the separation areas and was a key radionuclide released to water and air, mainly from F- and H-areas (CDC 2006). Cesium-137 was detected in 18 of the 19 SRS nonrandom perimeter samples at an average of 0.11 (±0.04) picocuries per gram (pCi/g) and ranged from less than the minimum detectable activity (MDA) to 0.17 pCi/g. The highest detection was located at SSNEL11 in Aiken County. Eight of the 10 riverbank soil samples had Cs-137 detections at an average of 2.03 (±2.86) pCi/g. The samples ranged from less than MDA to 8.63 pCi/g. The highest detection of all samples was at Little Hell boat landing.

Analysis for Cs-137 in riverbank soils collected at the public boat landings show that samples in 2011 had Cs-137 levels consistent with levels attributed to atmospheric fallout from past nuclear weapons testing. Results are depicted in Section 5.0, Figure 1.

Four out of six background samples had Cs-137 detections. The random background sample detection average was 2.37 (±4.58) pCi/g. The random background samples had detections ranging from less than MDA to 9.24 pCi/g . Cesium-137, on average, was highest in the random background samples followed by soil from public boat landings. The results are depicted in Section 5.0, Figure 2.

In addition, potassium-40, lead-212, lead-214, radium-226, and actinium-228 were the only other gamma-emitting radionuclides detected among surface soil samples. These are Naturally Occurring Radioactive Material (NORM) decay products that may account for these detections. All other gamma-emitting radionuclides had no detections above their respective MDA.

Gross alpha-emitting radionuclides were released to the air at SRS primarily from M-area, the reactor areas, and the separations facilities (CDC 2006). Analyses were conducted on gross alpha-emitting radionuclides in surface soil samples collected during 2011. There were no detections of gross alpha-emitting radionuclides in any of the soil samples collected in 2011.

Gross beta-emitting radionuclides were released from the separations areas on the SRS (CDC 2006). Gross beta was detected in seven SRS nonrandom perimeter samples at an average of 11.2 (±1.6) pCi/g and ranged from 9.2 to 14.2 pCi/g. The highest detection was in soil collected at SSJAK0211 in Aiken County. Seven riverbank boat landing soil samples had detections for gross beta-emitting radionuclides. The riverbank landing average was 20.7 (±7.6) pCi/g, and the values ranged from 13.1 to 35.2 pCi/g. Burtons Ferry Landing (SSBFL11) yielded the highest riverbank soil detection. There were no detections of gross beta-emitting radionuclides in any of the background soil samples collected in 2011. Results are depicted in Section 5.0, Figure 4.

Nonradiological Parameter Results

Data for all metals detected can be found in Section 6.0. The statistical data tables are found in Section 7.0 Comparison of select metal results are depicted in Figure 3 of Section 5.0.

Ten metals were analyzed in 19 nonrandom SRS perimeter surface soil samples collected in 2011. A complete list of all nonradiological analytes can be found in Section 5.0, Table 5. Findings were compared to the USEPA RSLs that are used as a screening tool, corresponding to certain levels of human health risk in soils (USEPA 2010). All sample results were below the USEPA RSLs. ESOP 2011 samples had detections of barium, beryllium, cadmium, chromium, copper, lead, manganese, and zinc. There were no detections above the Minimum Detection Limit (MDL) for mercury and nickel in the SRS perimeter samples. The following discussion of individual analytes will be limited to those of potential concern due to SRS operations.

Barium has been a constituent of the H-Area Hazardous Waste Management Facility (WSRC 1993). Barium was detected in all 19 SRS nonrandom perimeter samples at an average of 18.9 milligrams per kilogram (mg/kg) and ranged from 5.7 to 50 mg/kg. The highest detection was located at SSBWL0411 in Barnwell County. All samples were well below the RSL of 15,000 mg/kg and only SSBWL0411 was above the SC average of 38 mg/kg (Canova 1999).

Chromium solutions were used at the SRS as corrosion inhibitors. Chromium was a part of wastewater solutions resulting from dissolving stainless steel. It was also used in cleaning solutions in the separation areas (Till et al. 2001). Disposal of fly ash on land is a contributor of both chromium and nickel to soils (Alloway 1995). Chromium was detected in all19 SRS nonrandom perimeter samples at an average of 4.5 mg/kg and ranged from 1.2 to 12 mg/kg. The highest detection was located in SSGP11 in Aiken County. For comparison, the most conservative RSL screening level (ChromiumVI) is 230 mg/kg. The SC average for total chromium in soil is 16 mg/kg (Canova 1999).

Copper, while naturally occurring, can also be released to the environment through the combustion of wood, coal and oil (Alloway 1995). These mechanisms are possible sources of elevated copper in surface soils. Copper was detected in 16 SRS nonrandom perimeter samples at an average of 1.9 mg/kg and ranged from 1.1 to 4.6 mg/kg. The highest detection was located in SSAIK0211 in Aiken County. All samples were below the RSL of 3,100 mg/kg . The SC average for copper in soil is 9 mg/kg (Canova 1999).

Atmospheric emissions of lead from SRS occurred through coal and fuel combustion (Till et al. 2001). Depositions of lead in soil have a long resonance time. Lead tends to accumulate in soil where its bioavailability can exist far into the future (Alloway 1995). Lead was detected in eight SRS nonrandom perimeter samples at an average of 8.16 mg/kg and ranged from 5.1 to 11 mg/kg. The highest detection was located at SSBWL0411 in Barnwell County. For comparison, the RSL is 400 mg/kg and the state average for lead in soil is 16 mg/kg (Canova 1999).

Manganese has been released in the separations area processes and discharged to liquid waste tanks. It is also a byproduct of coal burning (Till et al. 2001). Manganese was detected in all 19 SRS nonrandom perimeter samples at an average of 66.8 mg/kg and ranged from 10 to 190 mg/kg. The highest detections was located at SSJAK11 in Aiken County and SSBWL0411 in Barnwell County. Five samples exceeded the state average of 100 mg/kg (Canova 1999), however all were below the RSL of 1,800 mg/kg.

The largest anthropogenic source of nickel globally is the burning of fuels and coal combustion (Alloway 1995). At SRS, nickel was directly released through M-area effluent from the plating rinse tanks and through site use of diesel generators (Till et al. 2001). Nickel was not detected in any of the SRS nonrandom perimeter samples. The state average for nickel is 6 mg/kg (Canova 1999), and the RSL of nickel is 1,500 mg/kg.

Zinc was released in relatively small amounts to the separations area seepage basins as well as the M-area seepage basin (Till et al. 2001). Zinc was detected in all 19 SRS nonrandom perimeter samples at an average of 8.9 mg/kg and ranged from 2.6 to 27 mg/kg. The highest detection was located at SSJAK0212 in Aiken County. The RSL is 23,000 mg/kg. All samples except SSJAK0212 (27 mg/kg) were also below the state average of 23 mg/kg (Canova 1999).

SRS facilities, such as F-and H-area, tritium facilities, waste tanks and the coal-fired power plants, have emitted mercury to the atmosphere (Till et al. 2001). Atmospheric fallout contributes to mercury findings in surface soil. None of the surface soil samples collected in 2011 yielded detections above the MDL of 0.1 mg/kg for mercury. The RSL for mercury is 5.6 mg/kg.

Cadmium enters the atmosphere through fuel and coal combustion (Till et al. 2001). Only two of the surface soil samples collected in 2011 yielded detections above the MDL of 1.0 mg/kg for cadmium. The two cadmium detections averaged of 2.2 mg/kg and ranged from 1.8 to 2.6 mg/kg. The highest detection was located at SSSNL11 in Barwell County. The RSL for cadmium in soil is 70 mg/kg.

SCDHEC and DOE-SR Data Comparison

Cesium-137, Cobalt-60 (Co-60) and Americium-241 (Am-241) were the only gamma-emitting radionuclides for which SCDHEC and DOE-SR shared analytical results. DOE-SR did not have any detections of Co-60 above the MDA. DOE-SR did detect Am-241 in one perimeter location as well as Am-241 in a 25 mile perimeter location. Since SCDHEC did not have any detections of Co-60 or Am-241 above the MDA, only the Cs-137 detections are compared. DOE-SR did not analyze for alpha or beta emitting radionuclides, nor did they analyze for metals. Samples varied by location and in number. DOE-SR collected 12 samples near the SRS perimeter and three samples within 25 miles. ESOP collected 19 nonrandom SRS perimeter samples. ESOP also sampled six background locations greater than 50 miles from SRS. DOE-SR sampled one background location 100 miles from SRS at Savannah, Georgia. Samples were collected from a variety of soil types. This should be taken into consideration in regards to data interpretation. Comparative data can be found in Section 5.0, Tables 9 and 10.

Cesium-137 was detected by both DOE-SR and SCDHEC. Cesium-137 was detected above the Minimum Detectable Concentration (MDC) in all 12 DOE-SR perimeter samples. SCDHEC detected Cs-137 in all of the 19 nonrandom perimeter SCDHEC samples. Cesium-137 was detected in both the DOE-SR background location and the SCDHEC background locations. For the 2011 samples, the SCDHEC nonrandom perimeter average for Cs-137 was 0.11 (± 0.04) pCi/g. The average for all the SCDHEC background samples was 2.37 (± 4.58) pCi/g. The DOE-SR Cs-137 average for all SRS perimeter samples was 0.162 pCi/g, and 0.183 pCi/g for those locations within 25 miles of SRS. The DOE-SR 100 mile background Cs-137 activity was 0.043 pCi/g (SRNS 2011). The DOE-SR data average for Cs-137 activity falls within one standard deviation of the SCDHEC data.

Cesium-137 was the only consistently analyzed parameter over past years. Trending data for Cs-137 in SRS perimeter samples is in Section 5.0, Figure 5. SCDHEC has trended Cs-137 since 2005 (SCDHEC 2005-2011). Data shows that SCDHEC average levels of Cs-137 in surface soils increased from 2005 to 2007. Results from 2008 through 2011 each show a decline year to year. DOE-SR data shows steady levels from 2005 to 2006. DOE-SR Cs-137 activity from 2007 to 2011 has shown a decline from highest CS-137 averages in 2006. (WSRC 2005c, 2006-2011). The average level of Cs-137 in surface soil can vary due to the highly variable nature of soils. Radiocesium bioavailability in soil is influenced by soil properties such as clay content, pH, organic matter, and soil microflora (Absalom et al. 2001). The increase of Cs-137 activity in the SCDHEC samples in 2006 through 2009 could be due to the 2006 addition of samples in closer proximity to the boundary of SRS, specifically in the Steel Creek floodplain. In the previous years only random samples within 50 miles of the SRS center point were sampled to determine the yearly average. In 2007, the addition of sampling at public boat landings was initiated. Excursions outside normally expected levels, contributed through unplanned Cs-137 releases, occurred at boat landings just downstream of SRS specifically in the Steel Creek floodplain area, driving the average higher. These areas have historically been impacted by SRS operations and higher than background results are to be expected. These yielded higher averages in 2006, 2007, 2008 and 2009. DOE-SR does not collect samples at these locations.

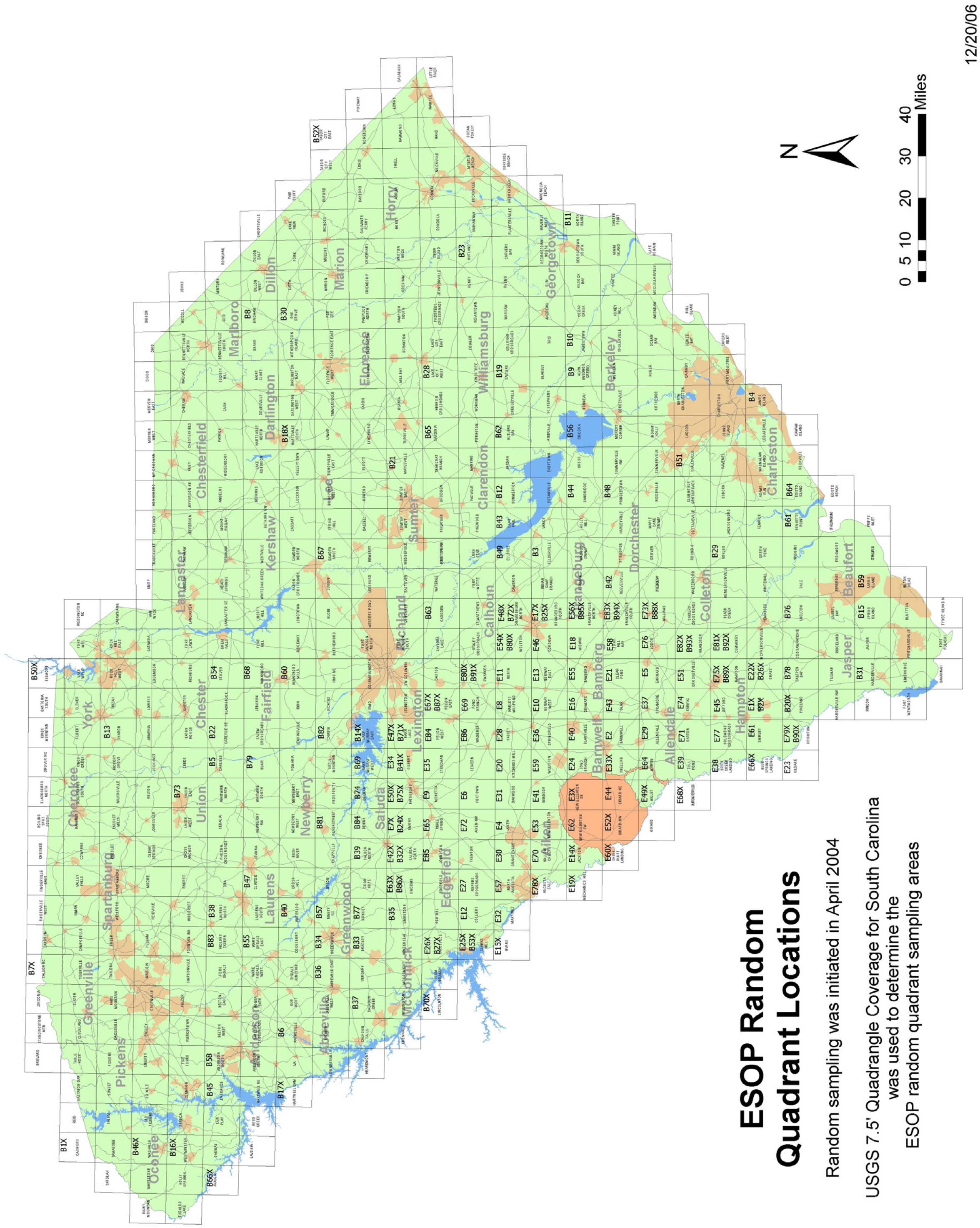
3.0 CONCLUSIONS AND RECOMMENDATIONS

ESOP will continue independent monitoring of SRS perimeter surface soil and periodically evaluate modification of the monitoring activities to better accomplish project goals and objectives. Monitoring will continue as long as there are activities at the SRS that create the potential for contamination entering the environment. Continued monitoring will provide an improved understanding of radionuclide and non-radionuclide activity in SRS perimeter surface soils and the surrounding areas. Additional monitoring will impart valuable information to human health exposure pathways. Trending of data over multiple years will give a more definitive answer as to whether radionuclide concentrations in the SRS area are declining due to radioactive decay or possibly increasing due to disturbances on SRS. The comparison of data results allows for independent data verification of DOE-SR monitoring activities. Cooperation between DOE-SR and SCDHEC provides credibility and confidence in the information being provided to the public.

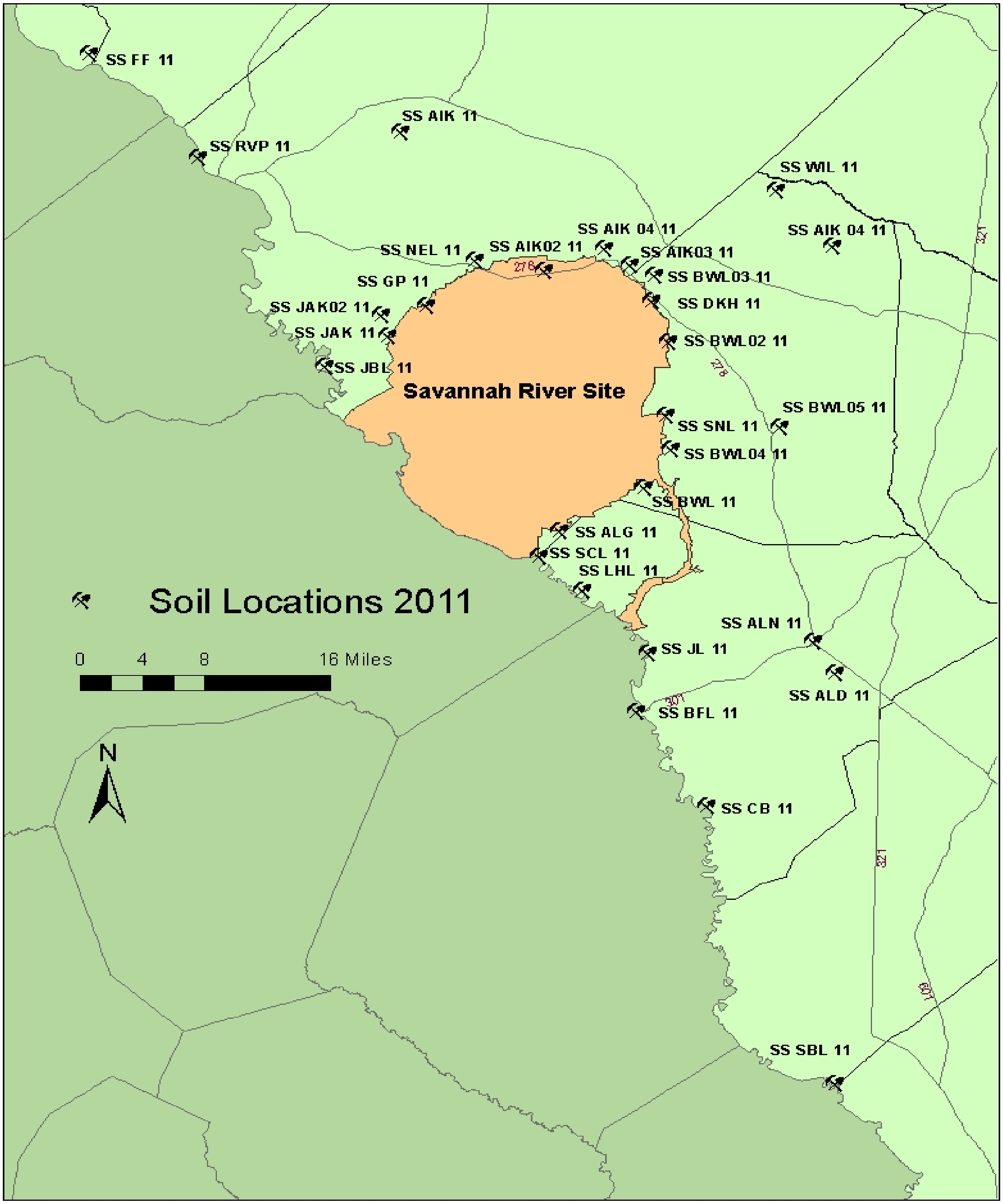
In 2012, SCDHEC will continue to monitor the surface soil along the perimeter of SRS for radionuclides. Riverbank soil samples will be collected from the publicly accessible Savannah River watershed boat landings where human exposure is likely. The SCDHEC data at this time does not show an impact of elevated metal concentrations to areas outside of SRS. However, continued monitoring along the perimeter of SRS is still necessary due to the potential impact of SRS site operations to the surrounding environments. Possible atmospheric releases due to control burns and soil disturbance at SRS could elevate metals in the surrounding area. Only through continued monitoring will this be determined. If perimeter samples show elevated metals levels, additional samples will be evaluated.

4.0 Surface Soil Monitoring Adjacent to SRS

Map 1. ESOP Random Sample Locations



Surface Soil Monitoring Adjacent to SRS
Map 2. SRS Perimeter Surface Soil Monitoring Locations



5.0 Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 1. Random Soil Samples Collected in 2011

2011 Random Surface Soil Sampling Locations Random Quadrants Outside the 50-mile SRS Perimeter or "B" Quadrants.			Geological
Quad	**7.5' Quad Name**	**Latitude by Lat and Longitude by Long**	**Region**
B71X	Barr Lake (50mi.)	3352.5 by 3400 and -8115 by -8122.5	UCP
B67	Camden South	3407.5 by 3415 and -8030 by -8037.5	UCP
B39	Saluda North	3400 by 3407.5 and -8145 by -8152.5	PM
B36	Abbeville East	3407.5 by 3415 and -8215 by -8222.5	PM
B30	Oak Grove	3415 by 3422.5 and -7930 by -7937.5	LCP

1. The randomly selected quadrants are from a United States Department of Interior 7.5 Minute Topographic Map Printed by the South Carolina Land Resources Commission, Rv 10/92.
2. "**X**" in any designated ID represents the presence of an **exclusion zone** of either a state border, 50 mi. limit bisector line that splits the quad area into an environmental side and a background side, or occurrence of background random pick area within 10 miles of a nuclear facility.
3. "**B**" means this is a South Carolina background pick outside of the 50 mile limit from SRS center point. Ten mile exclusion zone in "B" quads is used to reduce influence of any local reactor on SC background.
4. Parenthesis info by quad name identifies type of exclusion (NCX is North Carolina, GAX is Georgia, NRX is nuclear reactor, SRS is Savannah River Site exclusion zone border).
5. Purpose of random sampling is to compare public dose within 50 miles of SRS to a S. C. background.
6. Geological Regions are Blue Ridge (BR), Piedmont (PM), Upper & Lower Coastal Plain (U&LCP). Quadrants split by geological regions are assigned to the upper most region in the quadrant.

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 2. Nonrandom Soil Samples Collected in 2011

SAMPLE ID	LOCATION	COUNTY
SS ALG 11	Allendale Gate	Allendale
SS SNL 11	Snelling Gate	Barnwell
SS DKH 11	Darkhorse	Barnwell
SS ALN 11	Allendale	Allendale
SS GP 11	Green Pond	Aiken
SS JAK 11	Jackson	Aiken
SS AIK 11	Aiken	Aiken
SS JAK02 11	Jackson	Aiken
SS NEL 11	New Ellenton	Aiken
SS BWL 11	Co-located at VEG site BWL-004	Barnwell
SS AIK02 11	Boggy Gut Road	Aiken
SS BWL02 11	Co-located at VEG site BWL-002	Barnwell
SS BWL03 11	Co-located at VEG site BWL-001	Barnwell
SS AIK03 11	Co-located at EV site AIK 0903	Barnwell
SS ALD 11	Co-located at Allendale VEG Site ALD-251	Allendale
SS BWL04 11	Co-located at VEG site BWL-003	Barnwell
SS AIK04 11	UTR/ Old Barnwell Rd.	Aiken
SS BWL05 11	Barnwell Lake Edgar Brown	Barnwell
SS WIL 11	Williston Plum Location EVBWL-02	Barnwell

Table 3. Riverbank Soil Samples Collected in 2011

Sample Name	Abbr.	Location Description
Upstream of SRS		
SSFF11	FF	Fury's Ferry Boat Landing
SSSC11	SC	Steven's Creek Landing
SSRVP11	RVP	North Augusta Riverview Park Boat Landing
SSJBL11	JBL	Jackson Boat Landing
Downstream of SRS		
SSSCL11	SCL	Steel Creek Landing, Barnwell County
SSLHL11	LHL	Little Hell Landing
SSJL11	JL	Johnson's Landing
SSBFL11	BFL	Burtons' Ferry Landing
SSCB11	CB	Cohen's Bluff Landing

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 4. Radiological Analytes

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Ytrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Table 5. Nonradiological Analytes

Analyte	Abbreviation
Barium	Ba
Beryllium	Be
Cadmium	Cd
Chromium	Cr
Copper	Cu
Mercury	Hg
Manganese	Mn
Nickel	Ni
Lead	Pb
Zinc	Zn

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 6. Preliminary Remediation Goals of Anthropogenic Radionuclides Samples by SCDHEC

Radionuclide	Abbreviation	PRG
Americium-241	Am-241	**3.75 pCi/g**
Cesium-137	Cs-137	**25.4 pCi/g**
Cobalt-60	Co-60	**79.2 pCi/g**
Iodine-131	I-131	**5940 pCi/g**

Table 7. Regional Screening Levels of Metals sampled by SCDHEC

Analyte	Abbreviation	RSL
Barium	Ba	**15,000 mg/kg**
Beryllium	Be	**160 mg/kg**
Cadmium	Cd	**70 mg/kg**
Chromium	Cr	**230 mg/kg**
Copper	Cu	**3,100 mg/kg**
Mercury	Hg	**400 mg/kg**
Manganese	Mn	**1,800 mg/kg**
Nickel	Ni	**1,500 mg/kg**
Lead	Pb	**400 mg/kg**
Zinc	Zn	**23,000 mg/kg**

Table 8. Soil Screening Levels of Anthropogenic Radionuclides Samples by SCDHEC

Radionuclide	Abbreviation	SSL
Americium-241	Am-241	**0.088 pCi/g**
Cesium-137	Cs-137	**0.492 pCi/g**
Cobalt-60	Co-60	**0.081 pCi/g**
Iodine-131	I-131	**5.05 pCi/g**

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 9. Cs-137 Surface Soil Data Comparison: Nonrandom Perimeter SCDHEC and DOE-SR Perimeter Surface Soil Samples

SCDHEC		
Sample ID	**County**	**Cs-137**
SS ALG 11	Allendale	0.09
SS SNL 11	Barnwell	0.05
SS DKH 11	Barnwell	0.06
SS ALN 11	Allendale	0.12
SS GP 11	Aiken	0.07
SS JAK 11	Aiken	0.11
SS AIK 11	Aiken	0.13
SS JAK02 11	Aiken	0.08
SS NEL 11	Aiken	0.17
SS BWL 11	Barnwell	0.13
SS BWL02 11	Barnwell	0.15
SS BWL03 11	Barnwell	0.16
SS AIK03 11	Barnwell	0.12
SS ALD 11	Allendale	0.11
SS BWL04 11	Barnwell	0.17
SS AIK04 11	Aiken	0.08
SS BWL05 11	Barnwell	0.11
SS WIL 11	Barnwell	0.14
AVG		**0.11**
MEDIAN		**0.12**
STD		**0.04**

DOE-SR	
SRS Perimeter	**Cs-137**
Allendale Gate	0.16
Barnwell Gate	0.43
D-Area	0.15
Darkhorse @ Williston Gate	0.11
East Talatha	0.14
Green Pond	0.06
Highway 21/167	0.06
Jackson	0.23
Patterson Mill Road	0.12
Talatha Gate	0.08
West Jackson	0.28
Windsor Road	0.18
AVG	**0.16**
MEDIAN	**0.14**
STD	**0.10**

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 10. Cs-137 Surface Soil Data Comparison: SCDHEC and DOE-SR Surface Soil Samples Collected > 50 miles from the SRS Center Point.

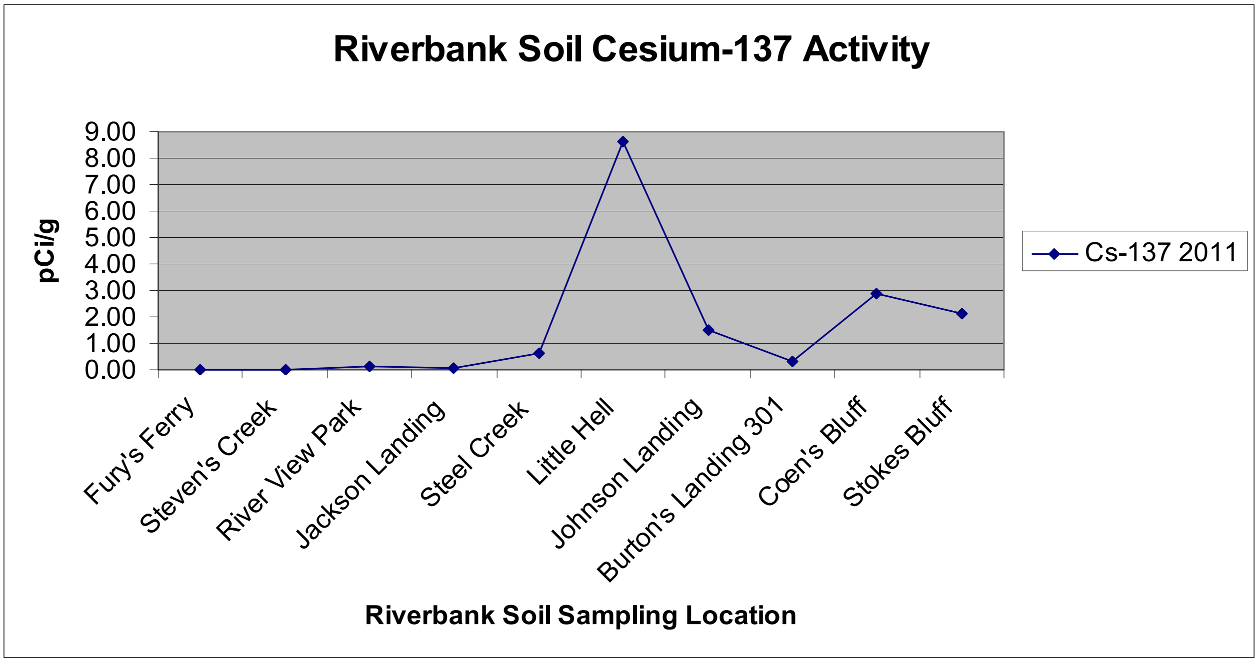
SCDHEC		
Sample	County	Cs-137
SSB71	Lexington	<MDA
SSB67	Camden	0.09
SSB39	Saluda	<MDA
SSB76	Jasper	9.24
SSB36	Abbeville	0.1
SSB30	Dillon	0.06
AVG		2.37
Median		0.09
STD		4.58

DOE-SR		
Sample	Sample	Cs-137
100-Mile	Savannah, GA	0.04

Tables and Figures

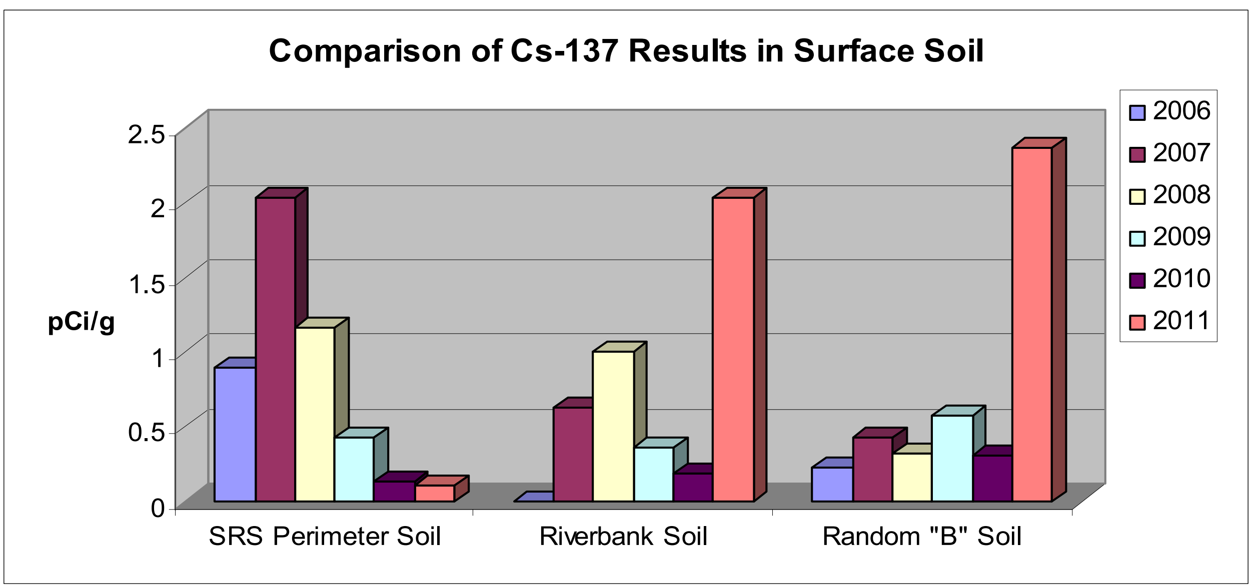
Surface Soil Monitoring Adjacent to SRS

Figure 1. Cesium-137 Levels in Savannah River Riverbank Surface Soil Samples



Note: Graph depicts samples in order of location along the Savannah River. The most upstream sample is on the left and the most downstream sample is on the right of the graph.

Figure 2. Trending Data for Cesium-137 by Yearly Averages of 2006-2011 and Individual Years

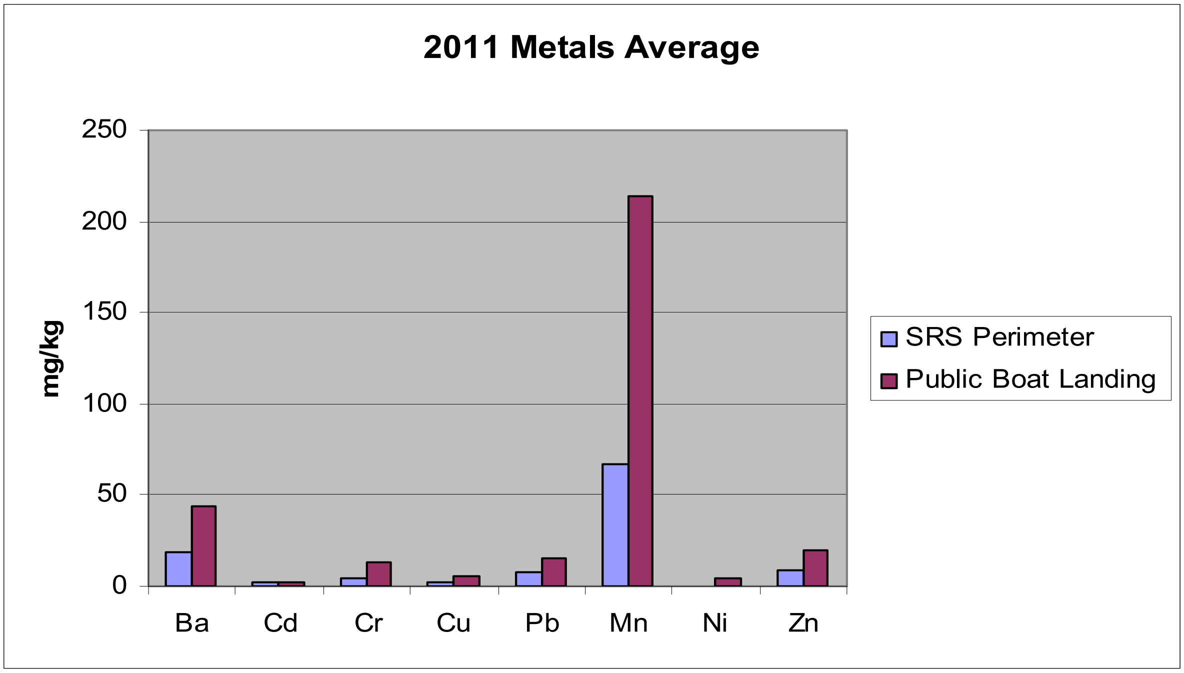


Note: There were no samples collected from riverbank soil in 2006

Tables and Figures

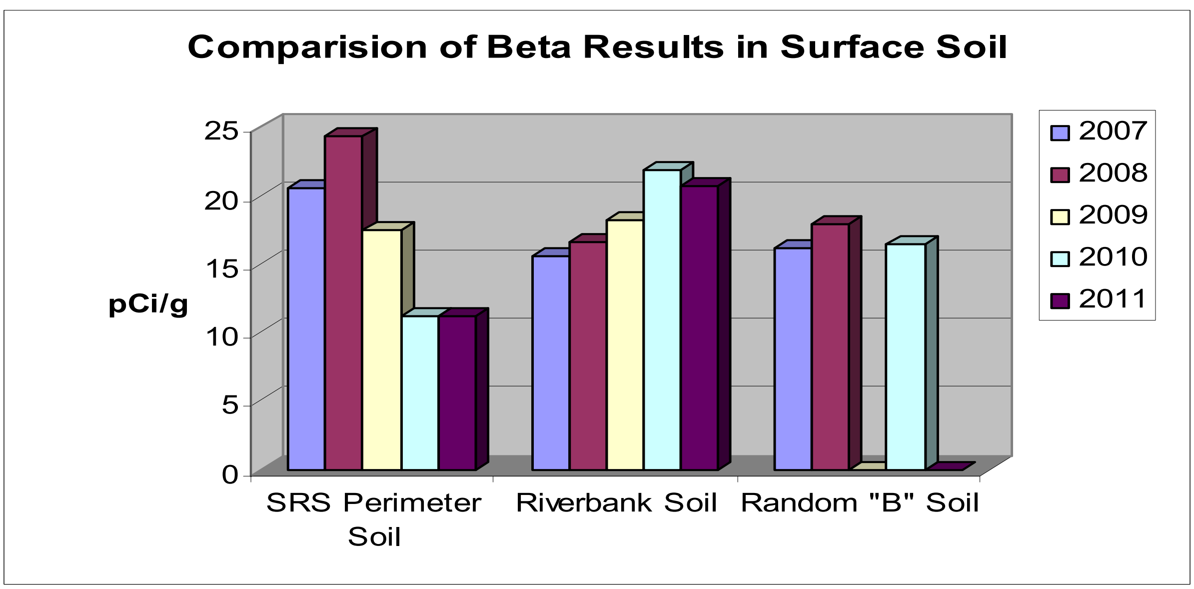
Surface Soil Monitoring Adjacent to SRS

Figure 3. 2011 Comparison of SRS perimeter and Public Boat landing metal averages



Note: There were no Ni detections in the SRS perimeter samples.

Figure 4. Trending Data for Beta Detections by Yearly Averages of 2007-2011 and Individual Years

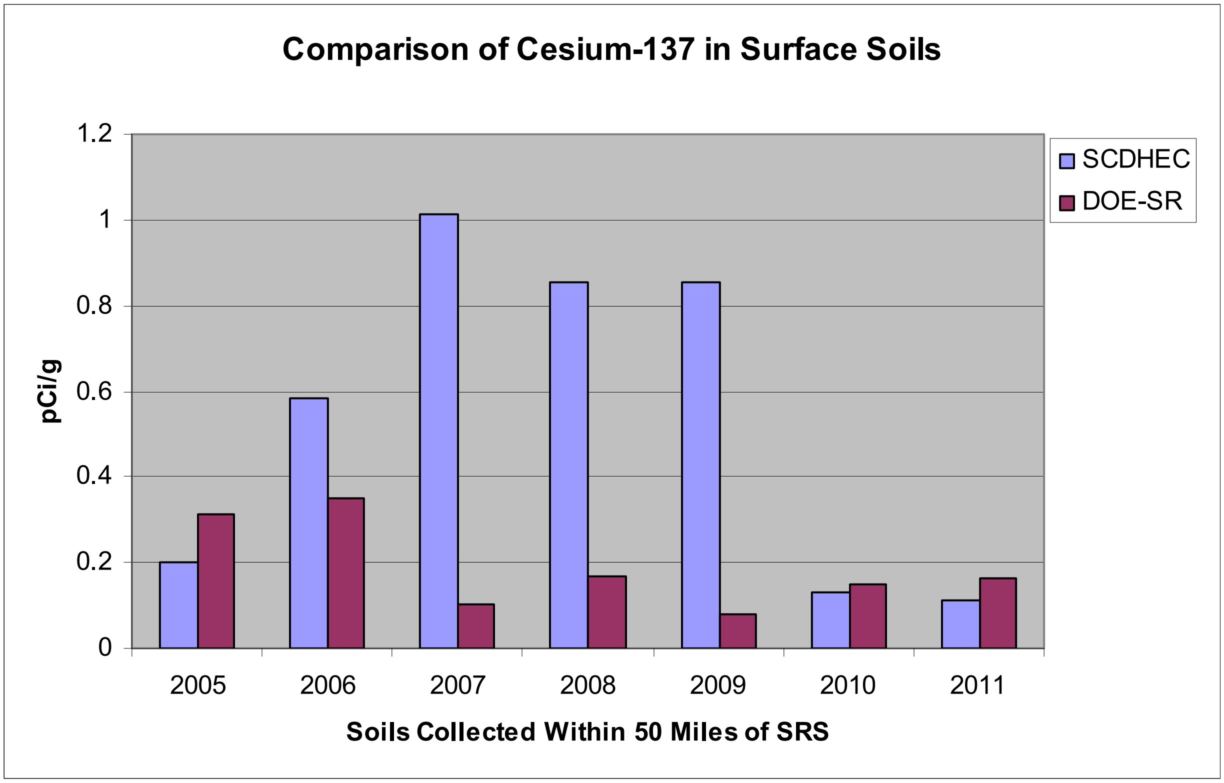


Note: There were no beta detections in any of the "B" soil samples collected in 2009 and 2011

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Figure 5. SCDHEC and DOE-SR Trending Data for Cesium-137 from 2005-2011



6.0 Data

Surface Soil Monitoring Adjacent to SRS

2011 RADIOLOGICAL DATA 19
2011 NONRADIOLOGICAL (METALS) DATA 29

Notes:
1. LLD= Lower Limit of Detection
2. MDA= Minimum Detectable Activity
3. SS= Surface soil

Surface Soil Monitoring Adjacent to SRS

2011 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SS SNEL 11	SS DKH 11	SS GP 11	SS JAK 11
Collection Date	2/23/2011	2/23/2011	2/8/2011	2/8/2011
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	10.6	10.5	10.5	10.6
Beta Activity	11.4	9.25	<LLD	<LLD
Beta Confidence Interval	6.29	6.07	NA	NA
Beta LLD	8.73	8.68	8.69	8.77
K-40 Activity	0.84	0.64	0.41	0.51
K-40 Confidence Interval	0.21	0.17	0.15	0.18
K-40 MDA	0.12	0.11	0.11	0.12
Cs-137 Activity	0.05	0.06	0.07	0.11
Cs-137 Confidence Interval	0.02	0.02	0.02	0.02
Cs-137 MDA	0.02	0.02	0.02	0.02
Pb-212 Activity	0.87	0.91	0.78	0.57
Pb-212 Confidence Interval	0.08	0.08	0.07	0.06
Pb-212 MDA	0.04	0.03	0.03	0.03
Pb-214 Activity	0.77	0.55	0.53	0.48
Pb-214 Confidence Interval	0.05	0.04	0.05	0.05
Pb-214 MDA	0.04	0.04	0.04	0.04
Ra-226 Activity	1.20	1.35	1.06	0.82
Ra-226 Confidence Interval	0.39	0.51	0.46	0.40
Ra-226 MDA	0.46	0.43	0.40	0.45
Ac-228 Confidence Interval	0.07	0.07	0.07	0.06
Ac-228 MDA	0.06	0.05	0.04	0.05

Note: Units are in pCi/g.
There were no detections in any 2011 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SS AIK 11	SS JAK02 11	SS NEL11	SS BWL 11
Collection Date	2/8/2011	2/8/2011	2/8/2011	2/23/2011
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	10.6	10.5	10.30	14.70
Beta Activity	10.6	14.2	<LLD	<LLD
Beta Confidence Interval	6.25	6.54	NA	NA
Beta LLD	8.73	8.67	8.57	8.50
K-40 Activity	0.48	0.99	1.31	0.59
K-40 Confidence Interval	0.17	0.20	0.22	0.18
K-40 MDA	0.12	0.11	0.13	0.10
Cs-137 Activity	0.13	0.08	0.17	0.13
Cs-137 Confidence Interval	0.02	0.02	0.02	0.02
Cs-137 MDA	0.01	0.02	0.02	0.02
Pb-212 Activity	0.40	0.60	0.95	0.69
Pb-212 Confidence Interval	0.04	0.06	0.09	0.06
Pb-212 MDA	0.03	0.04	0.04	0.03
Pb-214 Activity	0.38	0.65	0.95	0.53
Pb-214 Confidence Interval	0.04	0.05	0.06	0.04
Pb-214 MDA	0.03	0.04	0.04	0.03
Ra-226 Activity	<MDA	1.68	1.63	1.39
Ra-226 Confidence Interval	NA	0.54	0.46	0.49
Ra-226 MDA	0.38	0.42	0.51	0.39
Ac-228 Confidence Interval	0.06	0.06	0.08	0.06
Ac-228 MDA	0.05	0.05	0.06	0.05

Note: Units are in pCi/g.
There were no detections in any 2011 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SS AIK02 11	SS BWL02 11	SS AIK03 11	SS AIK04 11
Collection Date	2/8/2011	2/23/2011	2/23/2011	2/23/2011
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	10.4	10.3	10.2	10.20
Beta Activity	11.4	11.4	10.1	<LLD
Beta Confidence Interval	6.31	6.19	6.07	NA
Beta LLD	8.63	8.56	8.51	8.54
K-40 Activity	1.96	0.47	0.64	0.88
K-40 Confidence Interval	0.27	0.18	0.19	0.20
K-40 MDA	0.13	0.12	0.12	0.11
Cs-137 Activity	<MDA	0.15	0.12	0.08
Cs-137 Confidence Interval	NA	0.02	0.02	0.02
Cs-137 MDA	0.02	0.02	0.02	0.02
Pb-212 Activity	1.04	0.95	1.37	1.02
Pb-212 Confidence Interval	0.09	0.09	0.12	0.09
Pb-212 MDA	0.04	0.04	0.04	0.04
Pb-214 Activity	0.76	0.73	0.97	0.73
Pb-214 Confidence Interval	0.06	0.05	0.06	0.05
Pb-214 MDA	0.04	0.04	0.04	0.04
Ra-226 Activity	1.71	1.63	1.88	1.49
Ra-226 Confidence Interval	0.45	0.43	0.48	0.47
Ra-226 MDA	0.51	0.44	0.50	0.50
Ac-228 Confidence Interval	0.08	0.07	0.09	0.08
Ac-228 MDA	0.06	0.05	0.06	0.06

Note: Units are in pCi/g.
There were no detections in any 2011 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SS BWL03 11	SS BWL04 11	SS ALG 11	SS ALD 11
Collection Date	4/7/2011	4/7/2011	4/7/2011	6/21/2011
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	14.10	14.20	13.9	13.8
Beta Activity	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA
Beta LLD	11.40	11.50	11.3	11.2
K-40 Activity	0.45	7.50	0.49	1.09
K-40 Confidence Interval	0.21	0.64	0.22	0.25
K-40 MDA	0.16	0.16	0.13	0.15
Cs-137 Activity	0.16	0.17	0.09	0.11
Cs-137 Confidence Interval	0.03	0.03	0.02	0.02
Cs-137 MDA	0.02	0.02	0.02	0.02
Pb-212 Activity	1.09	0.98	0.42	1.46
Pb-212 Confidence Interval	0.10	0.09	0.05	0.12
Pb-212 MDA	0.04	0.04	0.03	0.05
Pb-214 Activity	0.75	0.73	0.40	1.15
Pb-214 Confidence Interval	0.06	0.06	0.04	0.08
Pb-214 MDA	0.05	0.05	0.04	0.05
Ra-226 Activity	1.45	1.23	<MDA	2.43
Ra-226 Confidence Interval	0.49	0.47	NA	0.66
Ra-226 MDA	0.52	0.55	0.42	0.58
Ac-228 Confidence Interval	0.10	0.09	0.06	0.10
Ac-228 MDA	0.07	0.07	0.05	0.07

Note: Units are in pCi/g.
There were no detections in any 2011 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SS ALN 11	SS BWL05 11	SS WIL 11
Collection Date	6/21/2011	6/23/2011	6/23/2011
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	13.6	13.30	13.10
Beta Activity	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA
Beta LLD	11.1	10.90	10.80
K-40 Activity	2.40	2.89	0.53
K-40 Confidence Interval	0.35	0.38	0.24
K-40 MDA	0.18	0.16	0.16
Cs-137 Activity	0.12	0.11	0.14
Cs-137 Confidence Interval	0.02	0.03	0.02
Cs-137 MDA	0.02	0.02	0.02
Pb-212 Activity	1.28	1.21	0.81
Pb-212 Confidence Interval	0.12	0.11	0.08
Pb-212 MDA	0.05	0.04	0.04
Pb-214 Activity	1.08	1.09	0.53
Pb-214 Confidence Interval	0.07	0.07	0.05
Pb-214 MDA	0.05	0.05	0.04
Ra-226 Activity	1.80	2.38	0.92
Ra-226 Confidence Interval	0.60	0.62	0.46
Ra-226 MDA	0.59	0.55	0.48
Ac-228 Confidence Interval	0.10	0.10	0.07
Ac-228 MDA	0.07	0.06	0.06

Note: Units are in pCi/g.
There were no detections in any 2011 boat landing surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Beta and Gamma Detections for Public Boat Landing Riverbank Soil Samples

	Fury's Ferry Boat Landing	Stevens Creek Boat Landing	Riverview Park Boat Landing	Jackson Boat Landing
Location Description	**SS FF 11**	**SS SC 11**	**SS RVP 11**	**SS JBL 11**
Collection Date	**8/11/2011**	**8/11/2011**	**8/11/2011**	**8/9/2011**
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A	N/A
Alpha LLD	13.3	13.6	14.1	13.6
Beta Activity	<LLD	14.20	<LLD	<LLD
Beta Confidence Interval	N/A	6.61	N/A	N/A
Beta LLD	8.65	8.80	9.05	8.81
K-40 Activity	2.118	6.081	0.585	0.480
K-40 Confidence Interval	0.271	0.540	0.277	0.181
K-40 MDA	0.128	0.191	0.165	0.090
Cs-137 Activity	<MDA	<MDA	0.125	0.074
Cs-137 Confidence Interval	NA	NA	0.027	0.017
Cs-137 MDA	0.020	0.031	0.022	0.016
Pb-212 Activity	1.162	1.990	1.077	0.429
Pb-212 Confidence Interval	0.108	0.178	0.105	0.048
Pb-212 MDA	0.044	0.060	0.050	0.034
Pb-214 Activity	0.872	1.891	0.907	0.457
Pb-214 Confidence Interval	0.062	0.109	0.065	0.041
Pb-214 MDA	0.046	0.063	0.052	0.034
Ra-226 Activity	2.240	3.377	1.899	1.032
Ra-226 Confidence Interval	0.625	0.771	0.677	0.425
Ra-226 MDA	0.544	0.784	0.632	0.413
Ac-228 Activity	1.190	2.010	1.088	0.416
Ac-228 Confidence Interval	0.084	0.130	0.089	0.049
Ac-228 MDA	0.068	0.093	0.068	0.048

Note: Units are in pCi/g.
There were no detections in any 2011 boat landing surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Beta and Gamma Detections for Public Boat Landing Riverbank Soil Samples

	Steel Creek Boat Landing	Little Hell Boat Landing	Johnson's Boat Landing
Location Description	**SS SCBL 11**	**SS LHL 11**	**SS JL 11**
Collection Date	**3/17/2011**	**8/9/2011**	**8/9/2011**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A
Alpha LLD	13.3	13.6	13.9
Beta Activity	13.10	15.8	24.70
Beta Confidence Interval	6.46	6.71	7.46
Beta LLD	8.66	8.79	8.96
K-40 Activity	9.034	6.850	15.750
K-40 Confidence Interval	0.662	0.563	1.077
K-40 MDA	0.127	0.153	0.150
Cs-137 Activity	0.626	8.631	1.500
Cs-137 Confidence Interval	0.059	0.683	0.126
Cs-137 MDA	0.019	0.026	0.024
Pb-212 Activity	0.711	1.191	1.230
Pb-212 Confidence Interval	0.073	0.112	0.118
Pb-212 MDA	0.043	0.067	0.055
Pb-214 Activity	0.973	1.410	1.265
Pb-214 Confidence Interval	0.061	0.096	0.076
Pb-214 MDA	0.046	0.076	0.058
Ra-226 Activity	1.569	3.746	2.127
Ra-226 Confidence Interval	0.476	0.831	0.693
Ra-226 MDA	0.540	0.828	0.687
Ac-228 Activity	0.722	1.348	1.358
Ac-228 Confidence Interval	0.070	0.103	0.103
Ac-228 MDA	0.061	0.071	0.085

Note: Units are in pCi/g.
There were no detections in any 2011 boat landing surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Beta and Gamma Detections for Public Boat Landing Riverbank Soil Samples

	Burton's Ferry Boat Landing	Cohen's Bluff Boat Landing	Stokes Bluff Boat Landing
Location Description	**SS BFL 11**	**SS CB 11**	**SS SBL 11**
Collection Date	**3/17/2011**	**9/8/2011**	**9/8/2011**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A
Alpha LLD	13.7	13.9	13.4
Beta Activity	35.20	21.12	20.50
Beta Confidence Interval	8.16	7.26	7.00
Beta LLD	8.84	8.96	8.69
K-40 Activity	19.040	14.750	11.580
K-40 Confidence Interval	1.317	1.016	0.845
K-40 MDA	0.223	0.156	0.161
Cs-137 Activity	0.294	2.906	2.111
Cs-137 Confidence Interval	0.039	0.235	0.175
Cs-137 MDA	0.029	0.024	0.026
Pb-212 Activity	1.657	1.145	1.618
Pb-212 Confidence Interval	0.153	0.110	0.148
Pb-212 MDA	0.066	0.055	0.059
Pb-214 Activity	2.214	1.148	1.163
Pb-214 Confidence Interval	0.116	0.078	0.084
Pb-214 MDA	0.069	0.060	0.061
Ra-226 Activity	4.108	2.578	2.866
Ra-226 Confidence Interval	0.964	0.665	0.792
Ra-226 MDA	0.833	0.700	0.747
Ac-228 Activity	1.461	1.155	1.627
Ac-228 Confidence Interval	0.116	0.117	0.113
Ac-228 MDA	0.102	0.082	0.084

Note: Units are in pCi/g.
There were no detections in any 2011 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Alpha, Beta and Gamma Detections for Random Background "B" (>50 miles) Surface Soil Samples

Location Description	SSB71	SSB67	SSB39
Collection Date	10/6/2011	10/11/2011	11/9/2011
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	12.80	12.70	12.50
Beta Activity	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA
Beta LLD	10.60	10.60	10.40
K-40 Activity	1.97	3.75	2.10
K-40 Confidence Interval	0.33	0.43	0.34
K-40 MDA	0.16	0.17	0.17
Pb-212 Activity	1.01	1.33	1.07
Pb-212 Confidence Interval	0.09	0.12	0.10
Pb-212 MDA	0.04	0.05	0.04
Cs-137 Activity	<MDA	0.09	<MDA
Cs-137 Confidence Interval	NA	0.02	NA
Cs-137 MDA	0.02	0.03	0.02
Pb-214 Activity	0.81	1.19	0.86
Pb-214 Confidence Interval	0.06	0.08	0.07
Pb-214 MDA	0.04	0.05	0.05
Ra-226 Activity	1.63	2.69	2.02
Ra-226 Confidence Interval	0.57	0.62	0.54
Ra-226 MDA	0.51	0.59	0.58
Ac-228 Activity	1.11	1.37	1.13
Ac-228 Confidence Interval	0.08	0.10	0.09
Ac-228 MDA	0.06	0.07	0.08

Note: Units are in pCi/g.
There were no detections in any 2011 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Alpha, Beta and Gamma Detections for Random Background (>50 miles) Surface Soil

Location Description	SSB76	SSB36	SSB30
Collection Date	11/22/2011	12/2/2011	12/7/2011
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	12.90	12.40	12.40
Beta Activity	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA
Beta LLD	10.70	10.40	10.30
K-40 Activity	7.35	<MDA	<MDA
K-40 Confidence Interval	0.68	NA	NA
K-40 MDA	0.23	0.13	0.14
Pb-212 Activity	1.40	0.54	0.83
Pb-212 Confidence Interval	0.14	0.06	0.08
Pb-212 MDA	0.07	0.04	0.04
Cs-137 Activity	9.24	0.10	0.06
Cs-137 Confidence Interval	0.61	0.02	0.02
Cs-137 MDA	0.03	0.02	0.02
Pb-214 Activity	1.48	0.45	0.58
Pb-214 Confidence Interval	0.10	0.05	0.06
Pb-214 MDA	0.09	0.04	0.04
Ra-226 Activity	2.13	1.02	<MDA
Ra-226 Confidence Interval	0.89	0.49	NA
Ra-226 MDA	0.96	0.46	0.54
Ac-228 Activity	1.44	0.52	0.91
Ac-228 Confidence Interval	0.12	0.06	0.08
Ac-228 MDA	0.09	0.06	0.07

Note: Units are in pCi/g.
There were no detections in any 2011 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2011 Metal Detections in Nonrandom SRS Perimeter Samples

Location Description	SS AIK03 11	SS SNL 11	SS BWL02 11	SS DKH 11	SS AIK04 11
Collection Date	2/23/2011	2/23/2011	2/23/2011	2/23/2011	2/23/2011
Barium in Soil	**6.5**	**27**	**14**	**13**	**16**
Beryllium in Soil	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium in Soil	<1.0	**2.6**	<1.0	<1.0	<1.0
Chromium in Soil	**4.1**	**9.4**	**2.5**	**2.8**	**5.4**
Copper in Soil	<1.0	**3.1**	<1.0	**1.6**	**2.1**
Mercury in Soil	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese in Soil	**11**	**26**	**50**	**25**	**21**
Nickel in Soil	<2.0	<2.0	<2.0	<2.0	<2.0
Lead in Soil	<5.0	**9.5**	<5.0	<5.0	**5.5**
Zinc in Soil	**3.4**	**14**	**3.7**	**7.1**	**7.3**

Location Description	SS BWL 11	SS NEL 11	SS AIK 11	SS GP 11	SS AIK02 11
Collection Date	2/23/2011	2/8/2011	2/8/2011	2/8/2011	2/8/2011
Barium in Soil	**11**	**32**	**6.6**	**5.7**	**18**
Beryllium in Soil	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium in Soil	<1.0	<1.0	<1.0	<1.0	**1.8**
Chromium in Soil	**1.9**	**4.5**	**1.2**	**12**	**8.6**
Copper in Soil	**1.1**	**2.6**	<1.0	1.4	4.6
Mercury in Soil	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese in Soil	**53**	**100**	**10**	**20**	73
Nickel in Soil	<2.0	<2.0	<2.0	<2.0	<2.0
Lead in Soil	<0.10	**7.5**	<5.0	<5.0	<5.0
Zinc in Soil	**3.5**	**11**	**2.6**	**4.5**	**9.8**

Location Description	SS JAK 11	SS JAK02 11	SS BWL03 11	SS BWL04 11	SS ALG 11
Collection Date	2/8/2011	2/8/2011	4/7/2011	4/7/2011	4/7/2011
Barium in Soil	**29**	**18**	**13**	**50**	**15**
Beryllium in Soil	<0.30	<0.30	<0.30	**0.32**	<0.30
Cadmium in Soil	<1.0	<1.0	<1.0	<1.0	<1.0
Chromium in Soil	**2.5**	**4.6**	**2.9**	**4.2**	**2.7**
Copper in Soil	1.9	2.2	1.2	1.5	1.3
Mercury in Soil	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese in Soil	**190**	**120**	**41**	190	**76**
Nickel in Soil	<2.0	<2.0	<2.0	<2.0	<2.0
Lead in Soil	<5.0	<5.0	<5.0	11	<5.0
Zinc in Soil	**4.6**	**27**	**5.2**	10	**10**

Note: Units are in mg/kg.

Surface Soil Monitoring Adjacent to SRS

2011 Metal Detections in Nonrandom SRS Perimeter Samples

Location Description	SS ALN 11	SS ALD 11	SS WIL 11	SS BWL05 11
Collection Date	**6/21/2011**	**6/21/2011**	**6/23/2011**	**6/23/2011**
Barium in Soil	**28**	**11**	**15**	**30**
Beryllium in Soil	<0.30	<0.30	<0.30	<0.30
Cadmium in Soil	<1.0	<1.0	<1.0	<1.0
Chromium in Soil	**4.6**	**3.8**	**3.1**	**3.9**
Copper in Soil	1.6	1.4	1.4	1.6
Mercury in Soil	<0.10	<0.10	<0.10	<0.10
Manganese in Soil	**120**	32	**61**	51
Nickel in Soil	<2.0	<2.0	<2.0	<2.0
Lead in Soil	7.7	9.7	5.1	9.3
Zinc in Soil	12	12	7.6	13

Note: Units are in mg/kg.

Surface Soil Monitoring Adjacent to SRS

2011 Metal Detections in Publicly Accessible Boat Landings

Location Description	SS CB 11	SS CB 11	SS JBL 11	SS LHL 11	SS JL 11
Collection Date	**9/8/2011**	**9/8/2011**	**8/9/2011**	**8/9/2011**	**8/9/2011**
Barium in Soil	**80**	**67**	**7.2**	**69**	**52**
Beryllium in Soil	**0.47**	<0.30	<0.30	**0.35**	<0.30
Cadmium in Soil	**1.7**	**1.2**	<1.0	**1.4**	<1.0
Chromium in Soil	**36**	**27**	**1.8**	**13**	**16**
Copper in Soil	**9.9**	**8.1**	<1.0	**14**	**5.4**
Mercury in Soil	**0.31**	**0.29**	<0.10	<0.10	<0.10
Manganese in Soil	**620**	**620**	**7.3**	**190**	**120**
Nickel in Soil	**5.4**	**4.4**	<2.0	**2.3**	**3.5**
Lead in Soil	**11**	**9.5**	<5.0	**32**	**12**
Zinc in Soil	**45**	**36**	**2.5**	**35**	**26**

Location Description	SS SCL 11	SS BFL 11	SS FF 11	SS SC 11	SS RVP 11
Collection Date	**10/3/2011**	**10/3/2011**	**8/11/2011**	**8/11/2011**	**8/11/2011**
Barium in Soil	**33**	**26**	**17**	**47**	<5.0
Beryllium in Soil	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium in Soil	<1.0	<1.0	<1.0	**2.4**	<1.0
Chromium in Soil	**5.5**	**4.2**	**6.9**	**18**	**3.2**
Copper in Soil	**1.8**	**2.1**	1.7	**4.6**	**2.1**
Mercury in Soil	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese in Soil	**280**	**230**	**42**	**14**	**17**
Nickel in Soil	<2.0	<2.0	<2.0	<2.0	<2.0
Lead in Soil	<5.0	<5.0	<5.0	**12**	<5.0
Zinc in Soil	**14**	**10**	**6.1**	**12**	**7.1**

Note: Units are in mg/kg.

7.0 Summary Statistics

Surface Soil Monitoring Adjacent to SRS

2011 NONRADIOLOGICAL (METALS) STATISTICS 33
2011 RADIOLOGICAL STATISTICS 34

Notes:
1. N/A = Not Applicable
2. SD = Standard Deviation

Surface Soil Monitoring Adjacent to SRS

2011 Summary Statistics – SCDHEC Surface Soil Metals Data
Nonrandom Perimeter Samples

Analyte	AVG:	SD	Median	Minimum	Maximum	Total Number Sampled	Detections
Cadmium	2.20	0.57	2.20	1.80	2.60	19	2
Chromium	4.46	2.74	3.90	1.20	12.00	19	19
Copper	1.91	0.90	1.60	1.10	4.60	19	16
Mercury	N/A	N/A	N/A	N/A	N/A	19	0
Manganese	66.8	54.7	51.0	10.0	190.0	19	19
Nickel	N/A	N/A	N/A	N/A	N/A	19	0
Lead	8.16	2.09	8.50	5.10	11.00	19	8
Zinc	8.86	5.69	7.60	2.60	27.00	19	19

Note: Units are in mg/kg.

2011 Summary Statistics – SCDHEC Surface Soil Radiological Data
Public Boat Landings

Analyte	AVG:	SD	Median	Minimum	Maximum	Total Number Sampled	Detections
Cadmium	1.7	0.5	1.6	1.2	2.4	10	4
Chromium	13.2	11.3	10.0	1.8	36.0	10	10
Copper	5.5	4.3	4.6	1.7	14.0	10	9
Mercury	0.30	0.01	0.30	0.29	0.31	10	2
Manganese	214	234	155	7	620	10	10
Nickel	3.9	1.3	4.0	2.3	5.4	10	4
Lead	15.3	9.4	12.0	9.5	32.0	10	5
Zinc	19.4	14.9	13.0	2.5	45.0	10	10

Note: Units are in mg/kg.

Surface Soil Monitoring Adjacent to SRS

2011 Summary Statistics – SCDHEC Surface Soil Radiological Data
Nonrandom Perimeter Samples

Analyte	AVG:	SD	Median	Minimum	Maximum	Total Number Sampled	Detections
Alpha	N/A	N/A	N/A	N/A	N/A	19	0
Beta	11.19	1.55	11.4	9.25	14.2	19	7
K-40	1.32	1.65	0.64	0.41	7.5	19	19
Cs-137	0.11	0.04	0.12	0.05	0.17	19	18
Pb-212	0.92	0.3	0.95	0.4	1.46	19	19
Pb-214	0.72	0.23	0.73	0.38	1.15	19	19
Ra-226	1.53	0.44	1.49	0.82	2.43	19	17
Ac-228	0.94	0.32	0.96	0.37	1.41	19	19

Note: Units are in pCi/g.

2011 Summary Statistics – SCDHEC Surface Soil Radiological Data
Public Boat Landings

Analyte	AVG:	SD	Median	Minimum	Maximum	Total Number Sampled	Detections
Alpha	N/A	N/A	N/A	N/A	N/A	10	0
Beta	20.66	7.64	20.5	13.1	35.2	10	7
K-40	8.63	6.57	7.94	0.48	19.04	10	10
Cs-137	2.03	2.86	1.06	0.07	8.63	10	8
Pb-212	1.22	0.45	1.18	0.43	1.99	10	10
Pb-214	1.23	0.51	1.16	0.46	2.21	10	10
Ra-226	2.55	0.98	2.41	1.03	4.11	10	10
Ac-228	1.24	0.45	1.27	0.42	2.01	10	10

Note: Units are in pCi/g.

2011 Summary Statistics – SCDHEC Surface Soil Radiological Data
Background "B" Samples

Analyte	AVG:	SD	Median	Minimum	Maximum	Total Number Sampled	Detections
Alpha	N/A	N/A	N/A	N/A	N/A	6	0
Beta	N/A	N/A	N/A	N/A	N/A	6	3
K-40	3.79	2.51	2.92	1.97	7.35	6	4
Cs-137	2.37	4.58	0.09	0.06	9.24	6	4
Pb-212	1.03	0.32	1.04	0.54	1.4	6	6
Pb-214	0.9	0.38	0.84	0.45	1.48	6	6
Ra-226	1.9	0.62	2.02	1.02	2.69	6	5
Ac-228	1.08	0.34	1.12	0.52	1.44	6	6

Note: Units are in pCi/g.

LIST OF ACRONYMS

DOE-SR	Department of Energy – Savannah River
ESOP	Environmental Surveillance and Oversight Program
LLD	Lower Limit of Detection
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MDL	Minimum Detection Level
NORM	Naturally Occurring Radioactive Material
PRG	Preliminary Remediation Goals
RSL	Regional Screening Level
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
SRNS	Savannah River Nuclear Solutions
SS	Surface Soil
SSL	Soil Screening Level
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

UNITS OF MEASURE

mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
±	Plus or minus. Refers to one standard deviation unless otherwise stated

REFERENCES

Absalom, J.P.; Young, S.D.; Crout N.M.J.; Sanchez A.; Wright, S.M.; Smolders, E.; Nisbet, A.F. and Gillett A.G. 2001. Predicting the Transfer of Radiocaesium from Organic Soils to Plants Using Soil Characteristics. Journal of Environment Radioactivity, vol. 52, no. 1, p. 31-43.

Alloway, B.J., 1995. Heavy Metals in Soils. Great Britain, St Edmundsbury Press, Suffolk.

Canova, J.L., 1999. Elements in South Carolina Inferred Background Soil and Stream Sediment Samples. South Carolina Geology, 1999, v.41, p.11-25.

Centers for Disease Control (CDC). 2006. Phase III of the SRS dose reconstruction project. Available from URL http://www.cdc.gov/nceh/radiation/Savannah/docs/TOCs.pdf

Corey, J.C. 1980. Transport of Radionuclides Through Soil and Groundwater. E. I. DuPont de Nemours and Company, Savannah River Plant, Aiken, SCDP-MS-80-95.

Savannah River Nuclear Solutions, LLC (SRNS). 2011. Savannah River Site Environmental Report for 2010. Savannah River Site Aiken, SC. SRNS–STI–2011–00059.

Savannah River Nuclear Solutions, LLC (SRNS). 2012. Savannah River Site Environmental Report for 2011. Savannah River Site, Aiken, South Carolina. SRNS-STI-2012-00200

SCDHEC. 2005. South Carolina Department of Health and Environmental Control 2004 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2006. South Carolina Department of Health and Environmental Control 2005 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2007. South Carolina Department of Health and Environmental Control 2006 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2008. South Carolina Department of Health and Environmental Control 2007 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2009. South Carolina Department of Health and Environmental Control 2008 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2010. South Carolina Department of Health and Environmental Control 2009 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2011. South Carolina Department of Health and Environmental Control 2010 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

Till, J.E., et al. 2001. Savannah River Site Environmental Dose Reconstruction Project, Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval, Evaluation of Materials Released From the Savannah River Site. RAC Report No. 1-CDC-SRS-1999-Final. Risk Assessment Corporation (RAC).

United States Department of Interior (USDOI). 1992. 7.5 Minute Topographic Geologic Survey Map of South Carolina. South Carolina Land Resources Commission RV 10/92

USEPA. 2009. Preliminary Remediation Goals for Radionuclides. http://epa-prgs.ornl.gov/radionuclides/download/res_soil_rad_prg_august_2010.xls

USEPA. 2010. Regional Screening Levels for Chemical Contaminants. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

Westinghouse Savannah River Company (WSRC). 1993. Final Record of Decision Remedial Alternative Selection for H-Area Hazardous Waste Management Facility. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-RP-93-1043.

WSRC. 2003. Radiological False Positives in Environmental Soil and Groundwater Data From Commercial Laboratories. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-MS-2003-00565.

WSRC. 2004. Savannah River Site Environmental Report for 2003. Environmental Monitoring & Analysis, Environmental Services Section, Westinghouse Savannah River Company, Aiken, SC. WSRC-TR-2004-00015.

WSRC. 2005a. Scoping Summary for the Savannah River and Floodplain Swamp Integrator Operable Unit. Westinghouse Savannah River Company, Aiken, SC. ERD-EN-2205-0163.

WSRC. 2005b. Ecological Screening Values for Surface Water, Sediment, and Soil: 2005 Update, Friday, G.P., Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina.WSRC-TR-2004-00227.

WSRC. 2005c. Savannah River Site Environmental Report for 2004. Environmental Monitoring & Analysis, Environmental Services Section, Westinghouse Savannah River Company, Aiken, SC. WSRC-TR-2005-00005.

WSRC. 2006. Savannah River Site Environmental Report for 2005. Washington Savannah River Company, Savannah River Site, Aiken, SC. WSRC-TR-2006-00007

WSRC. 2007. Savannah River Site Environmental Report for 2006. Washington Savannah River Company, Savannah River Site, Aiken, SC. WSRC-TR-2007-00008.

WSRC. 2008. Savannah River Site Environmental Report for 2007. Washington

This Page Intentionally Left Blank

2011 Radiological Monitoring of Terrestrial Vegetation Related to the Savannah River Site

Environmental Surveillance and Oversight Program

97VG003
Greg Mason, Project Manager
January 01, 2011 – December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street, N.E.,
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY....1

2.0 RESULTS AND DISCUSSION....1
TRITIUM IN VEGETATION....1
GAMMA IN VEGETATION....3

3.0 CONCLUSIONS AND RECOMMENDATIONS....4

4.0 MAP....5

5.0 TABLES AND FIGURES....6

6.0 DATA....10
2011 TRITIUM IN VEGETATION....11
2011 GAMMA IN VEGETATION....16

7.0 SUMMARY STATISTICS....24
2011 TRITIUM IN VEGETATION....25
2011 CESIUM-137 IN VEGETATION....26

LIST OF ACRONYMS AND UNITS OF MEASURE....27

REFERENCES....28

1.0 PROJECT SUMMARY

Terrestrial vegetation can be contaminated externally by direct deposition of airborne materials, water runoff, and precipitation that contains radioactivity. Vegetation can also be contaminated internally by uptake of radionuclides through the roots. Contaminated vegetation can be transported by physical means and, if eaten by animals, this radioactivity can enter the food chain.

The Department of Energy-Savannah River (DOE-SR) contracts for the collection and analysis of terrestrial vegetation, primarily Bermuda grass, to determine concentrations of radionuclides (SRNS 2012). The samples are obtained from twelve locations at the Savannah River Site (SRS) perimeter. The Environmental Surveillance and Oversight Program (ESOP) of the South Carolina Department of Health and Environmental Control (SCDHEC) monitors for the presence of radionuclides in vegetation around SRS, collecting leaves from broad-leafed evergreen trees and shrubs, such as wax myrtle (*Myrica cerifera*), laurel oak (*Quercus laurifolia*), or Carolina laurelcherry (*Prunus caroliniana*).

In 2011 ESOP conducted independent vegetation monitoring at 17 locations along the perimeter of SRS as well as three former SRS monitoring locations 25 miles from the center of SRS. Sampling was performed on a quarterly basis with samples obtained in March, June, September, and December. ESOP and DOE-SR perimeter stations sampled in 2011 are shown in Section 4.0.

Samples from 12 of 17 perimeter stations exhibited tritium levels greater than the Lower Limit of Detection (LLD), with the highest activity found on the eastern side of SRS. Vegetation was collected for gamma analysis at nine perimeter locations. Each sample was analyzed for Beryllium-7 (Be-7), Potassium-40 (K-40), Cobalt-60 (Co-60), Cesium-137 (Cs-137), Lead-212 (Pb-212), Lead-214 (Pb-214), and Americium-241 (Am-241). Cs-137 was detected at six of these locations, with the highest activities from stations on the northern side of SRS. Overall, both Cs-137 and tritium have decreased from last year.

In addition to routine sampling, six vegetation samples were obtained as part of the ongoing SCDHEC background study: three from within 50 miles of the SRS centerpoint and three from greater than 50 miles from the SRS centerpoint. All of the samples were analyzed for tritium as well as gamma-emitting radionuclides.

Tables and figures depicting average sample results as well as comparisons with SRS data are in Section 5.0. Sample results for Cs-137 and tritium are given in Section 6.0; summary statistics are in Section 7.0.

2.0 RESULTS AND DISCUSSION

Tritium in Vegetation

Tritium is a naturally occurring radioisotope of hydrogen that is normally found in very low concentrations (USEPA 2012). Sources of man-made tritium include nuclear reactors and government weapons production plants. Tritium releases on SRS include both atmospheric and liquid contributions (SRNS 2012). Although the United States Environmental Protection Agency (USEPA) has not established a Maximum Contaminant Level (MCL) for tritium in solid media (e.g. vegetation), the MCL for drinking water has been set at 20,000 picocuries per liter (pCi/L; USEPA 2009).

Tritium was detected in vegetation from 12 of the 17 perimeter sites sampled in 2011. The highest tritium levels detected during 2011 for each quarter were:

- Quarter 1 (March): AKN-007 at 853 pCi/L (Carolina laurel cherry)
- Quarter 2 (June): AKN-007 at 563 pCi/L (Carolina laurel cherry)
- Quarter 3 (September): AKN-004 at 363 pCi/L (wax myrtle)
- Quarter 4 (December): AKN-008 at 2654 pCi/L (wax myrtle)

There were two tritium detections at 25-mile stations; a 727 pCi/L detection at AKN-251 in March and a 239 pCi/L at ORG-251 in June.

The highest tritium detection in 2011 was from AKN-008, located on the north-northwest side of SRS. AKN-004 and AKN-007 are on the northwest and northeast sides of SRS, respectively (Figures 1 and 2). Samples were also collected at three stations located 25 miles from the SRS centerpoint. The highest detection was at AKN-251, which is located northwest of SRS in Langley, S.C.

Tritium analysis results from SCDHEC and DOE-SR sampling are presented in Section 5.0, Table 1. However, differences between the two programs in sampling dates, the vegetation sampled, and analysis methods should be considered during comparison. Data comparison of associated locations from the two programs was conducted by converting from picocuries per gram (pCi/g) to picocuries per liter (pCi/L), using a dry/wet weight ratio of 0.3 furnished by DOE-SR, using the formula:

$$pCi/L = [pCi/g \times (1/0.3)] / (1 - 0.3) \times 1g/mL \times 1000mL/L.$$

Two colocations (i.e. sample locations in relatively close proximity in space and time) are relevant to this report: the Patterson Mill Road and Allendale Gate locations. The Patterson Mill Road DOE-SR sample showed a tritium activity level of 490 pCi/L while the corresponding ESOP sample, BWL-004, was less than LLD. Colocated samples at the Allendale Gate each showed tritium activity less than LLD (<Minimum Detectable Concentration (MDC) for the DOE-SR sample; SRNS 2012).

The DOE-SR program detected tritium from four perimeter stations that had comparable ESOP locations in 2011 (SRNS 2012); ESOP detected tritium at two comparable locations. The DOE-SR average, 371 (± 171) pCi/L, was within one standard deviation of the ESOP average, 306 (± 52) pCi/L. All measures of central tendency and standard deviation were calculated using detections only. It should also be noted that temporal proximity was also taken into account when ESOP samples were “matched” to DOE-SR samples.

Gamma in Vegetation

The naturally occurring isotopes potassium-40 (K-40) and beryllium-7 (Be-7) were detected from all stations where gamma samples were collected in 2011. The lead (Pb) isotopes Pb-212 and Pb-214 were also detected, but not from all locations. Because these are naturally occurring isotopes the results will not be discussed in this section, but are presented in Section 6.0.

The man-made isotopes Cobalt-60 (Co-60) and Americium-241 (Am-241) were not detected during 2011; Cesium-137 (Cs-137), however, was detected at multiple locations. Cesium-137 is a man-made fission product and was a constituent of air and water releases on SRS, mainly from F and H-Areas. Liquid releases also occurred from the production reactors as a result of leaking fuel elements in the 1950s and 1960s (WSRC 1999).

Cesium-137 was detected at six of the nine perimeter stations sampled in 2011, and three of these stations produced Cs-137 results greater than the Minimum Detectable Activity (MDA) in all four quarters (Section 6.0). AKN-005 exhibited the highest Cs-137 activity in all four quarters: 0.28 pCi/g in March, 0.70 pCi/g in June, 0.40 pCi/g in September, and 0.46 pCi/g in December. AKN-005 is located off Highway 278 on the north end of SRS.

Results of analysis for Cs-137 at AKN-003, AKN-006, AKN-008, ALD-001, and BWL-006 followed what appear to be downward trends in 2011 (Figure 3). Averages for AKN-001 and BWL-004 showed no change in activity from 2010; AKN-002 and AKN-005 both showed activity increases for 2011. The overall average for Cs-137 activity appears to have resumed a downward trajectory that was interrupted by a slight rise in 2010.

Gamma analysis results for Cs-137 from ESOP and DOE-SR sampling in 2011 are presented in Section 5.0, Table 2. The Patterson Mill Road/BWL-004 colocations showed dissimilar results: less than MDC for the DOE-SR sample and 0.05 (± 0.02) pCi/g for the ESOP sample. The Allendale Gate/BWL-006 colocations each had detections, with the DOE-SR sample showing 0.61 (±0.07) pCi/g and the ESOP sample showing 0.28 (±0.03) pCi/g (SRNS 2012). Differences in analysis, sampling methods, and the dates samples were obtained may account for any discrepancies between the data.

For the other DOE-SR stations, the closest ESOP stations were selected for comparison, except for the DOE-SR Highway 21/167 detection of 0.55 (±0.06) pCi/g (SRNS 2012). This gamma sampling location does not have a corresponding ESOP sampling location and any attempted comparison would be invalid. For this reason, it was not used for calculating the DOE-SR mean, median, and standard deviation and is also not shown in Table 2.

DOE-SR detected Cs-137 at 5 of 11 sampling stations that had a comparable ESOP location or colocation. ESOP had detections at 5 of 11 comparable locations, although some ESOP locations correspond with more than one DOE-SR location. There was an additional Cs-137 detection at ALD-001. However, DOE-SR does not have a sampling location nearby so no comparison can be made.

Average Cs-137 levels at the Table 2 locations were also compared, using only detections to calculate the mean, median, and standard deviation. The DOE-SR average of 0.39 pCi/g (±0.17; SRNS 2012) was within two standard deviations of the ESOP average of 0.19 pCi/g (±0.15). Taken in total, the DOE-SR and ESOP data are similar.

3.0 CONCLUSIONS AND RECOMMENDATIONS

ESOP conducted independent vegetation monitoring in 2011 at 17 locations around the perimeter of SRS and three locations 25 miles from the center of SRS. Tritium was detected in vegetation from 12 of 17 of the perimeter stations and two of the 25-mile stations. The highest activity sample was collected on the north-northwest side of SRS. ESOP data supports the DOE-SR conclusion that elevated tritium levels at the site perimeter are due to atmospheric releases from SRS, although Plant Vogtle, a commercial nuclear power plant across the Savannah River from SRS, may also have an effect. Tritium levels decrease with increasing distance from SRS facilities.

A comparison of ESOP and DOE-SR tritium data was performed. Tritium was detected at one of two collocations by DOE-SR (Patterson Mill Road) and at neither location by ESOP (SRNS 2012). At the SRS perimeter locations, DOE-SR had detections in four samples while ESOP had detections in two. While the DOE-SR and ESOP tritium data sets appear to be dissimilar, both the mean and median are within one standard deviation of each other.

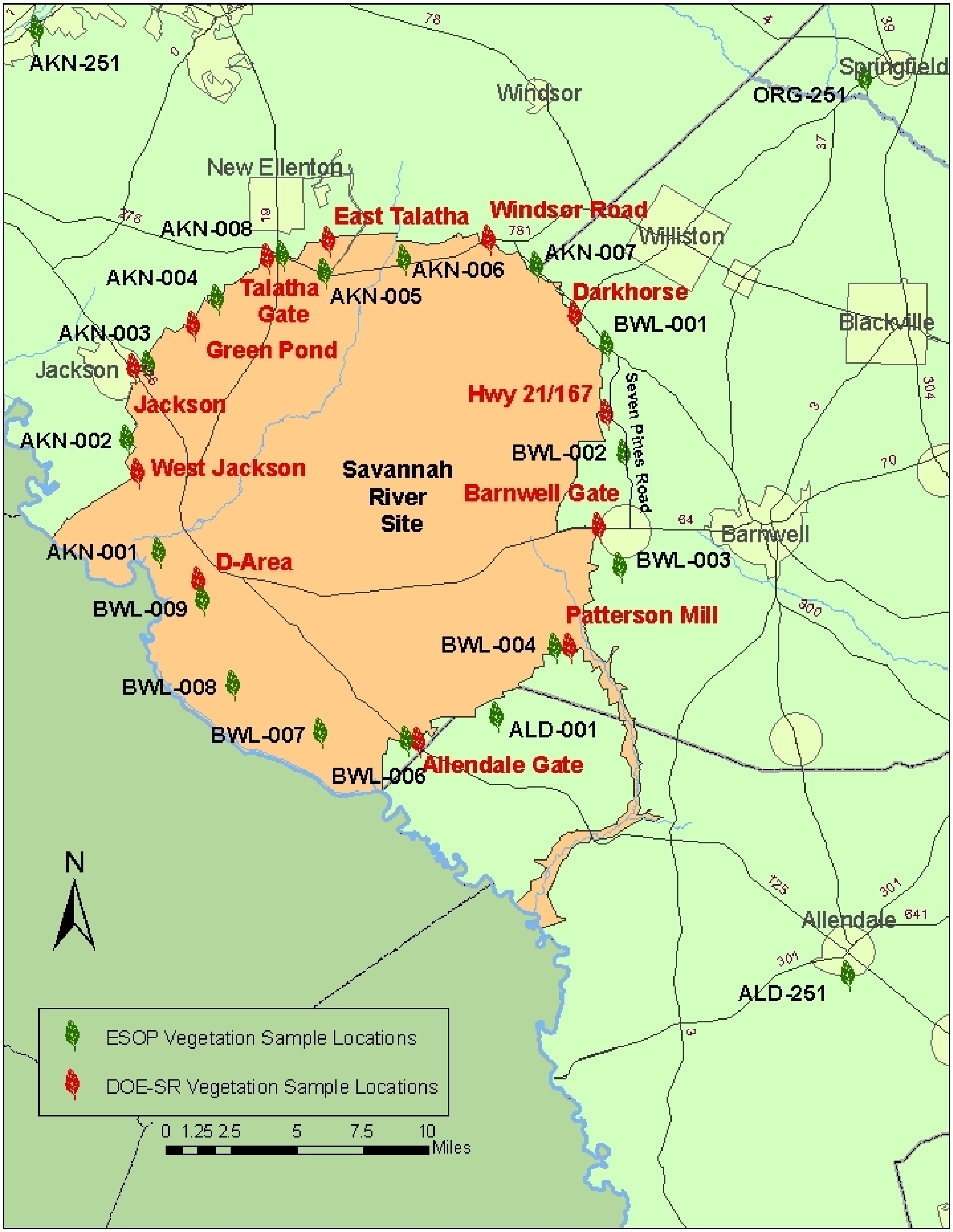
There are differences in analysis and sampling methods between the programs (e.g., ESOP collects leaves from trees, whereas DOE-SR conducts annual grass collections). Perhaps reconciling ESOP and DOE-SR methods would provide better comparability of data. Additionally, DOE-SR data are reported in pCi/g without denoting whether this activity relates to a gram of water or a gram of wet vegetation. ESOP recommends that DOE-SR report tritium activity in a different manner, such as picocuries per milliliter as in previous reports, to reflect the tritium activity in the water extracted from the sample.

A comparison of DOE-SR data and ESOP Cs-137 data was also performed. DOE-SR and ESOP data were similar, within two standard deviations of each other. ESOP data shows a decrease in average tritium activity from 2010. Seven ESOP locations showed either decreasing or static activity while two showed increasing activity.

It is unclear why these sites have higher cesium levels, as they are not located near SRS facilities, or in areas known to be affected by past releases. A review of the deposition plume from the 1955 Teapot Hornet test (Till et al. 2001) showed the highest radiation levels were not associated with the areas where ESOP finds the highest Cs-137 levels in vegetation.

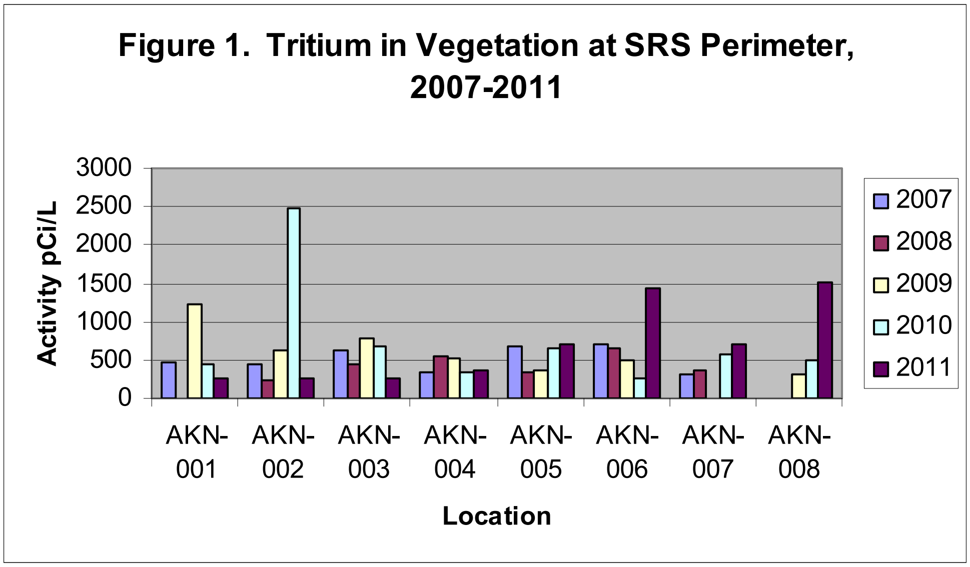
4.0 Radiological Monitoring of Terrestrial Vegetation

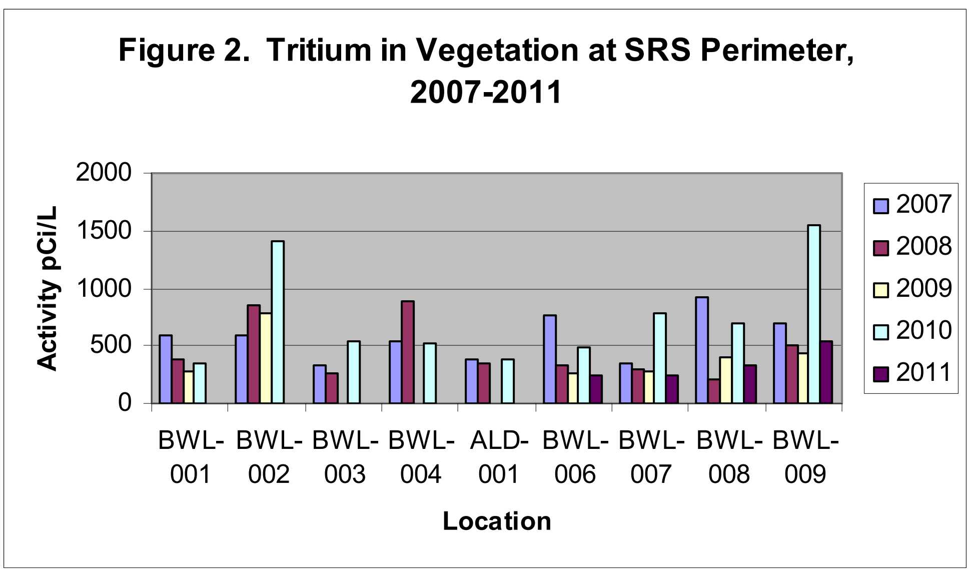
Map 1. ESOP and DOE-SR Radiological Vegetation Sampling Locations, 2011



5.0 Tables and Figures

Radiological Monitoring of Terrestrial Vegetation

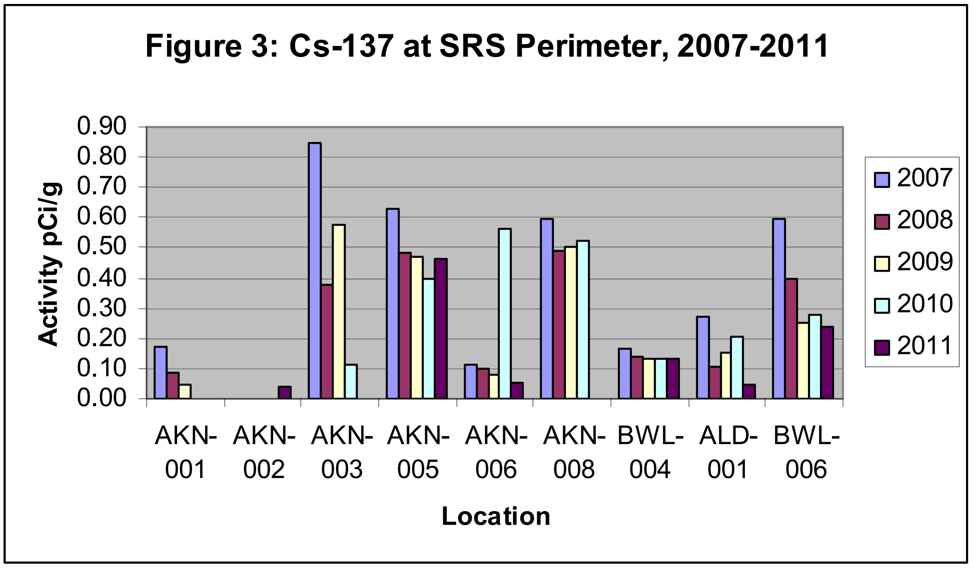




Notes:
(1) These graphs depict the average of all detections for calendar years 2007-2011 by sampling station.
(2) 2009 was the first year AKN-008 was sampled for tritium.
(3) Missing bars indicate an average that was less than the lower limit of detection.
(4) The bars for AKN-002, 003, and 004 as well as BWL-006, 007, and 008 represent a single detection.

Tables and Figures

Radiological Monitoring of Terrestrial Vegetation



Notes:
(1) This graph depicts the average of all detections for calendar years 2007-2011 by sampling station.
(2) Missing bars indicate an average that was less than the minimum detectable activity.

Tables and Figures

Radiological Monitoring of Terrestrial Vegetation

Table 1. Comparison of Tritium Analyses, DOE-SR and ESOP Data, 2011

DOE-SR Data					ESOP Data			
Station	Date	pCi/g	+/- 1 sig	pCi /L[a]	Station	Date	pCi/L	+/- 2 sig
D-Area	8/4/2011	<MDC	NA	NA	BWL-009 [b]	9/27/2011	<LLD	NA
West Jackson	8/3/2011	<MDC	NA	NA	AKN-002 [b]	9/20/2011	<LLD	NA
Jackson	8/3/2011	<MDC	NA	NA	AKN-003 [b]	9/28/2011	269	99
Green Pond	4/6/2011	0.10	0.02	495	AKN-004 [b]	3/29/2011	<LLD	NA
Talatha Gate	8/3/2011	<MDC	NA	NA	AKN-005 b	9/28/2011	<LLD	NA
East Talatha	8/4/2011	<MDC	NA	NA	AKN-006 [b]	9/28/2011	342	102
Windsor Road	8/4/2011	0.08	0.02	368	AKN-007	9/23/2011	<LLD	NA
Darkhorse	4/6/2011	0.07	0.02	130	BWL-001 [b]	3/21/2011	<LLD	NA
Highway 21/167	8/17/2011	<MDC	NA	NA	BWL-002 [b]	9/23/2011	<LLD	NA
Barnwell Gate	8/17/2011	<MDC	NA	NA	BWL-004 [a]	9/20/2011	<LLD	NA
Patterson Mill Road [c]	4/6/2011	0.10	0.02	490	BWL-004 [c]	3/21/2011	<LLD	NA
Allendale Gate [c]	8/4/2011	<MDC	NA	NA	BWL-006 [c]	9/27/2011	<LLD	NA

DOE-SR		ESOP	
Average	371	**Average**	306
Std Dev	171	**Std Dev**	52
Median	429	**Median**	306

<MDC denotes less than the DOE-SR Minimum Detectable Concentration
< LLD denotes less than reported Lower Limit of Detection
NA denotes Not Applicable
[a] Converted (See Section 5.1) [b] Comparable ESOP location [c] Colocation

Radiological Monitoring of Terrestrial Vegetation

Table 2. Comparison of Cs-137 Analyses, DOE-SR and ESOP Data, 2011

DOE-SR Data				ESOP Data			
Location	**Date**	**pCi/g (dry)**	**+/- 1 sig**	**Station**	**Date**	**pCi/g (fresh)**	**+/- 2 sig**
D-Area	8/4/2011	0.38	0.06	AKN-001[a]	9/27/2011	<MDA	NA
West Jackson	8/3/2011	<MDC	NA	AKN-002 [a]	9/20/2011	<MDA	NA
Jackson	8/3/2011	<MDC	NA	AKN-003 [a]	9/28/2011	<MDA	NA
Green Pond	4/6/2011	0.13	0.04	AKN-003 [a]	3/29/2011	<MDA	NA
Talatha Gate	8/3/2011	<MDC	NA	AKN-008 [a]	9/27/2011	<MDA	NA
East Talatha	8/4/2011	0.46	0.06	AKN-005 [a]	9/28/2011	0.40	0.04
Windsor Road	8/4/2011	<MDC	NA	AKN-006 [a]	9/28/2011	0.04	0.01
Darkhorse	4/6/2011	<MDC	NA	AKN-006 [a]	3/29/2011	<MDA	NA
Barnwell Gate	8/17/2011	0.38	0.06	BWL-004 [a]	9/20/2011	0.20	0.02
Patterson Mill Road [b]	4/6/2011	<MDC	NA	BWL-004 [b]	3/21/2011	0.05	0.02
Allendale Gate [b]	8/4/2011	0.61	0.07	BWL-006 [b]	9/27/2011	0.28	0.03

Average	0.39	**Average**	0.19
Std Dev	0.17	**Std Dev**	0.15
Median	0.38	**Median**	0.20

<MDC denotes less than the WSRC Minimum Detectable Concentration
< LLD denotes less than reported Lower Limit of Detection
[a] Comparable ESOP location [b] Colocation

6.0 Data

Radiological Monitoring of Terrestrial Vegetation

2011 Tritium in Vegetation 11

2011 Gamma in Vegetation 16

Notes:

1. pCi/L - picocuries per liter
2. pCi/g - picocuries per gram
3. LLD - Lower Limit of Detection
4. MDA - Minimum Detectable Activity
5. NA-Not Applicable

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2011 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/23/11	06/17/11	09/27/11	12/16/11
VGAKN-001	Tritium Activity	214	<LLD	306	<LLD
VGAKN-001	Tritium Confidence Interval	94	NA	100	NA
VGAKN-001	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/23/11	06/09/11	09/20/11	12/13/11
VGAKN-002	Tritium Activity	<LLD	<LLD	<LLD	248
VGAKN-002	Tritium Confidence Interval	NA	NA	NA	111
VGAKN-002	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/29/11	06/23/11	09/28/11	12/16/11
VGAKN-003	Tritium Activity	<LLD	<LLD	269	<LLD
VGAKN-003	Tritium Confidence Interval	NA	NA	99	NA
VGAKN-003	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/29/11	06/23/11	09/27/11	12/16/11
VGAKN-004	Tritium Activity	<LLD	<LLD	363	<LLD
VGAKN-004	Tritium Confidence Interval	NA	NA	103	NA
VGAKN-004	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/29/11	06/23/11	09/28/11	12/20/11
VGAKN-005	Tritium Activity	342	<LLD	<LLD	1092
VGAKN-005	Tritium Confidence Interval	99	NA	NA	138
VGAKN-005	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/29/11	06/17/11	09/28/11	12/20/11
VGAKN-006	Tritium Activity	<LLD	<LLD	342	2514
VGAKN-006	Tritium Confidence Interval	NA	NA	102	176
VGAKN-006	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/21/11	06/09/11	09/23/11	12/07/11
VGAKN-007	Tritium Activity	853	563	<LLD	<LLD
VGAKN-007	Tritium Confidence Interval	115	114	NA	NA
VGAKN-007	Tritium LLD	204	229	210	237

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2011 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/29/11	06/23/11	09/27/11	12/20/11
VGAKN-008	Tritium Activity	<LLD	<LLD	361	2654
VGAKN-008	Tritium Confidence Interval	NA	NA	103	179
VGAKN-008	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/21/11	06/09/11	09/23/11	12/07/11
VGBWL-001	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VGBWL-001	Tritium Confidence Interval	NA	NA	NA	NA
VGBWL-001	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/21/11	06/09/11	09/23/11	12/07/11
VGBWL-002	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VGBWL-002	Tritium Confidence Interval	NA	NA	NA	NA
VGBWL-002	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/21/11	06/09/11	09/20/11	12/07/11
VGBWL-003	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VGBWL-003	Tritium Confidence Interval	NA	NA	NA	NA
VGBWL-003	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/21/11	06/09/11	09/20/11	12/13/11
VGBWL-004	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VGBWL-004	Tritium Confidence Interval	NA	NA	NA	NA
VGBWL-004	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/23/11	06/09/11	09/23/11	12/13/11
VGALD-001	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VGALD-001	Tritium Confidence Interval	NA	NA	NA	NA
VGALD-001	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/23/11	06/17/11	09/27/11	12/16/11
VGBWL-006	Tritium Activity	<LLD	241	<LLD	<LLD
VGBWL-006	Tritium Confidence Interval	NA	105	NA	NA
VGBWL-006	Tritium LLD	204	229	210	237

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2011 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/23/11	06/17/11	09/27/11	12/16/11
VGBWL-007	Tritium Activity	<LLD	244	<LLD	<LLD
VGBWL-007	Tritium Confidence Interval	NA	105	NA	NA
VGBWL-007	Tritium LLD	204	229	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/23/11	No Sample	09/27/11	12/16/11
VGBWL-008	Tritium Activity	<LLD	NA	<LLD	337
VGBWL-008	Tritium Confidence Interval	NA	NA	NA	114
VGBWL-008	Tritium LLD	204	NA	210	237

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/23/11	06/17/11	09/27/11	12/16/11
VGBWL-009	Tritium Activity	<LLD	352	<LLD	733
VGBWL-009	Tritium Confidence Interval	NA	100	NA	122
VGBWL-009	Tritium LLD	209	207	210	227

Note: BWL-008 could not be collected in the second quarter, as the sampling location was inaccessible.

Radiological Monitoring of Terrestrial Vegetation Data; 25-Mile Stations
2011 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/21/11	06/09/11	09/20/11	12/07/11
VGAKN-251	Tritium Activity	727	<LLD	<LLD	<LLD
VGAKN-251	Tritium Confidence Interval	113	NA	NA	NA
VGAKN-251	Tritium LLD	209	207	210	227

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/21/11	06/09/11	09/20/11	12/07/11
VGORG-251	Tritium Activity	<LLD	239	<LLD	<LLD
VGORG-251	Tritium Confidence Interval	NA	96	NA	NA
VGORG-251	Tritium LLD	209	207	210	227

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/21/11	06/09/11	09/20/11	12/07/11
VGALD-251	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VGALD-251	Tritium Confidence Interval	NA	NA	NA	NA
VGALD-251	Tritium LLD	209	207	210	227

Radiological Monitoring of Terrestrial Vegetation Data; Background Samples
2011 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result
	Results (pCi/L)	10/25/11
VGBkg POW Rd. Greenwood	Tritium Activity	<LLD
VGBkg POW Rd. Greenwood	Tritium Confidence Interval	N/A
VGBkg POW Rd. Greenwood	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results (pCi/L)	10/25/11
VGBkg Prison Farm Rd. Honea Path	Tritium Activity	<LLD
VGBkg Prison Farm Rd. Honea Path	Tritium Confidence Interval	N/A
VGBkg Prison Farm Rd. Honea Path	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results (pCi/L)	12/13/11
VGBkg Hwy 278 Varnville	Tritium Activity	<LLD
VGBkg Hwy 278 Varnville	Tritium Confidence Interval	N/A
VGBkg Hwy 278 Varnville	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results (pCi/L)	12/13/11
VGBkg Hwy 278 Yemassee	Tritium Activity	<LLD
VGBkg Hwy 278 Yemassee	Tritium Confidence Interval	NA
VGBkg Hwy 278 Yemassee	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results (pCi/L)	12/22/11
VGBkg Hwy 301 Santee	Tritium Activity	<LLD
VGBkg Hwy 301 Santee	Tritium Confidence Interval	N/A
VGBkg Hwy 301 Santee	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results (pCi/L)	12/22/11
VGBkg Buff Rd. Summerton	Tritium Activity	<LLD
VGBkg Buff Rd. Summerton	Tritium Confidence Interval	N/A
VGBkg Buff Rd. Summerton	Tritium LLD	191

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2011 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	3/23/11	6/17/11	9/27/11	12/16/11
VGAKN-001	Be-7 Activity	1.48	<MDA	1.29	2.08
VGAKN-001	Be-7 Confidence Interval	0.51	NA	0.33	0.31
VGAKN-001	Be-7 MDA	0.49	1.31	0.38	0.28
VGAKN-001	K-40 Activity	1.79	2.38	1.20	0.96
VGAKN-001	K-40 Confidence Interval	0.29	0.31	0.23	0.24
VGAKN-001	K-40 MDA	0.11	0.12	0.14	0.36
VGAKN-001	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Co-60 MDA	0.02	0.01	0.01	0.02
VGAKN-001	Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Cs-137 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Cs-137 MDA	0.01	0.02	0.01	0.01
VGAKN-001	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Pb-212 MDA	0.03	0.03	0.03	0.04
VGAKN-001	Pb-214 Activity	0.07	<MDA	<MDA	<MDA
VGAKN-001	Pb-214 Confidence Interval	0.03	NA	NA	NA
VGAKN-001	Pb-214 MDA	0.03	0.04	0.04	0.05
VGAKN-001	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Am-241 MDA	0.11	0.12	0.11	0.31

	Results (pCi/g) fresh weight	3/23/11	6/9/11	9/20/11	12/13/11
VGAKN-002	Be-7 Activity	4.08	<MDA	1.36	1.97
VGAKN-002	Be-7 Confidence Interval	0.69	NA	0.49	0.32
VGAKN-002	Be-7 MDA	0.55	1.48	0.43	0.30
VGAKN-002	K-40 Activity	1.90	2.93	2.24	1.70
VGAKN-002	K-40 Confidence Interval	0.28	0.37	0.30	0.26
VGAKN-002	K-40 MDA	0.14	0.13	0.12	0.34
VGAKN-002	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Co-60 MDA	0.01	0.02	0.02	0.01
VGAKN-002	Cs-137 Activity	0.04	0.04	<MDA	<MDA
VGAKN-002	Cs-137 Confidence Interval	0.01	0.02	NA	NA
VGAKN-002	Cs-137 MDA	0.02	0.02	0.02	0.01
VGAKN-002	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Pb-212 MDA	0.03	0.04	0.04	0.03
VGAKN-002	Pb-214 Activity	0.32	0.09	0.20	0.19
VGAKN-002	Pb-214 Confidence Interval	0.04	0.03	0.04	0.04
VGAKN-002	Pb-214 MDA	0.03	0.04	0.03	0.04
VGAKN-002	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Am-241 MDA	0.12	0.12	0.13	0.26

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2011 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	3/29/11	6/23/11	9/28/11	12/16/11
VGAKN-003	Be-7 Activity	<MDA	<MDA	1.09	<MDA
VGAKN-003	Be-7 Confidence Interval	NA	NA	0.42	NA
VGAKN-003	Be-7 MDA	0.54	1.06	0.38	0.29
VGAKN-003	K-40 Activity	2.36	2.93	2.50	1.77
VGAKN-003	K-40 Confidence Interval	0.30	0.34	0.33	0.27
VGAKN-003	K-40 MDA	0.10	0.12	0.12	0.35
VGAKN-003	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Co-60 MDA	0.01	0.01	0.01	0.02
VGAKN-003	Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Cs-137 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Cs-137 MDA	0.02	0.02	0.01	0.02
VGAKN-003	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Pb-212 MDA	0.03	0.03	0.03	0.04
VGAKN-003	Pb-214 Activity	<MDA	<MDA	<MDA	0.11
VGAKN-003	Pb-214 Confidence Interval	NA	NA	NA	0.03
VGAKN-003	Pb-214 MDA	0.04	0.04	0.04	0.04
VGAKN-003	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Am-241 MDA	0.10	0.10	0.11	0.19

	Results (pCi/g) fresh weight	3/29/11	3/23/11	9/28/11	12/20/11
VGAKN-005	Be-7 Activity	2.71	<MDA	2.04	1.26
VGAKN-005	Be-7 Confidence Interval	0.60	NA	0.51	0.26
VGAKN-005	Be-7 MDA	0.50	1.26	0.39	0.28
VGAKN-005	K-40 Activity	1.92	1.87	1.98	1.39
VGAKN-005	K-40 Confidence Interval	0.28	0.27	0.29	0.25
VGAKN-005	K-40 MDA	0.11	0.10	0.11	0.35
VGAKN-005	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Co-60 MDA	0.02	0.01	0.01	0.01
VGAKN-005	Cs-137 Activity	0.28	0.70	0.40	0.46
VGAKN-005	Cs-137 Confidence Interval	0.03	0.06	0.04	0.04
VGAKN-005	Cs-137 MDA	0.01	0.01	0.01	0.02
VGAKN-005	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Pb-212 MDA	0.03	0.03	0.03	0.04
VGAKN-005	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Pb-214 MDA	0.03	0.03	0.04	0.05
VGAKN-005	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Am-241 MDA	0.11	0.10	0.11	0.31

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2011 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	3/29/11	6/17/11	9/28/11	12/20/11
VGAKN-006	Be-7 Activity	2.82	<MDA	2.42	2.11
VGAKN-006	Be-7 Confidence Interval	0.59	NA	0.45	0.32
VGAKN-006	Be-7 MDA	0.52	1.18	0.39	0.29
VGAKN-006	K-40 Activity	1.68	2.92	1.21	1.76
VGAKN-006	K-40 Confidence Interval	0.27	0.33	0.25	0.28
VGAKN-006	K-40 MDA	0.12	0.12	0.11	0.35
VGAKN-006	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Co-60 MDA	0.01	0.02	0.01	0.01
VGAKN-006	Cs-137 Activity	<MDA	0.10	0.04	0.03
VGAKN-006	Cs-137 Confidence Interval	NA	0.02	0.01	0.02
VGAKN-006	Cs-137 MDA	0.02	0.01	0.01	0.02
VGAKN-006	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Pb-212 MDA	0.03	0.03	0.03	0.04
VGAKN-006	Pb-214 Activity	<MDA	<MDA	0.06	0.09
VGAKN-006	Pb-214 Confidence Interval	NA	NA	0.03	0.03
VGAKN-006	Pb-214 MDA	0.04	0.04	0.03	0.05
VGAKN-006	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Am-241 MDA	0.11	0.11	0.11	0.35

	Results (pCi/g) fresh weight	3/29/11	6/23/11	9/27/11	12/20/11
VGAKN-008	Be-7 Activity	2.00	<MDA	1.08	0.90
VGAKN-008	Be-7 Confidence Interval	0.55	NA	0.43	0.22
VGAKN-008	Be-7 MDA	0.42	1.03	0.37	0.25
VGAKN-008	K-40 Activity	2.71	2.62	2.40	2.11
VGAKN-008	K-40 Confidence Interval	0.31	0.30	0.29	0.29
VGAKN-008	K-40 MDA	0.11	0.12	0.11	0.35
VGAKN-008	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Co-60 MDA	0.01	0.01	0.01	0.02
VGAKN-008	Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Cs-137 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Cs-137 MDA	0.01	0.01	0.01	0.02
VGAKN-008	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Pb-212 MDA	0.03	0.03	0.03	0.04
VGAKN-008	Pb-214 Activity	0.06	<MDA	<MDA	0.06
VGAKN-008	Pb-214 Confidence Interval	0.03	NA	NA	0.03
VGAKN-008	Pb-214 MDA	0.03	0.03	0.03	0.04
VGAKN-008	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Am-241 MDA	0.11	0.10	0.10	0.16

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2011 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	3/21/11	6/9/11	9/20/11	12/13/11
VGBWL-004	Be-7 Activity	3.02	<MDA	1.31	1.14
VGBWL-004	Be-7 Confidence Interval	0.66	NA	0.46	0.26
VGBWL-004	Be-7 MDA	0.59	1.36	0.46	0.29
VGBWL-004	K-40 Activity	2.07	2.77	1.58	2.08
VGBWL-004	K-40 Confidence Interval	0.28	0.32	0.27	0.31
VGBWL-004	K-40 MDA	0.11	0.13	0.12	0.37
VGBWL-004	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Co-60 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Co-60 MDA	0.01	0.02	0.01	0.02
VGBWL-004	Cs-137 Activity	0.05	0.21	0.20	0.07
VGBWL-004	Cs-137 Confidence Interval	0.02	0.03	0.02	0.02
VGBWL-004	Cs-137 MDA	0.01	0.02	0.01	0.02
VGBWL-004	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Pb-212 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Pb-212 MDA	0.03	0.03	0.03	0.04
VGBWL-004	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Pb-214 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Pb-214 MDA	0.03	0.04	0.04	0.05
VGBWL-004	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Am-241 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Am-241 MDA	0.11	0.12	0.11	0.29

	Results (pCi/g) fresh weight	3/23/11	6/9/11	9/23/11	12/13/11
VGALD-001	Be-7 Activity	<MDA	<MDA	<MDA	0.76
VGALD-001	Be-7 Confidence Interval	NA	NA	NA	0.20
VGALD-001	Be-7 MDA	0.47	1.55	0.41	0.24
VGALD-001	K-40 Activity	2.63	2.05	2.55	1.90
VGALD-001	K-40 Confidence Interval	0.32	0.31	0.30	0.27
VGALD-001	K-40 MDA	0.13	0.13	0.11	0.33
VGALD-001	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Co-60 Confidence Interval	NA	NA	NA	NA
VGALD-001	Co-60 MDA	0.01	0.01	0.01	0.01
VGALD-001	Cs-137 Activity	<MDA	0.05	<MDA	<MDA
VGALD-001	Cs-137 Confidence Interval	NA	0.02	NA	NA
VGALD-001	Cs-137 MDA	0.01	0.02	0.02	0.02
VGALD-001	Pb-212 Activity	0.05	<MDA	<MDA	<MDA
VGALD-001	Pb-212 Confidence Interval	0.02	NA	NA	NA
VGALD-001	Pb-212 MDA	0.03	0.04	0.02	0.03
VGALD-001	Pb-214 Activity	0.07	<MDA	0.07	0.11
VGALD-001	Pb-214 Confidence Interval	0.02	NA	0.03	0.03
VGALD-001	Pb-214 MDA	0.03	0.04	0.03	0.04
VGALD-001	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Am-241 Confidence Interval	NA	NA	NA	NA
VGALD-001	Am-241 MDA	0.11	0.12	0.11	0.27

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2011 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	3/23/11	6/17/11	9/27/11	12/16/11
VGBWL-006	Be-7 Activity	<MDA	<MDA	1.85	1.35
VGBWL-006	Be-7 Confidence Interval	NA	NA	0.51	0.32
VGBWL-006	Be-7 MDA	0.53	1.26	0.42	0.33
VGBWL-006	K-40 Activity	2.07	2.17	1.55	1.45
VGBWL-006	K-40 Confidence Interval	0.28	0.30	0.26	0.25
VGBWL-006	K-40 MDA	0.10	0.12	0.10	0.34
VGBWL-006	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Co-60 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Co-60 MDA	0.01	0.01	0.01	0.01
VGBWL-006	Cs-137 Activity	0.16	0.30	0.28	0.21
VGBWL-006	Cs-137 Confidence Interval	0.02	0.03	0.03	0.02
VGBWL-006	Cs-137 MDA	0.01	0.01	0.01	0.02
VGBWL-006	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Pb-212 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Pb-212 MDA	0.03	0.03	0.03	0.04
VGBWL-006	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Pb-214 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Pb-214 MDA	0.04	0.03	0.04	0.04
VGBWL-006	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Am-241 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Am-241 MDA	0.10	0.11	0.11	0.24

Radiological Monitoring of Terrestrial Vegetation Data; Background
2011 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	10/25/11
VGBkg POW Rd. Greenwood	Be-7 Activity	1.83
VGBkg POW Rd. Greenwood	Be-7 Confidence Interval	0.45
VGBkg POW Rd. Greenwood	Be-7 MDA	0.50
VGBkg POW Rd. Greenwood	K-40 Activity	1.81
VGBkg POW Rd. Greenwood	K-40 Confidence Interval	0.28
VGBkg POW Rd. Greenwood	K-40 MDA	0.35
VGBkg POW Rd. Greenwood	Co-60 Activity	<MDA
VGBkg POW Rd. Greenwood	Co-60 Confidence Interval	NA
VGBkg POW Rd. Greenwood	Co-60 MDA	0.01
VGBkg POW Rd. Greenwood	Cs-137 Activity	<MDA
VGBkg POW Rd. Greenwood	Cs-137 Confidence Interval	NA
VGBkg POW Rd. Greenwood	Cs-137 MDA	0.02
VGBkg POW Rd. Greenwood	Pb-212 Activity	<MDA
VGBkg POW Rd. Greenwood	Pb-212 Confidence Interval	NA
VGBkg POW Rd. Greenwood	Pb-212 MDA	0.04
VGBkg POW Rd. Greenwood	Pb-214 Activity	<MDA
VGBkg POW Rd. Greenwood	Pb-214 Confidence Interval	NA
VGBkg POW Rd. Greenwood	Pb-214 MDA	0.04
VGBkg POW Rd. Greenwood	Am-241 Activity	<MDA
VGBkg POW Rd. Greenwood	Am-241 Confidence Interval	NA
VGBkg POW Rd. Greenwood	Am-241 MDA	0.11

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	10/25/11
VGBkg Prison Farm Rd. Honea Path	Be-7 Activity	0.88
VGBkg Prison Farm Rd. Honea Path	Be-7 Confidence Interval	0.42
VGBkg Prison Farm Rd. Honea Path	Be-7 MDA	0.54
VGBkg Prison Farm Rd. Honea Path	K-40 Activity	2.83
VGBkg Prison Farm Rd. Honea Path	K-40 Confidence Interval	0.33
VGBkg Prison Farm Rd. Honea Path	K-40 MDA	0.34
VGBkg Prison Farm Rd. Honea Path	Co-60 Activity	<MDA
VGBkg Prison Farm Rd. Honea Path	Co-60 Confidence Interval	NA
VGBkg Prison Farm Rd. Honea Path	Co-60 MDA	0.01
VGBkg Prison Farm Rd. Honea Path	Cs-137 Activity	<MDA
VGBkg Prison Farm Rd. Honea Path	Cs-137 Confidence Interval	NA
VGBkg Prison Farm Rd. Honea Path	Cs-137 MDA	0.02
VGBkg Prison Farm Rd. Honea Path	Pb-212 Activity	<MDA
VGBkg Prison Farm Rd. Honea Path	Pb-212 Confidence Interval	NA
VGBkg Prison Farm Rd. Honea Path	Pb-212 MDA	0.04
VGBkg Prison Farm Rd. Honea Path	Pb-214 Activity	<MDA
VGBkg Prison Farm Rd. Honea Path	Pb-214 Confidence Interval	NA
VGBkg Prison Farm Rd. Honea Path	Pb-214 MDA	0.04
VGBkg Prison Farm Rd. Honea Path	Am-241 Activity	<MDA
VGBkg Prison Farm Rd. Honea Path	Am-241 Confidence Interval	NA
VGBkg Prison Farm Rd. Honea Path	Am-241 MDA	0.19

Radiological Monitoring of Terrestrial Vegetation Data; Background
2011 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	12/13/11
VGBkg Hwy 278 Varnville	Be-7 Activity	1.28
VGBkg Hwy 278 Varnville	Be-7 Confidence Interval	0.30
VGBkg Hwy 278 Varnville	Be-7 MDA	0.31
VGBkg Hwy 278 Varnville	K-40 Activity	1.21
VGBkg Hwy 278 Varnville	K-40 Confidence Interval	0.24
VGBkg Hwy 278 Varnville	K-40 MDA	0.35
VGBkg Hwy 278 Varnville	Co-60 Activity	<MDA
VGBkg Hwy 278 Varnville	Co-60 Confidence Interval	NA
VGBkg Hwy 278 Varnville	Co-60 MDA	0.01
VGBkg Hwy 278 Varnville	Cs-137 Activity	<MDA
VGBkg Hwy 278 Varnville	Cs-137 Confidence Interval	NA
VGBkg Hwy 278 Varnville	Cs-137 MDA	0.02
VGBkg Hwy 278 Varnville	Pb-212 Activity	<MDA
VGBkg Hwy 278 Varnville	Pb-212 Confidence Interval	NA
VGBkg Hwy 278 Varnville	Pb-212 MDA	0.04
VGBkg Hwy 278 Varnville	Pb-214 Activity	<MDA
VGBkg Hwy 278 Varnville	Pb-214 Confidence Interval	NA
VGBkg Hwy 278 Varnville	Pb-214 MDA	0.04
VGBkg Hwy 278 Varnville	Am-241 Activity	<MDA
VGBkg Hwy 278 Varnville	Am-241 Confidence Interval	NA
VGBkg Hwy 278 Varnville	Am-241 MDA	0.23

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	12/13/11
VGBkg Hwy 278 Yemassee	Be-7 Activity	1.89
VGBkg Hwy 278 Yemassee	Be-7 Confidence Interval	0.29
VGBkg Hwy 278 Yemassee	Be-7 MDA	0.28
VGBkg Hwy 278 Yemassee	K-40 Activity	0.91
VGBkg Hwy 278 Yemassee	K-40 Confidence Interval	0.23
VGBkg Hwy 278 Yemassee	K-40 MDA	0.34
VGBkg Hwy 278 Yemassee	Co-60 Activity	<MDA
VGBkg Hwy 278 Yemassee	Co-60 Confidence Interval	NA
VGBkg Hwy 278 Yemassee	Co-60 MDA	0.01
VGBkg Hwy 278 Yemassee	Cs-137 Activity	<MDA
VGBkg Hwy 278 Yemassee	Cs-137 Confidence Interval	NA
VGBkg Hwy 278 Yemassee	Cs-137 MDA	0.02
VGBkg Hwy 278 Yemassee	Pb-212 Activity	<MDA
VGBkg Hwy 278 Yemassee	Pb-212 Confidence Interval	NA
VGBkg Hwy 278 Yemassee	Pb-212 MDA	0.03
VGBkg Hwy 278 Yemassee	Pb-214 Activity	<MDA
VGBkg Hwy 278 Yemassee	Pb-214 Confidence Interval	NA
VGBkg Hwy 278 Yemassee	Pb-214 MDA	0.04
VGBkg Hwy 278 Yemassee	Am-241 Activity	<MDA
VGBkg Hwy 278 Yemassee	Am-241 Confidence Interval	NA
VGBkg Hwy 278 Yemassee	Am-241 MDA	0.14

Radiological Monitoring of Terrestrial Vegetation Data; Background
2011 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	12/22/11
VGBkg Hwy 301 Santee	Be-7 Activity	0.88
VGBkg Hwy 301 Santee	Be-7 Confidence Interval	0.25
VGBkg Hwy 301 Santee	Be-7 MDA	0.28
VGBkg Hwy 301 Santee	K-40 Activity	2.59
VGBkg Hwy 301 Santee	K-40 Confidence Interval	0.33
VGBkg Hwy 301 Santee	K-40 MDA	0.36
VGBkg Hwy 301 Santee	Co-60 Activity	<MDA
VGBkg Hwy 301 Santee	Co-60 Confidence Interval	NA
VGBkg Hwy 301 Santee	Co-60 MDA	0.01
VGBkg Hwy 301 Santee	Cs-137 Activity	<MDA
VGBkg Hwy 301 Santee	Cs-137 Confidence Interval	NA
VGBkg Hwy 301 Santee	Cs-137 MDA	0.01
VGBkg Hwy 301 Santee	Pb-212 Activity	<MDA
VGBkg Hwy 301 Santee	Pb-212 Confidence Interval	NA
VGBkg Hwy 301 Santee	Pb-212 MDA	0.04
VGBkg Hwy 301 Santee	Pb-214 Activity	0.01
VGBkg Hwy 301 Santee	Pb-214 Confidence Interval	0.03
VGBkg Hwy 301 Santee	Pb-214 MDA	0.04
VGBkg Hwy 301 Santee	Am-241 Activity	<MDA
VGBkg Hwy 301 Santee	Am-241 Confidence Interval	NA
VGBkg Hwy 301 Santee	Am-241 MDA	0.27

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	12/22/11
VGBkg Buff Rd Summerton	Be-7 Activity	1.55
VGBkg Buff Rd Summerton	Be-7 Confidence Interval	0.24
VGBkg Buff Rd Summerton	Be-7 MDA	0.23
VGBkg Buff Rd Summerton	K-40 Activity	0.91
VGBkg Buff Rd Summerton	K-40 Confidence Interval	0.22
VGBkg Buff Rd Summerton	K-40 MDA	0.31
VGBkg Buff Rd Summerton	Co-60 Activity	<MDA
VGBkg Buff Rd Summerton	Co-60 Confidence Interval	NA
VGBkg Buff Rd Summerton	Co-60 MDA	0.02
VGBkg Buff Rd Summerton	Cs-137 Activity	<MDA
VGBkg Buff Rd Summerton	Cs-137 Confidence Interval	NA
VGBkg Buff Rd Summerton	Cs-137 MDA	0.01
VGBkg Buff Rd Summerton	Pb-212 Activity	<MDA
VGBkg Buff Rd Summerton	Pb-212 Confidence Interval	NA
VGBkg Buff Rd Summerton	Pb-212 MDA	0.03
VGBkg Buff Rd Summerton	Pb-214 Activity	0.06
VGBkg Buff Rd Summerton	Pb-214 Confidence Interval	0.02
VGBkg Buff Rd Summerton	Pb-214 MDA	0.04
VGBkg Buff Rd Summerton	Am-241 Activity	<MDA
VGBkg Buff Rd Summerton	Am-241 Confidence Interval	NA
VGBkg Buff Rd Summerton	Am-241 MDA	0.26

7.0 Summary Statistics

Radiological Monitoring of Terrestrial Vegetation Data

2011 Vegetation Tritium Statistics 25

2011 Vegetation Cesium-137 Statistics 26

Notes:

1. pCi/L-picocuries per liter
2. pCi/g -picocuries per gram
3. N-Number of Samples With Detections
4. Std Dev-Standard Deviation
5. LLD-Lower Limit of Detection
6. MDA-Minimum Detectable Activity
7. ND-Non Detects
8. NA-Not Applicable

Radiological Monitoring of Terrestrial Vegetation Summary Statistics
2011 Vegetation Tritium Summary

Tritium Levels (pCi/L) in Vegetation from SRS Perimeter Stations, 2011						
Station	**N (ND)**	**Average**	**Uncertainty**	**Median**	**Maximum**	**Minimum**
AKN-001	2 (2)	260	97	260	306	<LLD
AKN-002	1 (3)	248	111	248	248	<LLD
AKN-003	1 (3)	269	99	269	269	<LLD
AKN-004	1 (3)	363	103	363	363	<LLD
AKN-005	2 (2)	717	119	717	1092	<LLD
AKN-006	2 (2)	1428	139	1428	2514	<LLD
AKN-007	2 (2)	708	115	708	853	<LLD
AKN-008	2 (2)	1508	141	1508	2654	<LLD
BWL-001	0 (4)	NA	NA	NA	<LLD	<LLD
BWL-002	0 (4)	NA	NA	NA	<LLD	<LLD
BWL-003	0 (4)	NA	NA	NA	<LLD	<LLD
BWL-004	0 (4)	NA	NA	NA	<LLD	<LLD
ALD-001	0 (4)	NA	NA	NA	<LLD	<LLD
BWL-006	1 (3)	241	105	241	241	<LLD
BWL-007	1 (3)	244	105	244	244	<LLD
BWL-008	1 (2)	337	114	337	337	<LLD
BWL-009	2 (2)	543	111	543	733	<LLD

Tritium Levels (pCi/L) in Vegetation from SRS Perimeter Stations, 2011						
Station	**N (ND)**	**Average**	**Uncertainty**	**Median**	**Maximum**	**Minimum**
AKN-251	1 (3)	727	113	727	727	<LLD
ALD-251	1 (3)	239	96	239	239	<LLD
ORG-251	0 (4)	NA	NA	NA	<LLD	<LLD

Tritium Levels (pCi/L) in SRS Perimeter Vegetation Samples, 2011					
N (ND)	**Average**	**Uncertainty**	**Median**	**Maximum**	**Minimum**
18 (49)	572	113	350	2654	<LLD

Tritium Levels (pCi/L) in 25-mile Radius Vegetation Samples, 2011					
N (ND)	**Average**	**Uncertainty**	**Median**	**Maximum**	**Minimum**
2 (10)	483	105	483	727	<LLD

Note: All measures of central tendency exclude non-detections.

Radiological Monitoring of Terrestrial Vegetation Summary Statistics
2011 Vegetation Cesium-137 Summary

Cesium-137 Levels (pCi/g-fresh) in SRS Perimeter Vegetation Samples, 2011						
Station	**N (ND)**	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
AKN-001	0 (4)	NA	NA	NA	<MDA	<MDA
AKN-002	2 (2)	0.04	0.00	0.04	0.04	0.04
AKN-003	0 (4)	NA	NA	NA	<MDA	<MDA
AKN-005	4 (0)	0.46	0.18	0.43	0.70	0.28
AKN-006	3 (1)	0.06	0.04	0.04	0.10	0.03
AKN-008	0 (4)	NA	NA	NA	<MDA	<MDA
BWL-004	4 (0)	0.13	0.08	0.13	0.21	0.05
ALD-001	1 (3)	0.05	NA	0.05	0.05	0.05
BWL-006	4 (0)	0.24	0.06	0.24	0.30	0.16

Cesium-137 Levels (pCi/g-fresh) in SRS Perimeter Samples, 2011					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
18 (18)	0.16	0.07	0.09	0.70	<MDA

Note: All measures of central tendency exclude non-detections.

List of Acronyms

ALD	Sample locations in Allendale County
AKN	Sample locations in Aiken County
BWL	Sample locations in Barnwell County
DOE-SR	Department of Energy-Savannah River
ESOP	Environmental Surveillance and Oversight Program
LLD	Lower Limit of Detection
MCL	Maximum Contaminant Level
MDC	Minimum Detectable Contamination
MDA	Minimum Detectable Activity
N	Number
NA	Not Applicable
ND	NonDetect
SCDHEC	South Carolina Department of Health and Environmental Control
Std Dev	Standard Deviation
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
USEPA	United States Environmental Protection Agency
WSRC	Westinghouse (now Washington 12/2005) Savannah River Company

Units of Measure

g/mL	grams per milliliter
mL/L	milliliters per liter
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/mL	picocuries per milliliter

REFERENCES

Savannah River Nuclear Solutions, LLC (SRNS). 2012. Savannah River Site Environmental Report for 2011. Savannah River Site Aiken, SC. SRNS-STI-2011-**00059.**

Till, J.E., et al. 2001. Savannah River Site Environmental Dose Reconstruction Project, Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval, Evaluation of Materials Released From the Savannah River Site. RAC Report No. 1-CDC-SRS-1999-Final. Risk Assessment Corporation (RAC).

United States Environmental Protection Agency (USEPA). 2012. US EPA Information. www.epa.gov/radiation/radionuclides

USEPA 2009. National Primary Drinking Water Regulations. http://www.epa.gov/ogwdw/consumer/pdf/mcl.pdf

Westinghouse Savannah River Company (WSRC). 1999. Radionuclides in the Savannah River Site Environment. Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-MS-99-00667.

This Page Intentionally Left Blank

2011 Radiological Monitoring of Edible Vegetation Adjacent to SRS

Environmental Surveillance and Oversight Program

01EV002
Robert Adams, Project Manager
January 01, 2011 - December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 3
- **2011 TRITIUM** 3
- **2011 GAMMA** 4
- **Cs-137** 6
- **TOTAL STRONTIUM** 7
- **ESOP and DOE-SR Data Comparisons** 7

3.0 CONCLUSIONS AND RECOMMENDATIONS 8

4.0 MAP 10

5.0 TABLES AND FIGURES 11

6.0 DATA 15

7.0 SUMMARY STATISTICS 20

LIST OF ACRONYMS 25

UNITS OF MEASURE 26

REFERENCES 27

APPENDIX 29

1.0 Project Summary

Radionuclide uptake by vegetation may occur by direct absorption into the plant through the foliage or roots, and grazing animal dose exposure occurs primarily by ingestion of the contaminated plant (Kathren 1984). Plant uptake of radionuclides depends upon many factors including species, tissue type, soil-water-plant relationships, soil type, and the chemical nature of the radionuclide in the soil (Hanlon 2004). "Sampling and analyzing native vegetation can provide information about the presence and movement of radionuclides in the environment" (Lawrence Livermore National Laboratory, LLNL 1997).

The Radiological Monitoring of Edible Vegetation Project is a component of the South Carolina Department of Health and Environmental Control's (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) that monitors edible food in perimeter and background locations around the Savannah River Site (SRS). SCDHEC ESOP monitoring addresses public concerns pertaining to SRS operations through independent monitoring of radionuclide activities in edible vegetation and fungi found around the perimeter of SRS. Edible vegetation was collected based solely on availability, and was directly dependent upon the growing season. Farmers, gardeners, and/or businesses surrounding the perimeter of SRS occasionally contribute some domestically grown crops, and wild edible vegetation including fungi are collected to monitor potential consumer exposures. Typical domestic crops collected include squash, corn, cucumbers, etc., and typical wild food sources include pokeberry leaves, hog plums, winged sumac berries, and edible fungi used in salads, greens, pies, condiments and teas (Section 6.0 Data). Edible fungi were added in 2010 to address exposure for the wild mushroom consumer due to the evidence for bioconcentration of cesium-137 (Cs-137) in some fungi and historical detections in SRS fungi (Botsch 1999, Du Pont 1984).

Since 1988, when the last heavy water reactor at SRS was shut down, the tritium supply was re-established using the new Tritium Extraction Facility (TEF). This facility's mission is to transfer new tritium gas to the nation's tritium inventory (WSRC 2006). The Southern Nuclear Operating Company operates the Vogtle Electric Generating Plant (VEGP) located in Burke County, GA adjacent to the SRS. Permitted tritium releases coming from the VEGP are a result of spent fuel pools during power operation, reactor operation by the fission process, and from fuel assemblies mainly during reactor operation and shortly after shutdown (Federal Register 1968).

Section 4.0, Map 1 shows the inner perimeter of counties (IPC) adjacent to the SRS boundary and the outer perimeter of counties (OPC) that make up the study area of concern (AOC). The AOC was sampled for edible vegetation including fungi and compared to their respective South Carolina backgrounds (SCbkg). Tritium (47 AOC and 16 SCbkg samples, Section 5.0 Table 1a), a suite of 24 gamma radionuclides (48 AOC plus 19 SCbkg, Section 5.0 Table 2), and total strontium beta (5 AOC plus 3 SCbkg, Section 6.0 Table 5) were analyzed in 2011 for radionuclide activity. Samples collected in the IPC, OPC, and SCbkg may indicate if an exposure activity concentration trend is occurring in edible vegetation samples. Fungi and green plant vegetation comparisons are kept separate since edible fungi are typically saprophytic and do not contain chlorophyll. Fungi and woody vegetation have relatively large absorptive surface areas compared to annual plants for uptake of radionuclides deposited in past years, i.e., fungal mycelia mats or woody plant root systems and leafy canopy areas. Both woody or perennial edible plants and fungi have a greater potential than annual or seasonal plants for concentrating some radionuclides deposited over many years. Annual plants tend to uptake recent depositions due to a decreased time for the leaching away of recent deposits from the absorptive surface to deeper layers. Radionuclide uptake over large areas is expected to be greater for plants with larger surface areas above or below ground through direct absorption and increased transpiration. Thus, the available absorptive surface area and competing or limiting factors, such as soil chemistry interactions, affect uptake (Hanlon 2004).

The SCDHEC AOC detections are separated into IPC versus OPC detections to establish depositional pattern trends from the SRS boundary to the AOC and SCbkg. These radionuclide detections are also broken down into various food types to determine the trends of exposure within different food groups. First, the “green plant food” and “fungi” category radionuclide concentrations in the AOC is compared with that in the SCbkg. All detections are then broken down into domestic versus wild food categories, and crops typically planted as annuals versus those resulting from perennial or woody crops. The data section shows all detections by the specific sample type (e.g., mustard, onion, bolete mushroom), and in some cases genus/species is given, if known. These comparisons establish the trends of radionuclide exposure potential within the local green plant and wild fungi consumables.

SCDHEC detected activities above the method minimum detectable concentrations for the following radionuclides in vegetation in 2011: tritium (H-3) in AOC fruits, flowers, greens, wild tea sources, cactus and fungi, but not in the SCbkg; Beryllium-7 (Be-7) in the AOC mustard , winged sumac drupes, and lichens; potassium-40 (K-40) in AOC and SCbkg fruits, flowers, greens, wild tea sources, cactus and fungi; lead-212 (Pb-212) in AOC and SCbkg fungi; lead-214 (Pb-214) in AOC and SCbkg fruits, greens, and fungi; cesium-137 (Cs-137) in AOC and SCbkg fungi only; total strontium in greens and fruit, and radium-226 (Ra-226) in SCbkg fungi only. Note that green plants had detections of tritium, Be-7, K-40, Pb-214, and total strontium. Fungi had detections of tritium (one), K-40, Pb-212, Pb-214, and Cs-137 in the AOC and SCbkg, Be-7 in the AOC only, and a single detection of Ra-226 in the SCbkg (Section 6.0 Data Tables).

The DOE-SR annually collects and analyzes terrestrial food products to determine the presence of certain alpha, beta, and gamma-emitting radionuclides that include tritium, strontium, plutonium, uranium, americium, curium, technetium, and neptunium species. Strawberries were collected to evaluate I-131 levels associated with the Fukushima Daichii Plant nuclear incident. The DOE-SR collected collards, peanuts, pecans, and watermelon in 2011 within each of four quadrants and from a location approximately 25 miles from SRS.

SCDHEC wild-type vegetation monitoring increased in 2010 and 2011, and now includes edible fungi since previous data indicated that the higher dose exposures occurred from consuming some woody perennials (e.g., wild plums), and certain edible fungi (e.g., bolete mushrooms) favored by wild mushroom and plant consumers. Split sample comparisons with DOE-SR are occasionally conducted to compare method results, but increasing the variety of vegetation sampled is more likely to find previously unknown dose exposure.

2.0 RESULTS AND DISCUSSION

The International Atomic Energy Agency (IAEA 2009) has established guideline levels for radionuclides in foods (alpha- beta-, and gamma-emitters) for general consumption. The appendix section shows the radionuclides of concern, the guideline levels, the intervention levels and their conversion to pCi/g for data comparison (Appendices Tables 1a,b,c). The IAEA guideline emphasizes the cumulative radioactivity guideline limits for food.

The US Food and Drug Administration (USFDA 2005) also has guidance levels for specific radionuclides called derived intervention levels (DILs), which USFDA has adopted to help determine whether domestic food in interstate commerce or food offered for import into the United States presents a safety concern (Strontium-90, Iodine-131, Cesium134+Cesium137, Plutonium-238 +Plutonium-239+Americium-241, Ruthenium-103+Ruthenium-106; Appendix Table 1c).

References to vegetation in general refers to the edible parts of green plants and fungi in this report. Otherwise more specific terms are used to indicate a category or specific type of green plant or fungi. The edible fungi collected are primarily heterotrophic (consume preformed organic matter) and saprophytic (digest and consume dead plant and animal matter), but not parasitic (consume living matter). Lichens are symbionts (benefit nutritionally) whose form (thallus) is altered by the associated organism (e.g., algae). The collected edible fungi produce spores outside of a structure (mushroom basidia) or within a structure (mushroom asci), and in lichens (Moore-Landecker 1972). Plants or green vegetation are distinguished from fungi, and edible vegetation without a qualifier refers to both.

Section 4.0, Map 1 depicts the counties around the perimeter of SRS and the USGS 7.5-minute quadrants that overlay those counties. All of the detections described herein are well below the IAEA and USFDA guidelines for the specific radionuclide in food (Appendix 1b,c).

<u>2011 Tritium</u>

Tritium is naturally present as a very small percentage of hydrogen in water, both liquid and vapor (ANL 2007). Historically, the main sources of tritium releases from the SRS operations were the reactor areas, the chemical separation facilities, and the tritium packaging areas. Tritium releases on the SRS include both atmospheric and liquid contributions (SRNS 2011). Tritiated water is more hazardous biologically than tritium gas and reacts chemically in living cells the same as nonradioactive water (CDC SRSHES 1997).

There were only 10 tritium detections out of 63 sample scans (AOC and SCbkg) of edible vegetation and fungi collected by SCDHEC in 2011 (Section 5, Table 1a). Tritium was detected in all three IPC counties (AKN, BWL, ALD) bordering SRS, and there was one detection in an Orangeburg County sample of the outer perimeter (ORG, EDF, HAM, MCM) counties (see acronym list). There were no tritium detections in the South Carolina background. Aerial deposition detections for tritium tend to be close to SRS sources (SRNS 2011), but occasional low-level detections occur within IPC counties. All IPC tritium detections (9) in distilled water from edible vegetation averaged 344 ±180 pCi/L with a median of 254 pCi/L and a maximum of 991 pCi/L (Section 5.0 Table 1a). Leafy greens and root vegetables had the highest detection statistics (avg 547 ±305 pCi/L, median 597 pCi/L, max of 991 pCi/L) versus fruit or seed vegetables (avg 331 ±87 pCi/L, median 340 pCi/L), and fungi (a single detection of 272 pCi/L) (Section 5.0 Table 1b). Any tritum aerial releases reaching the upper atmosphere would disperse over larger areas with increased distances resulting in reduced concentrations and unlikely detections at a distance based on the low levels found in vegetation at the SRS boundary and near Energy Solutions (formerly CHEM Nuclear). The primary mechanisms for aerial tritium depositions were wind and/or rain. Six of the ten tritium detections in vegetation occurred in the Barnwell County indicating the primary drift depositional pattern was to the northeast of the SRS in 2011 for sampled areas. Areas not sampled to the southwest were in Georgia. The observed levels of tritium were well below the IAEA Radionuclides Guidelines for Food (270 pCi/g, Appendix 1b). This limit would equal {270 pCi/g x (1g/1ml) x (1000ml/L)} = 270,000 pCi/L, which is far above the EPA drinking water limit of 20,000 pCi/L, and all the detections were <1000 pCi/L.

Five out of ten tritum AOC detections occurred in greens or plant body, four in plant fruits (biological definition), and one in a bolete mushroom (Section 5.0 Table 1b). A single tritium detection in a wild or escape vegetation (perennial grape) in the AOC was 228 pCi/L, annuals were all <MDA (Section 7.0 Table 1). Tritium detections (9 of 10) in edible green plants averaged 451 ±249 pCi/L with a median of 385 pCi/L (Section 5.0 Table 1b). The maximum of 991 pCi/L occurred in wild mustard leaf (Section 7.0 Table 1). Yucca flower was second highest in tritium (626 pCi/L), wild persimmons third (418 pCi/L), prickly pear cactus fourth (416 pCi/L), wild hog plums fifth (340 pCi/L), pokeberry leaf sixth (285 pCi/L), bolete mushroom seventh (272 pCi/L), and grapes eighth (228 pCi/L). Note that the wild-type perennials tend to have higher tritium detections than annual crops possibly due to their exposure to more than one season of deposited tritium and a generally larger absorptive surface area compared to annual crops (Section 7.0 Table 1). Numerous nondetections (<LLD) occurred primarily in domestic annual species or vegetables (14) such as collard, turnip, tomato, cucumber, corn, and squash (Section 7.0 Table 1). Summary Tables 1 a,b indicate that the least tritium potential exposure occurred primarily in domestic plants (annuals), followed by increasing tritium exposure in mostly wild plants (perennials - escaped grape, bolete fungi, wild fruit/flower, and wild leafy greens), and one exceptional wild mustard. Notice the difference in exposure of domestic leafy greens (<LLD) and wild leafy greens (highest tritium detection of 991 pCi/L), and that most tritium detections occurred in plum fruit and prickly pear leaves. The typical domestic annual plant with tritium exposure (<LLD) compared to the wild perennial plants exposure detections (>LLD) indicate that tritium exposures seem dependent on increasing time intervals and absorptive surface area.

<u>2011 Gamma</u>

The gamma-scan of detections in naturally occurring radioisotopes (Be-7, K-40, Pb-214, Pb-212, Ra-226) are not discussed in detail within Section 2.0, since they are part of the South Carolina normal background exposure. However, the detection results for all are included in the data tables.

South Carolina gamma-scan background detections occurred in fruits or seed, greens, bulbs or tubers, and fungi (Section 5.0 Table 3a,b). The AOC plus SCbkg gamma samples, included 39 AOC plus 15 SCbkg green vegetation samples, and 9 AOC plus 4 SCbkg edible fungi samples

(Section 5.0 Table 3a,b). The edible green plant samples and edible fungi samples were analyzed for a suite of 24 gamma-emitting radionuclides. Only potassium-40 (K-40), beryllium-7 (Be-7), and lead-214 (Pb-214) were detected in edible green vegetation in 2011, and Be-7 (lichen), K-40, cesium-137 (Cs-137), Pb-212, Pb-214, and radium-226 (Ra-226 only in SCbkg) were detected in edible fungi. Lead uptake in fungi, especially Pb-214, appeared higher than in green plants overall (Tables 3a,b). The single Ra-226 detection occurred in a SCbkg fungi sample from Laurens County.

Section 5.0 Tables 1b and 3a through 4 show the radionuclide summary statistics for different categories of edible green vegetation and fungi. A comparison was made between the AOC gamma radionuclides found in edible vegetation (K-40, Pb-214, Be-7) versus edible fungi (Be-7, K-40, Cs-137, Pb-212, Pb-214) (Section 5.0, Table 3 a,b). Radium-226 occurred only in fungi in the SCbkg. AOC Cs-137, Be-7, K-40, Pb-212, and Pb-214 averages and medians were higher in fungi than in green plants. So were the maximums except for Pb-214 in greens. Potassium-40 and Pb-214 were highest (AOC and IPC) in Allendale County plants (Section 5.0 Table 2) and Be-7 was highest in Allendale County Lichens. Lead-214 was highest in Allendale County including the SCbkg. Cesium-137 was higher in Barnwell County and in the SCbkg than in other counties (Section 5.0 Table 2). All gamma backgrounds came from Laurens County in the Piedmont geological region. Fertilizers and cretaceous geology are the suspected factors affecting K-40 distribution in the AOC, and all SCbkgs came from the Piedmont region. Potassium-40 activity is heavily influenced by fertilizer applications, and Pb-214 is part of the naturally occurring uranium decay products prevalent in saprolitic rock found in fracture zones of the Piedmont, Blue Ridge, and Fall Line areas of South Carolina. High uranium concentrations occur in some well water in southern Greenville County and primordial U-238 in saprolitic rock decays to Pb-214 and eventually Pb-206 (stable). Lead-212 is a decay product of the naturally occurring thorium series. The tritium and Cs-137 detections appear related to manmade activities. Beryllium-7 is a naturally occurring radionuclide and was found only in winged sumac drupes and wild mustard. Strontium-89/90 detections were determined based on beta decay (not gamma), and is discussed under the Strontium heading.

The gamma radionuclides in green plants and edible fungi vary by specific type of vegetation and food use groups (Section 5.0, Tables 3a,b). Beryllium-7 was found only in winged sumac drupes, wild mustard leaf, and reindeer lichen. Most food types or food use group detections were K-40 and Pb-214 in 2011. However, edible fungi appeared to be the exception by adding Ra-226 (only in SCbkg), Cs-137, and Pb-212. Radium-226 is a NORM decay product of the U-238 series and decays into radon-222 gas, which is part of the highest NORM exposures. Some radium compounds are soluble in water and account for it's mobility in saprolitic rock formations, it's presence in some well water, and radon gas releases in home showers and soil. The Cs-137 activity adds radionuclide exposure potentially due to historical depositions from atomic bomb tests fallout during 1950-1980. Cesium-137 detections occurred only in certain edible fungi such as boletes and chanterelles, and may be due to bioconcentration of depositions over many years (Botsch 1999, Yoshida 1998). Plants showed a higher K-40 activity in some annual crops (collards, turnips, radish) versus perennial (pokeberry leaf, prickly pear cactus, plum, persimmon, winged sumac drupes) vegetation (Section 7.0 Summary Tables 3,4). SCbkgs were highest for K-40 in fungi and domestic plants (Section 7.0 Summary Table 2). This trend may be related to fertilizers and/or the geology of the surface soils and influence on uptake of radionuclides (Rommelt 1990, Seel 1995). Section 5.0 Table 2 shows gamma detections by County. Cesium-137 in fungi was higher in the IPC (2.339 pCi/g avg) versus the SCbkg (2.157)(Section 5.0 Table 4). The OPC did not have Cs-137 detections. This clear trend of deposition is not necessarily related to SRS for many nuclear bomb tests fallout tracked from the southwest across South Carolina to the northeast and depositional concentrations would gradually decrease with each rain event (dilution effect). Also, RADNET (ERAMS) data maximums for rainfall in 1984 along a path from Ga (17 pCi/L in Ga) to SC (14.2 pCi/L in SC) illustrate the potential exposure in one year. Only 27 years have passed for the same date in 2011, which is less than one half-life for Cs-137 (30 yrs). Thus, maximums of >9.1 pCi/L (decay calculation for 17 pCi/L) remaining in rainfall from that period are potentially still detectable from those events, which were not necessarily the true population maximums, and other additive depostional events have occurred since and before that time. The maximum Cs-137 detection in 2011 occurred in bolete mushrooms (8.145 pCi/g near intersection of highway 278 and 39), which are proven bioconcentrators of Cs-137 (Section 5.0 Table 3a, Botsch 1999). Higher Cs-137 concentrations occurred in recent years, both in Bolete and Chanterelle mushrooms in the Steel Creek area of Allendale County. Bolete mushrooms have large mycelial mats that draw water and chemical elements from the soil surface and store the element radionuclides through saprophytic intake over a long lifetime. These low level bioconcentrations are not above the health risk guidelines (Appendix 1b,c).

Cesium-137

Cesium-137 is an alkali metal, which is chemically and metabolically similar to potassium. If ingested, it is distributed relatively uniformly throughout the whole body, including bone marrow (Federal Radiation Council 1965). The largest source of Cs-137 in the environment was fallout from atmospheric nuclear weapons tests in the 1950's and 1960's that dispersed and deposited Cs-137 worldwide. The highest Cs-137 detection (16 pCi/L) in South Carolina rainfall since January 1979 (most nuclear testing ceased after 1980) occurred in Barnwell, 15 May 1985. There were many Cs-137 detections in rainfall during and before that period, which indicated the continuing atmospheric potential contributions to the environment that may be absorbed by edible vegetation and passed down through linked critical exposure pathways. However, cesium is poorly absorbed by vegetation from the soil. Cesium is relatively uniformly distributed throughout all portions of the plant and does not tend to bioconcentrate except in some grains and mushrooms. Grains tend to have relatively high concentrations, but fruits and root vegetables (which have a high water content), tend to have low concentrations of cesium (Kathren 1984). Some fungi appear to bioconcentrate cesium and contribute the highest Cs-137 radioactive exposure through wild mushrooms compared to other food types (Botsch 1999).

Cesium-137 is a major radionuclide in spent nuclear fuel, high level radioactive waste resulting from the processing of spent nuclear fuel, and radioactive wastes associated with the operation of nuclear reactors and fuel reprocessing plants. Radioactive cesium is present in soil around the world largely as a result of fallout from past atmospheric nuclear weapons tests. The concentration of Cs-137 in surface soil from fallout ranges from about 0.1 to 1 pico curies per gram (pCi/g), averaging less than 0.4 pCi/g. Cesium is generally one of the less mobile radioactive metals in the environment. Cesium preferentially adheres quite well to the soil organic layer, and the concentration associated with sandy soil particles is estimated to be 280 times higher than in interstitial water. Concentration ratios are much higher in clay and loam soils (ANL 2007).

All of the detected radionuclides except tritium, Cs-137, and Sr-89/90 originate in NORM. NORM radionuclides are the source of most public exposure and are considered background when less than their natural occurrence in nature. Only some wild mushroom samples in 2011 would add radiation exposure to the individual consumer above NORM background mostly due to Cs-137, which is bioconcentrated by some mushrooms (Botsch 1999). The Cs-137 detections were generally <1 pCi/g except for boletes and chanterelles mushrooms (Data Tables and Section 5.0 Table 4). These detections reflect bioconcentrations over several years rather than a yearly depositional dose. These edible mushrooms are the fruiting bodies of long-lived organisms (with large mycelia mats), which are primarily saprophytes on dead vegetation. Thus, Cs-137 uptake by these fungi may be a reflection of the interactions between soil chemistry, the food host biochemistry, and the fungi. Cesium-137 tends to bind with organic material in the forest floor and is available to resident organisms before leaching to a confining layer such as clays (Linkov 1999). Many non-NORM radionuclides were distributed worldwide due to atomic tests primarily in the 1950's and 1960's, and the present detectable levels in soils today cannot be assigned to a single source (Aracnet 1957, RADNET 2006).

Total Strontium

Total strontium (Sr) contains many isotopes and the two most important are primarily beta emitters that contribute to dose exposure, i.e., Sr-89/90. Strontium-89 is short-lived (50.5 days) compared to Sr-90 (28.8 year half-life). Historical depositions contained Sr-90 that is still detected. Eight green plant samples were analyzed for total strontium in 2011 (Section 6.0 Table 5). Strontium was found in four AOC samples: collards (0.028 pCi/g), wild mustard (0.076 and 0.233 pCi/g), winged sumac drupes (0.133 pCi/g), and in one SCbkg pokeberry leaf sample (0.027 pCi/g). Most exposure to strontium occurred in subsistence types of wild vegetation. Strontium has four stable naturally occurring isotopes, but Sr-90 is a by-product of nuclear fission used primarily in nuclear auxiliary power devices (cheaper than Pu-238, but not as long-lived), and presents a health problem since strontium substitutes for calcium in bone. Alternately, Sr-89 and Sr-90 are used in the treatment of bone cancer and to increase bone density in women. Strontium is an abundant element and safe at low concentrations since it is used in toothpastes, treatments for osteoporosis, and fireworks. The IAEA guideline for total exposure to five radionuclides in food including Sr-90 is 2.7 pCi/g and the USFDA DIL guideline is 4.32 pCi/g for imported foods. The total strontium detected levels in the assayed samples were all well below those guidelines (Appendix 1 b,c).

ESOP and DOE-SR Data Comparison

Comparison is based on this reports tables and data sections and the SRNS Environmental Report 2011. DOE-SR edible vegetation tritium detections occurred in fruit and pecans. DOE-SR tritium maximum in fruits (0.097 pCi/g) was greater than in pecans (0.0624 pCi/g).

Application of the DOE-SR general dry/wet weight ratio used for vegetation allows a general comparison in terms of pCi/L of tritium for DOE-SR tritium data.
$\{[pCi/g \times (1/0.3)]/(1-0.3)\} \times (1g/1ml) \times (1000ml/1Liter) = pCi/L$

DOE-SR Tritium Conversion to pCi/L - ((0.097 pCi/g tritium in fruit x 3.333)/0.7)x1000=462 pCi/L for DOE-SR versus 991 pCi/L for SCDHEC. The tritium maximum in peanuts was lower, 0.0624 pCi/g=297 pCi/L. The SCDHEC maximum detection occurred in Barnwell County in wild mustard greens (991 pCi/L). SCDHEC reports only the tritium in water distillations from edible vegetation. These tritium concentration activities were far less than IAEA Radionuclides Guidelines for Food, which is 270 pCi/g for tritium (Appendix Table 1b). The statistics that follow are based on detections only for DOE-SR comparison to SCDHEC data. DOE-SR tritium in greens averaged 31 (±30) pCi/L with a median of 31 pCi/L and SCDHEC tritium in greens averaged 547 (±305) pCi/L with a median of 507 pCi/L. The difference is a factor of 10 or more and due to a comparison of domestic annuals (DOE-SR) to mostly wild type edible vegetation (SCDHEC) that was mostly perennial, and a higher LLD for SCDHEC. DOE-SR tritium in fruit averaged 377 (±80) pCi/L with a median of 380 pCi/L, and SCDHEC tritium in fruit averaged 331 (±87) pCi/L with a median of 340 pCi/L (Section 5.0 Table 1b).

The only DOE-SR gamma-emitting radionuclide detection maximums in edible vegetation were Cs-137 in collards (0.0432 pCi/g), peanuts (0.0110 pCi/g), and pecans (0.0134 pCi/g). These Cs-137 concentration activities were far less than IAEA Radionuclides Guidelines for Food, which is 27 pCi/g for Cs-137 (Appendix Table 1b). Strontium-89,90 was detected in collards at five locations (0.189 pCi/g maximum). These Sr-89,90 concentration activities were far less than IAEA Radionuclides Guidelines for Food, which is 2.7 pCi/g for Sr-90 (Appendix Table 1b). Uranium-234,-238 were detected in collards within the historical trend. Technetium-99 was detected only in collards and peanuts. Americium-241 was detected in collards (SRNS 2012)

The SCDHEC gamma-emitting radionuclide of concern was Cs-137, which occurred only in edible fungi (8.145 pCi/g maximum in boletes in Barnwell County). Lower Cs-137 detections occurred in Allendale and Aiken counties (Section 5.0 Table 4). The only Cs-137 in fungi occurred within the inner perimeter counties next to the SRS boundary except for two detections in the background County of Hampton (averaged 2.157 pCi/g). The County averages for these detections were 0.887 pCi/g (Allendale), 1.505 pCi/g (Aiken), 4.625 pCi/g (Barnwell), and 2.157 pCi/g (Hampton SCbkg) (Section 4.0 Table 2). Only Barnwell County had Cs-137 in fungi greater than the SCbkg (2.157 pCi/g).

The statistics that follow are based on detections only for DOE-SR comparison to SCDHEC data. SCDHEC AOC total strontium in greens averaged 0.117 (±0.088) pCi/g with a median of 0.104 pCi/g and DOE-SR Sr-89/90 averaged 0.098 (±0.057) pCi/g with a median of 0.089 pCi/g.

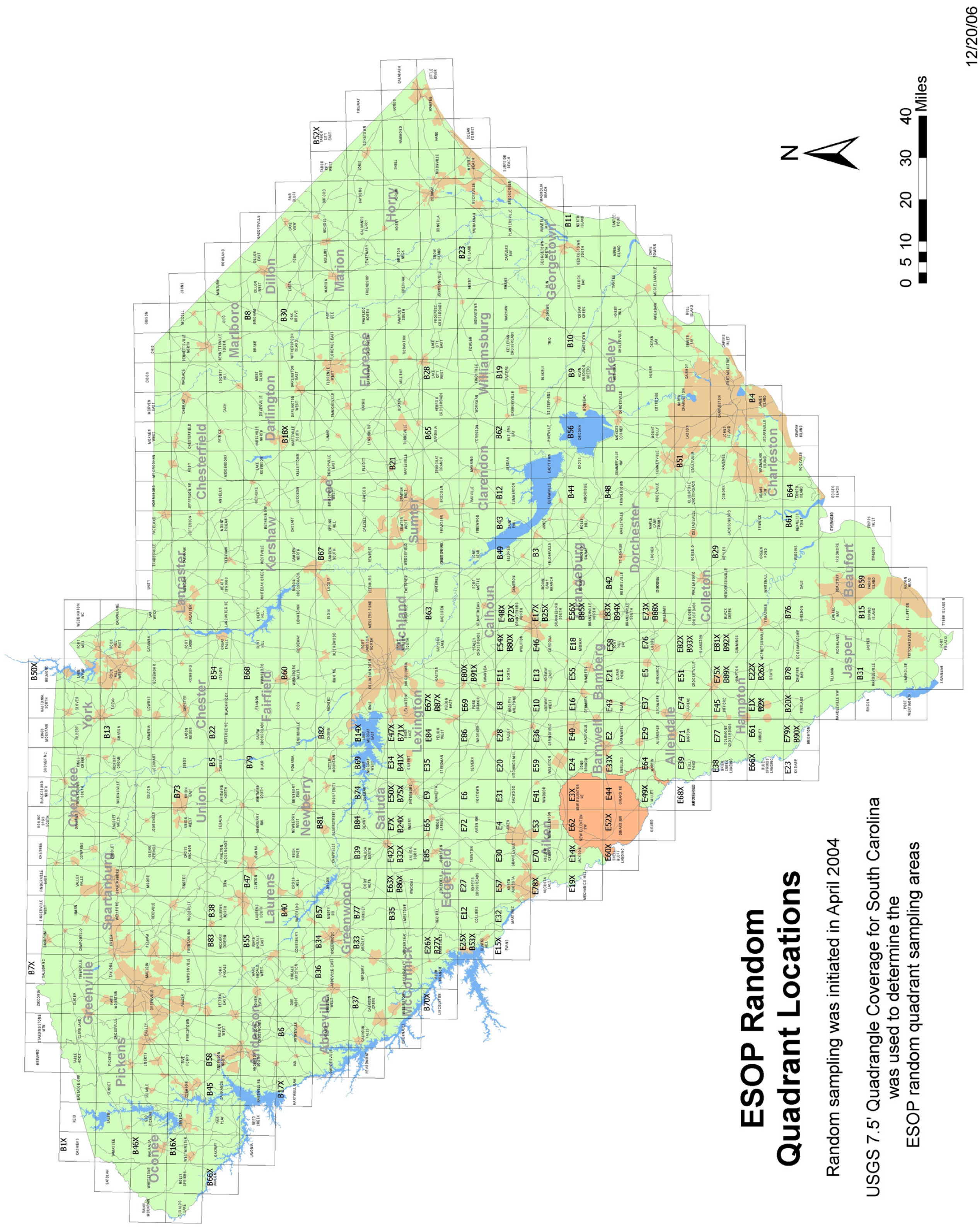
3.0 CONCLUSIONS AND RECOMMENDATIONS

Detected radionuclide concentrations found in edible vegetation sampled around SRS are well below the IAEA and USFDA standards for these emitters. Tritium continues to be the prevailing detectable analyte across all edible vegetation. However, Cs-137 dominates non-NORM gamma radionuclide exposure for the wild mushroom consumer.

The highest tritium sample (991 pCi/L or 0.991 pCi/g) occurred in a water distillation from a wild mustard leaf, which is far below the 20,000 pCi/L USEPA limit for tritium in water and IAEA food guideline of 270 pCi/g (Section 6.0 Data Table 1 and Appendix 1b). Cesium-137 levels in certain edible fungi species, primarily *Cantharelles* and *Boletus* species, add exposure for the wild mushroom consumer, whether animal or human. The highest Cs-137 occurred in a bolete mushroom (8.145 pCi/g), and was the main contributor to exposure for the wild mushroom consumer (Section 5.0 Table 4). This highest Cs-137 detection in 2011 was found in the Williston area near the highway 39 and 278 intersection. The highest strontium detection occurred in a wild mustard sample (0.233 pCi/g).

SCDHEC and the Department of Energy-Savannah River (DOE-SR) have different sampling schemes. The DOE-SR samples domestic plants and has annual participants in quadrants at 0-10 miles from the perimeter of the SRS and one quadrant at 25 miles. SCDHEC annual participants supply domestic plants, but the 2011 vegetation collections were mostly perennial wild edible vegetation including fungi and generally within 10 miles of the SRS border. Backgrounds were generally along a 50-mile perimeter with one annual background participant in Laurens County. SCDHEC will continue to establish relationships with annual contributors around the perimeter of the SRS, but has added emphasis in sampling a broader selection of wild edible vegetation, especially woody species and fungi, in an attempt to detect any previously unknown radionuclide contamination exposure. ESOP plans to continue to collect wild plants in addition to normal garden vegetation and edible wild fungi to help identify the maximally exposed individual.

4.0 2011 Radiological Monitoring of Edible Vegetation
Map 1. County and Quadrant Locations



5.0 Tables and Figures

2011 Radiological Monitoring of Edible Vegetation

Table 1a. Comparison of Tritium (pCi/L) in Edible Vegetation by County/Areas, 2011

County	Avg	SD	Median	D#	S#	Maximum
Aiken	228	NA	228	1	19	228
Allendale	254	26	254	2	10	272
Barnwell	552	250	508	6	15	991
Edgefield	<LLD	NA	<LLD	0	1	<LLD
Orangeburg	285	NA	285	1	2	285
AOC County Statistics	330	NA	269	10	47	
County/Areas Within SCbkg	Avg	SD	Median	D#	S#	Maximum
Laurens (all within SCbkg)	<LLD	NA	<LLD	0	10	<LLD
McCormick (most within SCbkg)	<LLD	NA	<LLD	0	1	<LLD
Edgefield	<LLD	NA	<LLD	0	4	<LLD
Hampton	<LLD	NA	<LLD	0	1	<LLD
Area	Avg	SD	Median	D#	S#	<LLD
SCbkg County Statistics	<LLD	NA	<LLD	0	16	Maximum
IPC	344	180	254	9	43	991
OPC	285	NA	285	1	3	285
AOC	330	150	269	10	47	991
Total Sample Number for Tritium					63	NA

Notes:
1 - IPC (Aiken, Allendale, Barnwell)
2 - OPC (Most of Edgefield, Hampton, Orangeburg not within SCbkg)
3 - AOC (Entire area of concern and includes both IPC and OPC)
4 - SCbkg (Any sample location greater than 50 miles from an SRS center-point.)
Some backgrounds were from the outer areas of Edgefield and Hampton counties.
5 - Calculated statistics are all on a county basis.
6 - The highest and most frequent tritium detections occurred in Barnwell county.
7 - The trend shows the IPC>OPC>SCbkg and AOC>SCbkg tritium in edible vegetation.
A random statistical analysis of tritum in nonedible vegetation (SCDHEC 2010) showed the same trend.
8 - Nine out of ten detections occurred in the IPC and only one in the OPC.
9 - Tritium source appears potentially from SRS and/or Plant Vogtle atmospheric releases.
10 - All edible vegetation samples were land based and not aquatic.

Table 1b. Comparison of Tritium (pCi/L) in Edible Vegetation by Sample Types

AOC Types	Avg	SD	Median	D#	S#	Maximum
Green Plants (Only)	451	249	385	9	38	991
Fruit/Seed	331	87	340	4	15	418
Greens/Root	547	305	597	5	23	991
Fungi (Only)	272	NA	272	1	9	272
SCbkg (All)	<LLD	NA	<LLD	0	16	<LLD
ALL Vegetation (with SCbkg)	433	242	340	10	63	991

1 - Grown for fruit and/or seed use.
2 - Grown for plant body consumption as leaf, stem, and/or root use.
3 - SCbkg (specific) refers to SCbkg sample type only.
4 - SCbkg (All) refers to statistics based on all background samples regardless of type sample.
5 - AOC refers to area of concern sampled for comparison to South Carolina background (SCbkg).
6- The greens/root wild types tend to have larger surface areas and exposure times for direct absoprtion of tritium in air and rainwater.
7 - The trend is AOC>SCbkg tritium concentration in edible vegetation.
8 - The term vegetation includes fungi, plant or green plant references exclude fungi.

5.0 Tables and Figures
2011 Radiological Monitoring of Edible Vegetation

Table 2. Gamma (pCi/g) in Edible Vegetation and Fungi in SRS Perimeter Counties

HMP (SCbkg)	Avg	SD	Median	MAX	D#	N#	Be-7 Avg	K-40 Avg	Pb-212 Avg	Pb-214 Avg	Cs-137 Avg	Ra-226 Avg
K-40	*10.917*	12.249	*5.846*	*38.960*	18	19		13.385				
Cs-137	2.157	1.614	2.157	3.298	2	19					2.157	
Pb-212	0.551	NA	0.551	0.551	1	19			0.551			
Pb-214	0.477	0.281	0.404	0.896	8	19				0.408		
Ra-226	3.290	NA	3.290	3.290	1	19						3.290
AKN (IPC)	Avg	SD	Median	MAX	D#	N#	Be-7 Avg	K-40 Avg	Pb-212 Avg	Pb-214 Avg	Cs-137 Avg	Ra-226 Avg
K-40	4.881	2.251	4.830	10.230	20	20		3.399				
Cs-137	1.505	1.068	1.505	2.260	2	20					*1.505*	
Pb-214	0.198	0.096	0.174	0.324	4	20				0.198		
ALD (IPC)	Avg	SD	Median	MAX	D#	N#	Be-7 Avg	K-40 Avg	Pb-212 Avg	Pb-214 Avg	Cs-137 Avg	Ra-226 Avg
Be-7	3.653	NA	3.653	3.653	1	6	3.653					
K-40	8.538	9.345	3.575	22.890	5	6		8.538				
Cs-137	0.887	0.851	1.330	1.831	3	6					0.887	
Pb-212	0.130	NA	0.130	0.130	1	6			0.130			
Pb-214	0.496	0.136	0.471	0.681	4	6				0.496		
BWL (IPC)	Avg	SD	Median	MAX	D#	N#	Be-7 Avg	K-40 Avg	Pb-212 Avg	Pb-214 Avg	Cs-137 Avg	Ra-226 Avg
Be-7	0.832	NA	0.832	0.832	1	19	0.832					
K-40	*5.150*	6.713	3.192	*22.760*	19	19		*5.392*				
Cs-137	4.625	3.330	4.204	8.145	3	19					4.625	
Pb-214	0.212	0.165	0.147	0.624	9	19				*0.212*		
ORG (OPC)	Avg	SD	Median	MAX	D#	N#	Be-7 Avg	K-40 Avg	Pb-212 Avg	Pb-214 Avg	Cs-137 Avg	Ra-226 Avg
K-40	3.182	3.603	3.182	5.730	2	2		3.628				
Pb-214	0.105	0.086	0.105	0.166	2	2				0.121		
EDF (OPC)	Avg	SD	Median	MAX	D#	N#	Be-7 Avg	K-40 Avg	Pb-212 Avg	Pb-214 Avg	Cs-137 Avg	Ra-226 Avg
K-40	4.694	NA	4.694	4.694	1	1		4.694				
Grand Total	SCbkg	19			AOC	48						
Inner Perimeter Counties (IPC) - AKN, ALD, BWL						Area of Concern (AOC) - IPC and OPC combined.						
IPC	Be-7	K-40	Pb-212	Pb-214	Cs-137	AOC	Be-7 Avg	K-40 Avg	Pb-212 Avg	Pb-214 Avg	Cs-137 Avg	Ra-226 Avg
Avg	2.243	5.777	0.130	0.302	2.339	Avg	2.243	5.130	0.130	0.257	2.339	NA
SD	1.995	2.591	NA	0.168	2.004	SD	1.995	2.069	#DIV/0!	0.164	2.004	NA
Median	2.243	5.392	0.130	0.212	1.505	Median	2.243	4.694	0.130	0.205	1.505	NA
Maximum	3.653	8.538	0.130	0.496	4.625	Maximum	3.653	8.538	0.130	0.496	4.625	NA
							Be-7 Avg	K-40 Avg	Pb-212 Avg	Pb-214 Avg	Cs-137 Avg	Ra-226 Avg
						AOC-SCbkg	2.243	<SCbkg	<SCbkg	<SCbkg	0.182	<SCbkg
OPC	Be-7	K-40	Pb-212	Pb-214	Cs-137	IPC-SCbkg	Be-7	K-40	Pb-212	Pb-214	Cs-137	Ra-226 Avg
Avg	NA	4.161	NA	0.121	NA	Avg	2.243	<SCbkg	<SCbkg	<SCbkg	0.182	<SCbkg
SD	NA	0.754	NA	NA	NA	OPC-SCbkg	Be-7	K-40	Pb-212	Pb-214	Cs-137	Ra-226 Avg
Median	NA	4.161	NA	0.121	NA	Avg	<SCbkg	<SCbkg	<SCbkg	<SCbkg	<SCbkg	<SCbkg
Maximum	NA	4.694	NA	0.121	NA							

Notes: pCi/g

1 - K-40, Pb-212, and Ra-226 avg highest in SCbkg, therefore <SCbkg in all areas.
2 - Pb-214 and Cs-137 highest in IPC, and OPC Pb-214 <SCbkg.
3 - Only Cs-137 is highest in IPC and about twice as high as SCbkg with no detect in OPC.
4 - Detections - SCbkg (K-40, Pb-212, Pb-214, Ra-226, Cs-137), OPC (K-40, Pb-214), IPC (K-40, Pb-212, Pb-214, Cs-137).
5 - Ra-226 was detected only in SCbkg where uranium containing rock is more prevalent.
6 - K-40 avg trend (SCbkg 13.385,OPC 3.6275,IPC 5.777), and median trend (SCbkg 7.410,OPC 3.6275,IPC 5.392) are similar.
7 - K-40 had the highest frequency of detections in all areas.
8 - Cs-137 was found in all areas except OPC.
9 - ALD had the highest Avg, Median, and MAX for K-40, and the highest Pb-214 for the IPC.
10 - BWL had the highest Avg, Median, and MAX for Cs-137 in the IPC.
11 - The SCbkg had the highest K-40 and Pb-212 Avg, Median, and MAX, and the highest MAX for Pb-214.
12 - The OPC did not have the highest value for any radionuclide.
13 - K-40 and Pb-214 were common to all areas.

5.0 Tables and Figures
2011 Radiological Monitoring of Edible Vegetation

Tables 3a,b - Edible Vegetation Gamma (pCi/g) in Food Use Groups, 2011

Table 3a. Area of Concern (AOC)							
Category	**Radionuclides**	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
Fruit/Seed	K-40	2.495	1.095	2.180	4.809	16	17
	Pb-214	0.180	0.086	0.174	0.324	8	17
Greens/Bulbs/Tubers	K-40	4.842	2.263	4.895	10.200	22	22
	Pb-214	0.269	0.215	0.166	**0.681**	7	22
	Be-7	1.606	1.095	1.606	**2.384**	2	22
All Green Plants	K-40	3.877	2.160	3.488	10.200	39	39
	Pb-214	0.221	0.160	0.166	**0.681**	15	39
	Be-7	1.606	1.095	1.606	**2.384**	2	39
Fungi	K-40	**12.355**	8.848	**13.285**	**22.890**	8	9
	Cs-137	**2.270**	2.521	**1.525**	**8.145**	9	9
	Pb-212	**0.130**	NA	**0.130**	**0.130**	1	9
	Pb-214	**0.402**	0.217	**0.433**	0.624	4	9
	Be-7	**3.653**	NA	**3.653**	**3.653**	1	9
Table 3b. South Carolina Background (SCbkg)							
Category	**Radionuclides**	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
Fruit/Seed	K-40	2.347	0.815	2.090	3.511	4	4
	Pb-214	0.128	0.740	0.128	0.181	2	4
Greens/Bulbs/Tubers	K-40	5.675	2.013	5.844	7.935	10	11
	Pb-214	0.375	0.286	0.292	0.779	4	11
All Green Plants	K-40	4.724	2.322	5.052	7.935	14	15
	Pb-214	0.293	0.258	0.199	0.779	6	15
Fungi	K-40	**32.595**	4.607	**31.150**	**38.960**	4	4
	Cs-137	**2.157**	1.614	**2.157**	**3.298**	2	4
	Pb-212	***0.551***	NA	**0.551**	**0.551**	1	4
	Pb-214	**0.580**	0.273	**0.571**	**0.896**	2	4
	Ra-226	**3.290**	NA	**3.290**	**3.290**	1	4

Notes:
1 - Teas and condiments covered under sources, i.e., fruit or seed, greens or bulbs or tubers, and fungi.
2 - AOC and SCbkg highest values in bold for radionuclide average, median, and maximum.
3 - Highest overall (AOC or SCbkg) is underlined.
4 - Highest in AOC (K-40 max, Cs-137 avg, median, max).
5 - Highest in SCbkg (avg, median in K-40 and avg, median, max in Pb-212, Pb-214, and Ra-226) in Fungi.
6 - Ra-226 detection occurred only in fungi in SCbkg.

5.0 Tables and Figures
2011 Radiological Monitoring of Edible Vegetation

Table 4. Edible Fungi Gamma (pCi/g) Detections in the AOC and SCbkg, 2011

Fungus	Date	ID	Location	Cs-137	K-40	Pb-212	Pb-214	Ra-226
Lichen	4/1/2011	EV042	ALD	**0.215**	<MDA	<MDA	<MDA	<MDA
Only one Be-7 detection (3.653 pCi/g) occurred in fungi related lichen.								
Jellies	09/28/11	EV094	ALD	**0.172**	1.265	<MDA	<MDA	<MDA
Chanterelles	8/18/2011	EV078w	ALD	***1.831***	13.120	0.130	0.361	<MDA
Boletes	8/18/2011	EV07980	ALD	**1.330**	22.890	<MDA	0.505	<MDA
Boletes	8/23/2011	EV083w	AKN	**2.260**	3.527	<MDA	0.119	<MDA
Boletes	10/27/11	EV098	AKN	**0.750**	3.108	<MDA	<MDA	<MDA
Boletes	8/24/2011	EV084	BWL	**4.204**	22.760	<MDA	0.624	<MDA
Boletes	8/25/2011	EV085	BWL	**8.145**	18.720	<MDA	<MDA	<MDA
Boletes	8/31/2011	EV086	BWL	**1.525**	13.450	<MDA	<MDA	<MDA
South Carolina Fungi Backgrounds								
Portabella	11/19/11	EV099	LAU	<MDA	**29.290**	**0.551**	**0.896**	**3.290**
Chicken	9/17/2011	EV091	LAU	<MDA	**33.010**	<MDA	0.281	<MDA
Boletes	8/12/2011	EV07677	HPT	**1.016**	**29.120**	<MDA	0.702	<MDA
Chanterelles	8/12/2011	EV07475	HPT	***3.298***	**38.960**	<MDA	0.441	<MDA
Bolete Fungi Statistics			**County Basis Statistics**					
Bolete Cs-137	AOC Avg	**3.036**	**ALD Avg**	**0.887**	**12.425**	**0.130**	**0.433**	<MDA
Bolete Cs-137	SCbkg	1.016	**AKN Avg**	**1.505**	**3.318**	<MDA	**0.119**	<MDA
Golden Chanterelles Statistics			**BWL Avg**	**4.625**	**18.310**	<MDA	**0.624**	<MDA
Chanterelle Cs-137	AOC Avg	1.831	**LAU Avg**	<MDA	**31.150**	**0.551**	**0.588**	**3.290**
Chanterelle Cs-137	SCbkg	**3.298**	**HPT Avg**	**2.157**	**34.040**	<MDA	**0.571**	<MDA
			IPC Avg	**2.339**	**11.351**	**0.130**	**0.392**	<MDA
			OPC Avg	**NA**	**NA**	**NA**	**NA**	**NA**
			AOC Avg	**2.339**	**11.351**	**0.130**	**0.392**	<MDA
			SCbkg Avg	**2.157**	**32.595**	**0.551**	**0.580**	**3.290**

Notes:

1 - Chanterelles are *Cantharellus cibarius*.
2 - Portabella mushroom spores planted from domestic source.
3 - Chicken is *Laetiporus sulfureus*.
4 - All others are mixtures of specified type, e.g., Boletes refers to more than one bolete species.
5 - Reindeer Lichen was the only fungi with a Be-7 detect, and was the only sample with no K-40 detection.
6 - Cs-137 detects in AOC boletes were higher than in SCbkg boletes.
7 - All K-40 and Pb-212 and Pb-214 SCbkg detects were higher than in AOC.
8 - Ra-226 detect occurred only in the SCbkg in an accidental planting of a domestic species (escape).
The high lead radionuclides possibly due to the fungi being disposed of among wood and metal trash.

6.0 Data
2010 Radiological Monitoring of Edible Vegetation

DATA 16

Notes:
1. Bold numbers denote detections.
2. A blank field following ±2 SIGMA occurs when the sample is <LLD or <MDA.
3. LLD= Lower Limit of Detection, MDA=Minimum Detectable Activity
4. MDA= Minimum Detectable Activity
5. * More than 8 half lives had elapsed
6. NA - Denotes not applicable.
7. D# is number of detections
8. N# is number of samples
9. pCi/L – all tritium values
10. pCi/g – all other radionuclide (gamma) values
11. All units are in pCi/g. D# is number of detections

6.0 Data
2011 Radiological Monitoring of Edible Vegetation Section 6.

Data Table 1a. Tritium (pCi/L) in Edible Greens												
Domestic Greens	**Tritium in AOC Collard Greens**										**Turnip leaf**	**Domestic**
Location	**EV034a**	**EV034b**	**EV034c**	**EV034d**	**EV034e**	**EV034f**	**EV035**	**EV040**	**EV039**	**EV037**	**EV036 a**	**Greens**
Collection Date	1/28/11	1/28/11	1/28/11	1/28/11	1/28/11	1/28/11	2/1/11	3/28/11	2/27/11	2/27/11	2/1/11	**AOC Statistics**
county	Aiken	Aiken	Aiken	Aiken	Aiken	Aiken	Aiken	Barnwell	Laurens	Laurens	Aiken	**Avg/median**
Tritium Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium C.I.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Tritium LLD	207	207	207	207	207	207	207	216	216	216	207	**SCbkg**
Area or Region	AOC								SCbkg		AOC	<LLD
Wild Greens	**Tritium in Wild Mustard Greens**					**Tritium in Pokeberry Leaf**						**Wild**
Location	**EV041**	**EV043**	**EV044**	**EV050**	**EV064**	**EV059**	**EV051**	**EV053**	**EV054**	**EV057**	**EV048**	**Greens**
Collection Date	3/28/11	4/1/11	4/1/11	4/27/11	6/27/11	5/19/11	4/28/11	4/28/11	4/28/11	5/19/11	4/14/2011	**AOC Statistics**
county	Aiken	Allendale	Barnwell	Barnwell	Laurens	Barnwell	Aiken	Allendale	Allendale	Orangeburg	Edgefield	**Avg/median**
Tritium Activity	<LLD	<LLD	<LLD	<LLD	<LLD	**991**	<LLD	<LLD	<LLD	**285**	<LLD	638
Tritium C.I.	NA	NA	NA	NA	NA	122	NA	NA	NA	105	NA	
Tritium LLD	216	216	216	216	211	211	211	211	211	211	216	**SCbkg**
Area or Region	AOC				**SCbkg**	AOC					**SCbkg**	<LLD
Data Table 1b. Tritium in Fruits and Roots												
Domestic Veg	**Squash**		**Turnip root**	**Corn**	**Tomato**		**Cucumber**		**Radish**		**Peas**	**Domestic**
Location	**EV069**	**EV063**	**EV036a**	**EV089**	**EV070**	**EV071**	**EV062**	**EV068**	**EV090**	**EV065**	**EV066**	**Fruit/Root**
Collection Date	6/27/11	6/8/11	2/1/11	9/16/11	6/27/11	6/30/11	6/8/11	6/27/11		6/27/11	6/27/11	**AOC Statistics**
county	Laurens	Barnwell	Aiken	Barnwell	Laurens	Barnwell	Barnwell	Laurens	Laurens	Laurens	Laurens	**Avg/median**
Tritium Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium C.I.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Tritium LLD	206	211	207	213	206	206	211	206	213	211	206	**SCbkg**
Area or Region	**SCbkg**	AOC			**SCbkg**			**SCbkg**	**SCbkg**		**SCbkg**	<LLD
Wild Fruit	**Persimmons**				**Plums**					**Wild Grape**	**Wild Fruits**	
Location	**EV092a**	**EV093**	**EV095**	**EV096**	**EV052**	**EV056a**	**EV056b**	**EV058**	**EV060**	**EV082**		
Collection Date	9/27/11	9/27/11	9/28/11	9/28/11	4/28/11	5/18/11	5/18/11	5/19/11	5/19/11	8/23/11	**AOC Statistics**	
county	Aiken	Aiken	Barnwell	Barnwell	Aiken	Barnwell	Barnwell	Orangeburg	Edgefield	Aiken	**Avg**	**Median**
Tritium Activity	<LLD	<LLD	<LLD	418	<LLD	385	294	<LLD	<LLD	228	**366**	**385**
Tritium C.I.	NA	NA	NA	104	NA	103	100	NA	NA	98		
Tritium LLD	213	213	213	213	211	211	211	211	211	213		
Area or Region	AOC				AOC				**SCbkg**	AOC		
Atypical Wild Veg	**Winged Sumac Drupe**		**Prickly Pear Cactus**				**Yucca Flower**	**Apple-Pear**	**Curly Dock**			**Atypical Veg**
Location	**EV045**	**EV092b**	**EV061**	**EV072**	**EV081**	**EV049**	**EV055**	**EV097**		**EV046**	**EV047**	**AOC Statistics**
Collection Date	4/13/11	9/27/11	5/20/11	6/30/11	8/18/11	4/14/11	5/18/11	10/14/11		4/14/11	4/14/11	**Avg**
county	Aiken	Aiken	Edgefield	Barnwell	Allendale	Edgefield	Barnwell	Aiken		Edgefield	McCormack	486
Tritium Activity	**NS**	<LLD	<LLD	**597**	**235**	<LLD	**626**	<LLD		<LLD	<LLD	**Median**
Tritium C.I.	too dry	NA	NA	109	98	NA	111	NA		NA	NA	597
Tritium LLD	216	213	211	206	213	216	211	213		216	216	**SCbkg**
Area or Region	AOC		**SCbkg**	AOC		**SCbkg**	AOC			AOC	**SCbkg**	<LLD
Data Table 1c. Tritium in Fungi												
Wild Fungi	**Tritium in Golden Chanterelles**			**Tritium in Boletes**				**Chicken**	**Lichen**	**Jelly**	**Portabella**	**Wild**
Location	**EV078**	**EV079**	**EV074**	**EV078b**	**EV079b**	**EV083**	**EV098**	**EV080**	**EV042**	**EV094**	**EV099**	**Fungi**
Collection Date	8/18/11	8/18/11	8/12/11	8/18/11	8/18/11	8/23/11	10/27/2011	8/18/11	4/1/11	9/28/2011	11/19/2011	**AOC Statistics**
county	Allendale	Allendale	Hampton	Allendale	Allendale	Aiken	Aiken	Allendale	Allendale	Allendale	Laurens	**Avg/median**
Tritium Activity	<LLD	<LLD	<LLD	272	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	272
Tritium C.I.	NA	NA	NA	100	NA	NA	NA	NA	NA	NA	NA	
Tritium LLD	213	213	213	213	213	213	213	213	216	213	213	**SCbkg**
Area or Region	AOC		**SCbkg**	AOC				AOC			**SCbkg**	<LLD

Notes:
1 - See Appendix for abbreviations and species.
2 - NS means no sample.

6.0 Data
2011 Radiological Monitoring of Edible Vegetation

Data Table 2a. Gamma (pCi/g) in Collard Green Plants

Plant	AOC Collard leaf					AOC Collard stalk		Collard SCbkg	
Field ID	EV034a	EV034b	EV034c	EV034d	EV040	EV034e	EV034f	EV037	EV039
Collection Date	1/28/11	1/28/11	1/28/11	1/28/11	3/28/11	1/28/11	1/28/11	2/27/11	3/28/11
County	akn	akn	akn	akn	bwl	akn	akn	lau	lau
K-40 Activity	**6.470**	**6.560**	**10.200**	**9.620**	**5.25**	**5.890**	**6.070**	**4.710**	**4.920**
K-40 C.I.	1.260	1.320	1.260	1.410	0.575	1.230	1.270	0.596	0.647
K-40 MDA	0.483	0.510	0.450	0.543	0.188	0.691	0.552	0.245	0.229

Data Table 2b. Gamma (pCi/g) in Mustard Greens and Turnip Plants

Plant	Mustard Greens				Turnip Greens	Turnip Tuber
Area	AOC			SCbkg	SCbkg	SCbkg
Field ID	EV041	EV044	EV050	EV067	EV064	EV064b
Collection Date	4/1/11	4/1/11	4/27/11	6/27/11	6/27/11	6/27/11
County	AKN	BWL	BWL	LAU	LAU	LAU
Be-7	<MDA	**0.832**	<MDA	<MDA	<MDA	<MDA
CI	**NA**	**0.304**	**NA**	**NA**	**NA**	**NA**
MDA		**0.311**				
K-40 Activity	**4.850**	**2.440**	**0.293**	**7.935**	**5.184**	**6.207**
K-40 C.I.	0.631	0.419	**3.880**	0.786	0.638	0.695
K-40 MDA	0.240	0.194	0.547	0.213	0.234	0.263
Pb-214 Activity	<MDA	<MDA	<MDA	**0.217**	**0.367**	**0.779**
K-40 C.I.	NA	NA	NA	0.047	0.061	0.077
K-40 MDA				0.053	0.058	0.062

Data Table 2c. Gamma (pCi/g) in Pokeberry Leaf

Plant	AOC Pokeberry Leaf				SCbkg
Field ID	EV051	EV053	EV054	EV057	EV048
Collection Date	4/28/11	4/28/11	4/28/11	5/19/11	4/14/11
County	AKN	ALD	BWL	ORG	EDF
K-40 Activity	**5.472**	**3.575**	**4.879**	**5.730**	**6.450**
K-40 C.I.	0.604	0.483	0.630	0.635	0.577
K-40 MDA	0.189	0.211	0.280	0.200	0.138
Pb-214 Activity	**<MDA**	**0.681**	**0.235**	**0.166**	**<MDA**
Pb-214 C.I.	NA	0.067	0.062	0.044	NA
Pb-214 MDA	0.050	0.054	0.063	0.050	0.043

Notes:

1 - All other gamma analyses for the respective food group were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144,Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

6.0 Data
2011 Radiological Monitoring of Edible Vegetation

Data Table 3. Gamma (pCi/g) in Fruits									
Plant	**AOC Wild Persimmon Fruit**				**AOC/Squash/SCbkg**		**AOC/Tomato/SCbkg**		**AOC Grapes**
Field ID	**EV092a**	**EV095**	**EV096**	**EV093**	**EV063**	**EV069**	**EV071**	**EV070**	**EV082w**
Date	9/27/11	9/28/11	9/28/11	9/27/11	6/8/11	6/27/11	6/30/11	6/27/11	8/23/11
County	**AKN**	**BWL**	**BWL**	**AKN**	**BWL**	**LAU**	**BWL**	**LAU**	**AKN**
K-40 Activity	**3.024**	**3.192**	**3.250**	**3.488**	**1.468**	**1.698**	**1.875**	**3.511**	**1.460**
K-40 C.I.	0.453	0.410	0.425	0.436	0.344	0.315	0.361	0.376	0.348
K-40 MDA	0.173	0.171	0.179	0.164	0.141	0.146	0.160	0.116	0.185
Pb-214	<MDA	**0.243**	**0.100**	**0.128**	<MDA	**0.181**	**0.123**	<MDA	**0.220**
Pb-214 C.I.	NA	0.045	0.043	0.049	NA	0.039	0.042	NA	0.044
Pb-214 MDA	0.055	0.042	0.043	0.048	0.045	0.034	0.040	0.035	0.045
Plant	**AOC Pears**		**AOC Corn**	**AOC/Cucumber/SCbkg**		**Plant**	**Radish SCbkg**		
Field ID	**EV088w**	**EV097**	**EV089**	**EV062**	**EV068**	**Field ID**	**EV065**	**EV090**	
Date	9/2/11	10/14/11	9/16/11	6/8/11	6/27/11	**Date**	6/27/11	9/16/11	
County	**BWL**	**AKN**	**BWL**	**BWL**	**LAU**	**County**	**LAU**	**LAU**	
K-40	**0.819**	**3.475**	**3.711**	**1.373**	**2.298**	**K-40**	**7.41**	**7.50**	
K-40 C.I.	0.272	0.438	0.677	0.364	0.357	**K-40 C.I.**	0.73	0.92	
K-40 MDA	0.140	0.169	0.280	0.156	0.125	**K-40 MDA**	0.19	0.26	
Plant	**AOC Wild Plum Fruit**				**Plum SCbkg**	**Plant**	**AOC Sumac Drupes**		
Field ID	**EV058**	**EV056a**	**EV056b**	**EV052**	**EV060**	**Field ID**	**EV092b**	**EV045**	
Date	5/19/11	5/18/11	5/18/11	4/28/11	5/19/11	**Date**	9/27/11	4/13/11	
County	**ORG**	**BWL**	**BWL**	**AKN**	**EDF**	**County**	**AKN**	**AKN**	
K-40	**1.525**	**2.099**	**2.131**	**2.229**	**1.882**	**Be-7**	<MDA	**2.380**	
K-40 C.I.	0.297	0.333	0.331	0.369	0.350	**Be-7 C.I.**	NA	0.499	
K-40 MDA	0.153	0.125	0.158	0.169	0.133	**Be-7 MDA**	1.621	0.425	
Pb-214	**0.076**	**0.228**	<MDA	<MDA	**0.076**	**K-40**	**4.809**	**4.770**	
Pb-214 C.I.	0.034	0.034	NA	NA	0.032	**K-40 C.I.**	0.936	0.695	
Pb-214 MDA	0.039	0.035	0.045	0.050	0.038	**K-40 MDA**	0.490	0.309	
						Pb-214	**0.324**	<MDA	
						Pb-214 C.I.	0.102	NA	
						Pb-214 MD	0.099	0.073	

Notes:

1 - All other gamma analyses for the respective food group were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144,Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

6.0 Data
2011 Radiological Monitoring of Edible Vegetation

Data Table 4. Edible Fungi Gamma (pCi/g) Detections in the AOC and SCbkg, 2011

Fungus	Date	ID	Location	Cs-137	K-40	Pb-212	Pb-214	Ra-226
Lichen	4/1/2011	EV042	ALD	**0.215**	<MDA	<MDA	<MDA	<MDA
Only fungi with a Be-7 detection (3.653 pCi/g) occurred in a Reindeer Lichen.								
Jellies	9/28/2011	EV094	ALD	**0.172**	1.265	<MDA	<MDA	<MDA
Chanterelles	8/18/2011	EV078w	ALD	**1.831**	13.120	0.130	0.361	<MDA
Boletes	8/18/2011	EV07980	ALD	**1.330**	22.890	<MDA	0.505	<MDA
Boletes	8/23/2011	EV083w	AKN	**2.260**	3.527	<MDA	0.119	<MDA
Boletes	10/27/2011	EV098	AKN	**0.750**	3.108	<MDA	<MDA	<MDA
Boletes	8/24/2011	EV084	BWL	**4.204**	22.760	<MDA	0.624	<MDA
Boletes	8/25/2011	EV085	BWL	**8.145**	18.720	<MDA	<MDA	<MDA
Boletes	8/31/2011	EV086	BWL	**1.525**	13.450	<MDA	<MDA	<MDA
South Carolina Fungi Backgrounds								
Portabella	11/19/2011	EV099	LAU	<MDA	**29.290**	**0.551**	**0.896**	**3.290**
Chicken	9/17/2011	EV091	LAU	<MDA	**33.010**	<MDA	0.281	<MDA
Boletes	8/12/2011	EV07677	HPT	**1.016**	**29.120**	<MDA	0.702	<MDA
Chanterelles	8/12/2011	EV07475	HPT	**3.298**	**38.960**	<MDA	0.441	<MDA

Notes:
1 - All other gamma analyses in fungi were <MDA.
2 - All other gamma analyses for the respective food group were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

Data Table 5. Total Strontium (pCi/g)

ID	EV040	EV041	EV044	EV045	EV046	EV047	EV048	EV039
County	Bwl	Akn	Bwl	Akn	Edf	MCM	Edf	Lau
Collected	03/28/11 17:00	04/01/11 08:00	04/01/11 12:30	04/13/11 11:30	04/14/11 13:15	04/14/11 10:00	04/14/11 10:30	03/28/11 17:00
Result	**0.028**	**0.076**	**0.233**	**0.133**	<MDA	<MDA	**0.027**	<MDA
CSU	0.016	0.030	0.084	0.051	0.015	0.011	0.016	0.016
MDA	0.024	0.023	0.025	0.033	0.024	0.023	0.025	0.028
Type EV	Collards	Wild Mustard	Wild Mustard	Sumac Drupe	Curly Dock	Curly Dock	Pokeberry	Collards
Area	AOC					SCbkg		
Summary	**Avg**	SD	**Median**			**Avg**	SD	**Median**
Statistics	**0.117**	0.088	**0.104**			**0.027**	NA	**0.027**

Notes:
1 - All are leafy greens except Winged Sumac Drupes used as a tea source.

7.0 Summary Statistics
2011 Radiological Monitoring of Edible Vegetation

Summary Statistics by Vegetation Type and Radionuclides 21

Notes:

1. S# is total sample number. N# will sometimes equal S#.
3. N/A = Not Applicable
4. Min. – Minimum
5. Max. = Maximum
6. * more than 8 half lives had elapsed
7. D# is number of detections
8. N# is number of samples in group
9. pCi/L – all tritium values
10. pCi/g – all other radionuclide (gamma) values

7.0 Summary Statistics
2011 Radiological Monitoring of Edible Vegetation

Summary StatisticsTable 1. Tritium (pCi/L) in AOC and SCbkg Edible Vegetation (includes Fungi), 2011.

Food Type	Avg	SD	Median	Max	D#	N#	A/P	D/W
Collards	<LLD	NA	<LLD	<LLD	0	8	A	D
Turnips	<LLD	NA	<LLD	<LLD	0	2	A	D
Tomatoes	<LLD	NA	<LLD	<LLD	0	1	A	D
Cucumbers	<LLD	NA	<LLD	<LLD	0	1	A	D
Squash (Zuchini)	<LLD	NA	<LLD	<LLD	0	1	A	D
Corn	<LLD	NA	<LLD	<LLD	0	1	A	D
Asian apple-pear	<LLD	NA	<LLD	<LLD	0	1	P	W
Winged Sumac (fruit)	<LLD	NA	<LLD	<LLD	0	1	P	W
Curly Dock	<LLD	NA	<LLD	<LLD	0	1	P	W
Red Sulfur Fungus	<LLD	NA	<LLD	<LLD	0	1	P	W
Chanterelles	<LLD	NA	<LLD	<LLD	0	2	P	W
Jellies (fungi)	<LLD	NA	<LLD	<LLD	0	1	P	W
Lichen (Reindeer)	<LLD	NA	<LLD	<LLD	0	1	P	W
Mustards	991	NA	991	991	1	5	P	W
Yucca flower	626	111	626	626	1	1	P	W
Cactus (prickly pear)	416	NA	416	597	2	2	P	W
Persimmons	418	NA	418	418	1	4	P	W
Plums (hog)	340	64	340	385	2	4	P	W
Pokeberry Leaf	285	NA	285	285	1	4	P	W
Bolete Mushrooms	272	NA	272	272	1	4	P	W
Grapes (Escaped muscadine)	228	NA	228	228	1	1	P	W
Area of Concern (AOC) Statistics (Sample Type Basis)								
Avg	433	Summary average of tritium across food types.						
SD	242	Standard deviation around average.						
Median	340	Central tendency across area of concern.						
D#	10	Total number of tritium detections out of 53 samples.						
N#	47							
SCbkg	<LLD	NA	<LLD	<LLD	0	16	A/P	D/W
Plums (hog)	<LLD	NA	<LLD	<LLD	0	1	P	W
Peas	<LLD	NA	<LLD	<LLD	0	1	A	D
Cucumbers	<LLD	NA	<LLD	<LLD	0	1	A	D
Zuchini	<LLD	NA	<LLD	<LLD	0	1	A	D
Tomato	<LLD	NA	<LLD	<LLD	0	1	A	D
Prickly Pear Cactus	<LLD	NA	<LLD	<LLD	0	1	P	W
Mustard	<LLD	NA	<LLD	<LLD	0	2	P	W
Curly Dock	<LLD	NA	<LLD	<LLD	0	1	P	W
Pokeberry Leaf	<LLD	NA	<LLD	<LLD	0	1	P	W
Radish	<LLD	NA	<LLD	<LLD	0	2	A	D
Collards	<LLD	NA	<LLD	<LLD	0	2	A	D
Chanterelles	<LLD	NA	<LLD	<LLD	0	1	P	W
Portabella (Escape)	<LLD	NA	<LLD	<LLD	0	1	P	W
Total Tritium Samples (AOC plus SCbkg)						63	A/P	D/W

Notes:
1 - "D" means a domestic sample. "W" means a wild type sample.
2 - "A" means annual plant. "P" means perennial. "Escape" refers to a domestic species found in the wild.

7.0 Summary Statistics
2011 Radiological Monitoring of Edible Vegetation

Summary Statistics Table 2a. Edible Vegetation Categories in Area of Concern (AOC), Gamma Detections (pCi/g), 2011

Green Plants	Avg	SD	Median	Max	D#	S#	AvgAOC-SCbkg	MedianAOC-SCbkg	Max-SCbkg
Be-7 Activity	1.606	1.095	1.606	2.380	2	39	**1.606**	**1.606**	**2.380**
K-40 Activity	3.877	2.160	3.488	10.200	39	39	<SCbkg	<SCbkg	<SCbkg
Pb-214 Activity	0.221	0.160	0.166	0.681	15	39	<SCbkg	<SCbkg	<SCbkg
Fungi	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**	**AvgAOC-SCbkg**	**MedianAOC-SCbkg**	**Max-SCbkg**
K-40 Activity	**12.355**	8.848	**13.285**	**22.890**	8	9	<SCbkg	<SCbkg	<SCbkg
Cs-137 Activity	**2.270**	2.521	**1.525**	**8.145**	9	9	**0.113**	<SCbkg	**4.847**
Pb-212 Activity	**0.130**	NA	**0.130**	**0.130**	1	9	<SCbkg	<SCbkg	<SCbkg
Pb-214 Activity	0.402	0.217	**0.433**	0.624	4	9	<SCbkg	<SCbkg	<SCbkg
Domestic Annuals	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**	**AvgAOC-SCbkg**	**MedianAOC-SCbkg**	**Max-SCbkg**
K-40 Activity	4.664	2.960	5.050	10.200	16	16	<SCbkg	<SCbkg	<SCbkg
Pb-214 Activity	0.135	0.017	0.135	0.147	2	16	<SCbkg	<SCbkg	<SCbkg
Domestic Perennials	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**	**AvgAOC-SCbkg**	**MedianAOC-SCbkg**	**Max-SCbkg**
K-40 Activity	0.819	NA	0.819	0.819	1	1	<SCbkg	<SCbkg	<SCbkg
Wild Perennials	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**	**AvgAOC-SCbkg**	**MedianAOC-SCbkg**	**Max-SCbkg**
K-40 Activity	3.279	1.402	3.221	5.730	22	22	<SCbkg	<SCbkg	<SCbkg
Pb-214 Activity	**0.234**	0.169	0.220	**0.681**	13	22	**0.128**	**0.114**	**0.545**
Be-7 Activity	1.606	1.095	1.606	2.384	2	39	**1.606**	**1.606**	**2.384**

Table 2b. Edible Vegetation Categories in South Carolina Background (SCbkg), Gamma Detections (pCi/g), 2011

Green Plants	Avg	SD	Median	Max	D#	S#
K-40 Activity	4.724	2.322	5.052	7.935	14	15
Pb-214 Activity	0.293	0.258	0.199	0.779	6	15
Fungi	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**
K-40 Activity	**32.595**	4.607	**31.150**	**38.960**	4	4
Cs-137 Activity	**2.157**	1.614	**2.157**	**3.298**	2	4
Pb-212 Activity	**0.551**	NA	**0.551**	**0.551**	1	4
Pb-214 Activity	**0.580**	0.273	**0.571**	**0.896**	4	4
Ra-226 Activity	**3.290**	NA	**3.290**	**3.290**	1	4
Domestic Annuals	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**
K-40 Activity	5.138	2.173	5.052	7.935	10	10
Pb-214 Activity	0.386	0.274	0.292	0.779	4	10
Wild Perennials	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**
K-40 Activity	4.604	2.407	5.180	6.450	3	4
Pb-214 Activity	0.106	0.042	0.106	0.136	2	4

Notes:

1 - All other gamma analyses for the respective food group were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144,Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

2 - Fungi dominate the average and maximum statistics for Cs-137 detections > SCbkg.

3 - Potassium-40 was highest in fungi AOC and SCbkg.

4 - Lead-214 was highest among perennials that were mostly large woody root systems.

5 - Domestic perennial used wild perennial SCbkg.

6 - Wild perennials dominate the average, median, and maximum statistics for Pb-214 > SCbkg.

7 - Be-7 was detected in only two AOC samples (winged sumac and wild mustard). Biased high since no SCbkg subtraction.

7.0 Summary Statistics
2011 Radiological Monitoring of Edible Vegetation

Summary Statistics Table 3. Leafy Green Plants Gamma (pCi/g) Detections

Collard Summary Statistics, AOC and SCbkg

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Collards	7.151	1.940	6.470	10.200	7	7
SCbkg	0.622	0.036	0.622	0.647	2	2
AOC-SCbkg	6.530	NA	5.849	9.553	NA	NA

Mustard Summary Statistics, AOC and SCbkg

Be-7	Avg	SD	Median	Maximum	D#	N#
AOC Mustards	0.832	NA	0.832	0.832	1	3
SCbkg	<MDA	NA	<MDA	<MDA	0	1
AOC-SCbkg	0.832	NA	0.832	0.832	NA	NA
K-40	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Mustards	2.528	2.280	2.440	2.440	3	3
SCbkg	7.935	NA	7.935	7.935	1	1
AOC-SCbkg	<MDA	NA	<MDA	<MDA	NA	NA
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Mustards	<MDA	<MDA	<MDA	<MDA	7	7
SCbkg	0.217	NA	0.217	0.217	2	2
AOC-SCbkg	<MDA	NA	<MDA	<MDA	NA	NA

Turnip Summary Statistics, SCbkg

K-40	Avg	SD	Median	Maximum	D#	N#
SCbkg	5.696	0.723	5.696	6.207	1	1
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
SCbkg	0.573	0.291	0.573	0.779	2	2

Pokeberry Summary Statistics, AOC and SCbkg

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Pokeberry	4.914	0.961	5.176	5.176	4	4
SCbkg	6.450	NA	6.450	6.450	1	1
AOC-SCbkg	<MDA	NA	<MDA	<MDA	NA	NA
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Pokeberry	0.360	0.279	0.235	0.681	3	4
SCbkg	<MDA	NA	<MDA	<MDA	1	1
AOC-SCbkg	0.360	NA	0.235	0.681	NA	NA

Prickly Pear Cactus Summary Detection Statistics, AOC

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Cactus	1.671	0.242	1.671	1.842	2	2
SCbkg Cactus	<MDA	NA	<MDA	<MDA	0	1
AOC-SCbkg	1.671	NA	1.671	1.842	NA	NA
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Cactus	0.278	0.224	0.278	0.437	2	2
SCbkg Cactus	0.1359	NA	0.1359	0.1359	1	1
AOC-SCbkg	0.143	NA	0.143	0.301	NA	NA
Single Sample Summary Statistics						
SCbkg Lettuce K-40	5.184	NA	5.184	5.184	1	1
SCbkg Lettuce Pb-214	0.367	NA	0.367	0.367	1	1
AOC Yucca flower K-40	1.693	1.460	1.693	1.693	1	1
AOC Yucca flower Pb-214	0.091	NA	0.091	0.091	1	1

Notes:

1 - All other gamma analyses for the respective food group were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144,Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

2 - Summary statistics combine analyses of domestic and wild type plants, e.g., domestic and wild mustards.

7.0 Summary Statistics
2011 Radiological Monitoring of Edible Vegetation

Summary Statistics Table 4. Fruits Gamma (pCi/g) Detections

Wild Plum Fruit Summary Statistics, AOC and SCbkg

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Plum	1.996	0.319	2.115	2.229	4	4
SCbkg	1.882	NA	1.882	1.882	1	1
AOC-SCbkg	0.114	NA	0.233	0.347	NA	NA
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Plum	0.152	0.108	0.152	0.228	2	4
SCbkg	0.076	NA	0.076	0.076	1	1
AOC-SCbkg	0.076	NA	0.076	0.152	NA	NA

Wild Persimmon Fruit Summary Statistics, AOC

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Persimmon	3.239	0.192	3.221	3.488	4	4
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Persimmon	0.157	0.075	0.128	0.243	3	4

Winged Sumac Drupes Summary Detection Statistics, AOC

Be-7	Avg	SD	Median	Maximum	D#	N#
AOC Sumac	2.38	NA	2.38	2.380	1	2
K-40	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Sumac	4.7895	0.027577	4.7895	4.809	2	2
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Sumac	0.3238	NA	0.3238	0.324	1	2

Squash Summary Detection Statistics, AOC

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Squash	1.468	NA	1.468	1.468	1	1
SCbkg Squash	1.698	NA	1.698	1.698	1	1
AOC-SCbkg	-0.230	NA	-0.230	-0.230	NA	NA
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
SCbkg Squash	0.181	NA	0.181	0.181	1	1

Tomato Summary Detection Statistics, AOC

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Tomato	2.693	1.157	2.693	3.511	2	2
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Tomato	0.123	NA	0.123	0.123	1	2

Radish Summary Detection Statistics, SCbkg

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Radish	7.457	0.066	7.457	7.503	2	2

Cucumber Summary Detection Statistics, AOC

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Cucumber	1.373	NA	1.373	1.373	1	1
SCbkg Cucumber	2.298	NA	2.298	2.298	1	1
AOC-SCbkg	-0.925	NA	-0.925	-0.925	NA	NA

Pear Fruit Summary Detection Statistics, AOC

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Pears	2.147	1.878	2.147	3.475	2	2

Single Sample Edible Vegetation Summary Detection Statistics, AOC

K-40	Avg	SD	Median	Maximum	D#	N#
AOC Corn	3.711	NA	3.711	3.711	1	1
AOC Grapes	1.460	1.460	1.460	1.460	1	1
Pb-214	**Avg**	**SD**	**Median**	**Maximum**	**D#**	**N#**
AOC Grapes	0.220	NA	0.220	0.220	1	1

Notes:

1 - All other gamma analyses for the respective food group were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144,Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

2 - Some plant types were only collected in the AOC or SCbkg and not both.

LIST OF ACRONYMS

8HLE	Eight half-lives elapsed
AIK	Aiken County
ALD	Allendale County
ANL	Argonne National Laboratory
AOC	Area of Concern or study area. Includes the IPC and OPC.
Avg	Average
"B"	Background samples (>50 miles from an SRS center point)
BMB	Bamberg County
BWL	Barnwell County
CAL	Calhoun County
CDC	Centers for Disease Control
Ci	Curie
C.I.	Confidence interval
D#	The number of detections for a particular radionuclide.
DER	Duplicate Error Ratio
DIL	Derived Intervention Level
DOE	Department of Energy
DOE-SR	Department of Energy - Savannah River
"E"	Perimeter samples (<50 miles from SRS)
EDF	Edgefield County
EMS	Environmental Monitoring Section
EPA	Environmental Protection Agency
EQC	Environmental Quality Control
ESOP	Environmental Surveillance and Oversight Program
GA	Georgia
HMP	Hampton County
IAEA	International Atomic Energy Agency
IPC	Inner Perimeter of Counties around and adjacent to the DOE-SRS boundary.
LAU	Laurens County
LEX	Lexington County
LLD	Lower Limit of Detection
MCL	Maximum Contaminant Level
MCM	McCormick County
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MEI	Maximally Exposed Individual
MOX	Mixed Oxide
N#	The number of samples with any detections.
NA	Not Applicable
NORM	Naturally Occurring Radioactive Material
OPC	The Outer Perimeter of Counties adjacent to and outside of the IPC and SRS
ORG	Orangeburg County
R	dry/wet weight ratio
RAC	Radiological Assessments Corporation

REMD	Radiological Environmental Monitoring Division
S#	The total sample number with and without detections.
SAL	Saluda County
SC	South Carolina
SCbkg	South Carolina background or outside of a 50-mile perimeter around an SRS center point
SCDHEC	South Carolina Department of Health and Environmental Control
SD	Standard Deviation
SOP	Guideline Operating Procedure
SRS	Savannah River Site
SRNS	Savannah River Nuclear Solutions
TEF	Tritium Extraction Facility
US	United States
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USFDA	United States Food and Drug Administration
USGS	United States Geological Survey
VEGP	Vogtle Electric Generating Plant
WSRC	Washington Savannah River Company (formerly Westinghouse Savannah River Company)

UNITS OF MEASURE

Activity or radioactivity is measured by the number of atoms disintegrating per unit time (CDC 2009).

Bq	becquerel. A unit of measure of radioactivity. A becquerel is one disintegration per second.
Bq/kg	becquerel per kilogram
mg/kg	milligram per kilogram
mrem	millirem
mrem/yr	millirem per year
pCi	pico Curies. A unit of measure of radioactivity. A pico curie is equivalent to the radioactivity present in one trillionth of one gram of radium.
pCi/g	pico curies per gram
pCi/L	pico curies per liter
pCi/m³	pico curies per cubic meter
ppm	parts per million
ug/kg	micro grams per kilogram
±	Plus or minus. Refers to one standard deviation unless otherwise stated.

REFERENCES

Aracnet. 1957. Off-Site Radioactive Fallout, Operation Plumbbob, Atomic Cloud Track Maps, 1957. Radioactive Fallout: Operation Plumbbob 1957, **http://www.aracnet.com/~histgaz/atomi/fallout.htm.**

Argonne National Laboratory (ANL). 2007. Health-Based Radionuclide Concentrations in Drinking Water and Air. Human Health Fact Sheet. www.evs.anl.gov/pub/doc/ANL_ContaminantFactSheets_All_070418.pdf

ANL. 2007b. Radiological and Chemical fact Sheets to Support Health risk Analyses for Contaminated Areas. www.evs.anl.gov/pub/doc/ANL_ContaminantFactSheets_All_070418.pdf.

Botsch. 1999. Investigation of the Radiation Exposure of Inhabitants of Contaminated Areas in Northern Ukraine. Center for Radiation Protection and Radioecology, University of Hanover, Germany and the State Agroecological Academie of Ukraine, Ukraine.

Centers of Disease Control (CDC) SRS Health Effects Subcommittee (SRSHES). 1997. Dose Reconstruction News. "Estimating the Atmospheric Tritium Source Term at SRS: A Progress Report", Vol II #3.

Du Pont, 1984. *United States Department of Energy, Savannah River Plant Environmental Report For 1984*, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Federal Register. 1968. www.gpoaccess.gov/fr/.

Federal Radiation Council. 1965. Revised Fallout Estimates for 1964-1965 and Verification of the 1963 Prediction. http://www.epa.gov/radiation/docs/federal/frc_rpt6.

Hanlon, Edward A., 2004. Naturally Occurring Radionuclides in Agricultural Products, December 2004, University of Florida, Institute of Agricultural and Food Sciences (IAFS), Florida Cooperative Extension Service.

International Atomic Energy Agency (IAEA). 2009. http://www.iaea.org/trc/radio-nuclides.htm

Kathren, R.L. 1984. Radioactivity in the Environment: Sources, Distribution, and Surveillance. Harwood Academic Publishers, New York, New York.

Lawrence Livermore National Laboratory (LLNL). 1997. Site Annual Environmental Report, UCRL-50027-97, Oakland, California.

Linkov and W. R. Schell (eds.). 1999. Contaminated Forests: Recent Developments in Risk Identification and Future Perspectives, Kluewer, Amsterdam.

Moore-Landecker. 1972. Fundamentals of the Fungi. Prentice-Hall, Inc., Englewood Cliffs, N.J. ISBN:0-13-339267-8.

Pacific Northwest Laboratory (PNL). 2004. 8.8 Food and Farm Products Monitoring, Hanford Site Environmental Report for Calendar Year , DE-AC05-76RL01830, Department of Energy-Hanford Site, Richland, Washington.

RADNET. 2006. Information about source points of anthropogenic radioactivity, A Freedom of Nuclear Information Resource, http://www.davistownmuseum.org/cbm/, Chernobyl Plume: Country-by-Country.

Rommelt, R., Hiersche, L., Schaller, G., and Wirth, E. 1990. Influence of soil fungi (Basidiomycetes) on the migration of Cs134 + 137 and Sr90 in coniferous forest soil. In: Transfer of Radionuclides in Natural and Semi-Natural Environments (eds. G. Desmet, P. Nassimbeni and M. Belli), Elsevier Applied Science, London, New York.

Savannah River Nuclear Solutions, LLC (SRNS 2011). Savannah River Site Environmental Report for 2010. Savannah River Site Aiken, SC. **SRNS-STI-2011-00059**

Seel, J. F., Whicker, F. W., and Adriano, D. C. 1995 Uptake of Cs-137 in Vegetable Crops Grown on a Contaminated Ladebed, 1995 Health Physics Society manuscript.

USFDA. 2005. US Food and Drug Administration. www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/ChemicalContaminants/Radionuclides

USEPA. 2007. US EPA Information. www.epa.gov/radiation/radionuclides.

Westinghouse Savannah River Company (WSRC). 1997. Assessment of SRS Radiological Liquid and Airborne Contaminants and Pathways. Jannik, G.T., Westinghouse Savannah River Company, Savannah Rive Site, Aiken, South Carolina. WSRC-TR-970152.

WSRC. 1999. Radionuclides in the Savannah River Site Environment. Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-MS-99-00667.

WSRC. 2006. Savannah River Site Environmental Report for 2005. Washington Savannah River Company, Savannah River Site, Aiken, SC. WSRC-TR-2006-00007

World-Nuclear Organization. March 2009. www.world-nuclear.org/info/info30.html

Yoshida, S., and Muramatsu, Y., 1998. Concentrations of alkali and alkaline earth elements in mushrooms and plants collected in a Japanese pine forest, and their relationship with Cs137. J. Environ. Radioactivity 41, 183-205.

APPENDIX

Appendix Table 1a.

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Ytrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Appendix Table 1 b. International Atomic Energy Agency Radionuclides Guidelines for Food

Radionuclides in Foods		Guideline Levels	
Radionuclides	Units	kBq/kg	pCi/g
Pu-238, Pu-239, Pu-240, Am-241		1	0.27
Sr-90, Ru-106, I-129, I-131, U-235		100	2.7
S-35, Co-60, Sr-89, Ru-103, Cs-134, Cs-137, Ce-144, Ir-192		1000	27
H-3, C-14, Tc-99		10000	270

Appendix Table 1c.

USFDA Derived Intervention Levels (DILS) for Each Radionuclide Group for Food in			
Domestic Commerce and Food Offered for Import		Guideline Levels	
Radionuclide Group	Units	Bq/kg	pCi/g
Strontium-90		160	4.32
Iodine-131		170	4.59
Cesium-134 + Cesium-137		1200	32.4
Plutonium-238 + Plutonium-239 + Am-241		2	0.054
Ruthenium-103 + Ruthenium-106		$((C_3/6800) + (C_6/450)) < 1$	

Notes:

1 - For spices use a dilution factor of 10.

2 - C3 and C6 refer to concentrations of Ru-103 and Ru-106.

This Page Intentionally Left Blank

2011 Radiological Monitoring of Dairy Milk

Environmental Surveillance and Oversight Program

97MK007
Crystal Robertson, Project Manager
January 01, 2011 - December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

DHEC
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY....1

2.0 RESULTS AND DISCUSSION....2
- TRITIUM RESULTS....2
- GAMMA-EMITTING RADIONUCLIDES RESULTS....3
- STRONTIUM-89/90 RESULTS....4

3.0 CONCLUSIONS AND RECOMMENDATIONS....4

4.0 MAP....6

5.0 TABLES AND FIGURES....7

6.0 DATA....9
- 2011 TRITIUM AND GAMMA-EMITTING MILK DATA....10
- 2011 STRONTIUM MILK DATA....12

7.0 SUMMARY STATISTICS....13
- 2011 STRONTIUM SUMMARY STATISTICS FOR ALL MILK SAMPLE DETECTIONS....14
- SUMMARY STATISTICS COMPARISON OF PERIMETER/BACKGROUND LOCATIONS....14

LIST OF ACRONYMS AND UNITS OF MEASURE....15

REFERENCES....16

1.0 PROJECT SUMMARY

Operations at the Savannah River Site (SRS) have resulted in the potential for radiological constituents to be released to the surrounding environment. Milk from dairies around the SRS are routinely analyzed for levels of radioactivity that could impact human health. This project provides radiological dairy milk monitoring of selected dairies within a 50-mile radius of the SRS in South Carolina (SC). This project also provides analytical data for comparison to published Department of Energy-Savannah River (DOE-SR) data.

Consumption of milk products containing radioactive materials can be an major human exposure pathway. When an atmospheric release occurs, radionuclides can be deposited on pastures and ingested by grazing dairy animals. The animals would then release a portion of the radioactivity into the milk that is consumed by humans (CDC 2001). Radioactive strontium is a calcium analogue and may show a tendency to accumulate in bones and teeth (Kathren 1984).

Plants and animals assimilate different radioisotopes based on the chemistry and not on the radioactive nature of the components. Cesium-137 (Cs-137) is less readily taken up by plant roots than strontium-90 (Sr-90), but the opposite is true for direct absorption from foliar (leaf) deposits. Cesium-137 is transferred rapidly from pasture grass to the muscles of animals. Strontium-90 is an isotope that can bioconcentrate in bones when there is a deficiency of calcium in the diet of the individual. This pathway is of particular importance in the case of infants and children because they are more likely to drink large quantities of milk and they are actively developing bones and teeth (Kathren 1984). Irrigation of a pasture with contaminated groundwater or uptake by plants from contaminated soil can provide alternate modes of release and contribution to this exposure pathway. Iodine-131 (I-131) is rapidly transferred to milk and accumulates in the thyroid of humans. Cobalt-60 (Co-60) is unlikely to bioaccumulate, but it can be absorbed in the blood and tissues before it is slowly eliminated (USEPA 2002). Most of the Co-60 contamination came exclusively from the SRS between 1968 to 1984 when Co-60 was used as a heat source for a thermoelectric generator (WSRC 1998). Tritium (H-3) is a radioisotope of hydrogen that produces beta particles, and therefore, can impact anything containing water or hydrocarbons. Tritium exists everywhere in the environment, and its volatility quickly achieves equilibrium in the environment and the body (Larson 1958). Therefore, tritium targets the whole body.

During 2011, DOE-SR collected samples from six dairy locations, in South Carolina (SC) and Georgia (GA) (Table 1). DOE-SR milk samples are collected quarterly within a 25-mile radius of the SRS. Only four of the dairies that DOE-SR sampled are located in SC and the remaining two are located in GA (SRNS 2012). The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) collected milk at six dairy locations within the state to provide an independent source of data on radionuclide concentrations of concern in milk (Table 1). Of the six SCDHEC samples, four of them are within a 50-mile perimeter of an SRS center point and two are background samples beyond the 50 mile perimeter.

SCDHEC personnel collected unpasteurized milk samples on a quarterly basis in 2011. Of the four samples within the 50-mile perimeter, one was from a goat milk dairy and was collected only as often as available. All milk samples from each quarter were analyzed for tritium, strontium-89/90 (Sr-89/90), and select gamma-emitting radionuclides, specifically I-131, Cs-137, and Co-60. SCDHEC samples for total strontium (Sr-89/90), instead of just Sr-90, due to prefered laboratory techniques. In order to provide a conservative result, it is assumed the total strontium detected is in the form of Sr-90.

SCDHEC did not detect tritium in any of the 21 milk samples collected during 2011. Gamma emitting radionuclides were not detected by SCDHEC, with the exception of one anomaly that occurred in April 2011. The anomaly was a lone detection of iodine-131 shortly after the March 11, 2011, Great Japan Earthquake and Tsunami that triggered a meltdown at the Fukushima Dai-ichi Nuclear Power Plant. Strontium-89/90 was detected in six samples collected from perimeter locations and in three samples collected from background locations in 2011 (Section 6.0, 2011 Strontium Milk Data table). The source of the strontium is likely due to historical atmospheric nuclear weapons testing. Strontium has slow long-term fallout properties and a long half-life (Larson 1958). None of the Sr-89/90 detections in 2011 exceeded the United States Environmental Protection Agency (USEPA) drinking water Maximum Contaminant Level (MCL) of 8 picocuries per liter (pCi/L) for Sr-90 (USEPA 2002b).

DOE-SR detected tritium in 5 of 24 milk samples collected in 2011. Two of these detections were in samples from SC dairies. Cesium-137 was detected in one milk sample from a GA dairy. DOE-SR also had 5 detections of Sr-89/90 in milk samples; 3 from SC dairies and 2 from GA dairies (SRNS 2012).

During 2011, concentrations of radionuclides of concern in milk did not deviate from historically expected levels as measured by DOE-SR and SCDHEC. SCDHEC will continue to monitor dairies for radionuclides that have the potential to impact human health.

2.0 RESULTS AND DISCUSSION

<u>Tritium Results</u>

Historically tritium has been the main product of operations at SRS, produced as a nuclear weapon enhancement component. The majority of tritium released was in the production reactors and separation areas (CDC 2001). Milk tritium contributions come not only from atmospheric depositions, but from food sources and also groundwater wells. Over 99% of tritium occurs as tritiated water and groundwater. Background test wells (SCDHEC 2003) have tritium contributions (atomic legacy source likely) that are higher than the range found in milk. Tritium averages are lower in milk because of plant uptake factors, intrinsic transfer factors, bioelimination factors, and the variation in distributions of atmospheric depositions.

No SCDHEC milk sample collected during 2011 exhibited tritium activity above the Lower Limit of Detection (LLD) of 213 pCi/L. This was consistent with the 2010 results, where no milk sample exhibited tritium activity above the same LLD (SCDHEC 2011). Figure 1 of Section 5.0 illustrates average tritium detections for the last ten years SCDHEC has sampled milk. All tritium detections have been below the USEPA drinking water MCL of 20,000 pCi/L for tritium. DOE-SR detected tritium in 5 of 24 milk samples for 2011. Two of these detections were from dairies in SC. The maximum activity was 438 (± 83.8) pCi/L in a sample from a GA dairy (SRNS 2012). Summary statistics show that all results for tritium were below the

Minimum Detectable Activity (MDA). The tritium results for all milk samples collected by SCDHEC are given in Section 6.0. These past radionuclide contributions to milk may come from the SRS, other nuclear facilities, and legacy contamination from the cold war period (CDC 2001).

Gamma-Emitting Radionuclides Results

The gamma-emitting radionuclides I-131, Cs-137, and Co-60 are man-made radioactive elements that can impact public health and were all products of SRS activities. These radionuclides were produced by fission in reactor fuels, and they were primarily released in surface streams in the 1960s or into the atmosphere in the separation areas (CDC 2001; WSRC 1998). SCDHEC tested for I-131, Cs-137, and Co-60 in all milk samples collected in 2011. All analytical results for these radionuclides were below the sample MDA, with the exception of one anomaly that occurred in April, 2011. On April 7th, 2011, I-131 was detected at 16.49 (± 7.839) pCi/L of activity in a cow milk sample from Govan, SC.

Iodine-131 decays rapidly in the environment due to a halflife of only 8.05 days, however if consumed by grazing animals it is bioconcentrated in the milk (Kathren 1984). Iodine-131 has never been detected in any of the past ESOP milk samples since the program began, and cannot be attributed to historical releases because of the short halflife. This occurance is most likely a result of releases from the Fukushima Dai-ichi Nuclear Power Station (NPS) in Japan. The sample was intentionally collected shortly after the March 11, 2011, Great Japan Earthquake and Tsunami that triggered a meltdown at the NPS. Atmospheric releases from the Fukushima Dai-ichi NPS for I-131 were estimated to be $1.3x10^{17}$ becquerel per day. The amount released is consistent with the “vanishingly small” amounts crossing the Pacific and showing up in media across the United States (MacKenzie 2011).

Iodine-131 is a human health concern because if consumed by humans is readily taken into the bloodstream before a portion is deposited in the thyroid. There it will continue to decay emitting fairly high-energy beta particles and gamma rays (ANL 2005). The ESOP sample from Govan did exceed the USEPA MCL of 3 pCi/L for I-131. The MCL is set as low as reasonably achievable and it is based on long term or continual exposure assuming a 70 year life time. The United States Food and Drug Administration’s Derived Intervention Level (DIL) for I-131 in milk is 4700 pCi/L, which is set “to assure that no one will reach a specific dose that would warrant protective actions as a result of an event” (McMahon 2011). The ESOP sample from Govan was well below the DIL, and is expected to deteriorate rapidly.

All analytical results for gamma-emitting radionuclides are located in Section 6.0. With the exception of the anomaly in April, these results were consistent with 2010 results (SCDHEC 2011). No summary statistics were calculated for these radionuclides due to a lack of numerical data. DOE-SR did not detected Co-60 in any samples of the 24 milk samples in 2011. DOE-SR did detect Cs-137 at an activity of 3.49 (± 0.867) pCi/L in one sample collected from a dairy in GA (SRNS 2012). DOE-SR conducted a special sampling for I-131 on April 4th, 2011, due to the releases from the Fukushima Dai-ichi NPS. DOE-SR collected samples from all 6 dairies and I-131 was detected in 5 of them, ranging in SC from 3.11 (± 0.429) pCi/L to 12.3 (± 0.904) pCi/L.

Strontium-89/90 Results

Strontium is present around the world due to nuclear weapons atmospheric testing in the 1950s and 1960s (CDC 2001). Since strontium has slow fallout from the atmosphere and a 29-year half-life, it is still present in the environment; however, concentrations are low and continue to decrease over time (USEPA 2002b; Larson 1958). SRS operations have also released strontium into the environment through normal site operations and equipment failure. Strontium was a product of fission in SRS reactors, and was subsequently released in the F-area and H-area (WSRC 1998).

Samples were collected quarterly in 2011 for Sr-89/90 analysis (Section 6.0). Nine out of 21 SCDHEC milk samples collected in 2011 exhibited strontium activities above the MDA, including three detections in background samples. The range for these detections was 0.40 pCi/L to 1.96 pCi/L, with the minimum detection in a goat milk sample from Windsor, SC, and the maximum detection in a cow milk sample from Leesville, SC. These detections averaged 0.80 (± 0.34) pCi/L for the year (Section 7.0). This average is a slight increase from 2010, when the strontium average was 0.37 (± 0.11) pCi/L (SCDHEC 2011). Figure 2 (Section 5.0) shows the trend for SCDHEC strontium detections for the last ten years. The averages used in Figure 2 are calculated using every detection above the MDA for that year including background samples. All strontium averages have been below the USEPA established MCL of 8 pCi/L for Sr-90 since testing initiated in 1998 (USEPA 2002b). DOE-SR detected Sr-89/90 in 5 samples collected in 2011. Three of the 5 detections were in samples from SC dairies. The maximum activity was 2.27 (± 0.408) pCi/L from a dairy in GA (SRNS 2012).

Statistical analysis was limited to a comparison of averages of all samples collected within 50-mile perimeter and all background samples, as shown in Section 7.0. Three of the 9 DHEC samples above the MDA were from background locations. The result was a negligible effect of Sr-90 in milk from dairies with close proximity to the SRS (Section 7.0).

3.0 CONCLUSIONS AND RECOMMENDATIONS

The DOE-SR uses all analytical results, including below Minimum Detectable Concentration (MDC), to compute averages. SCDHEC uses only results above the MDA to compute averages. Consequently, dairy milk analytical data comparisons between SCDHEC and DOE-SR were not conducted.

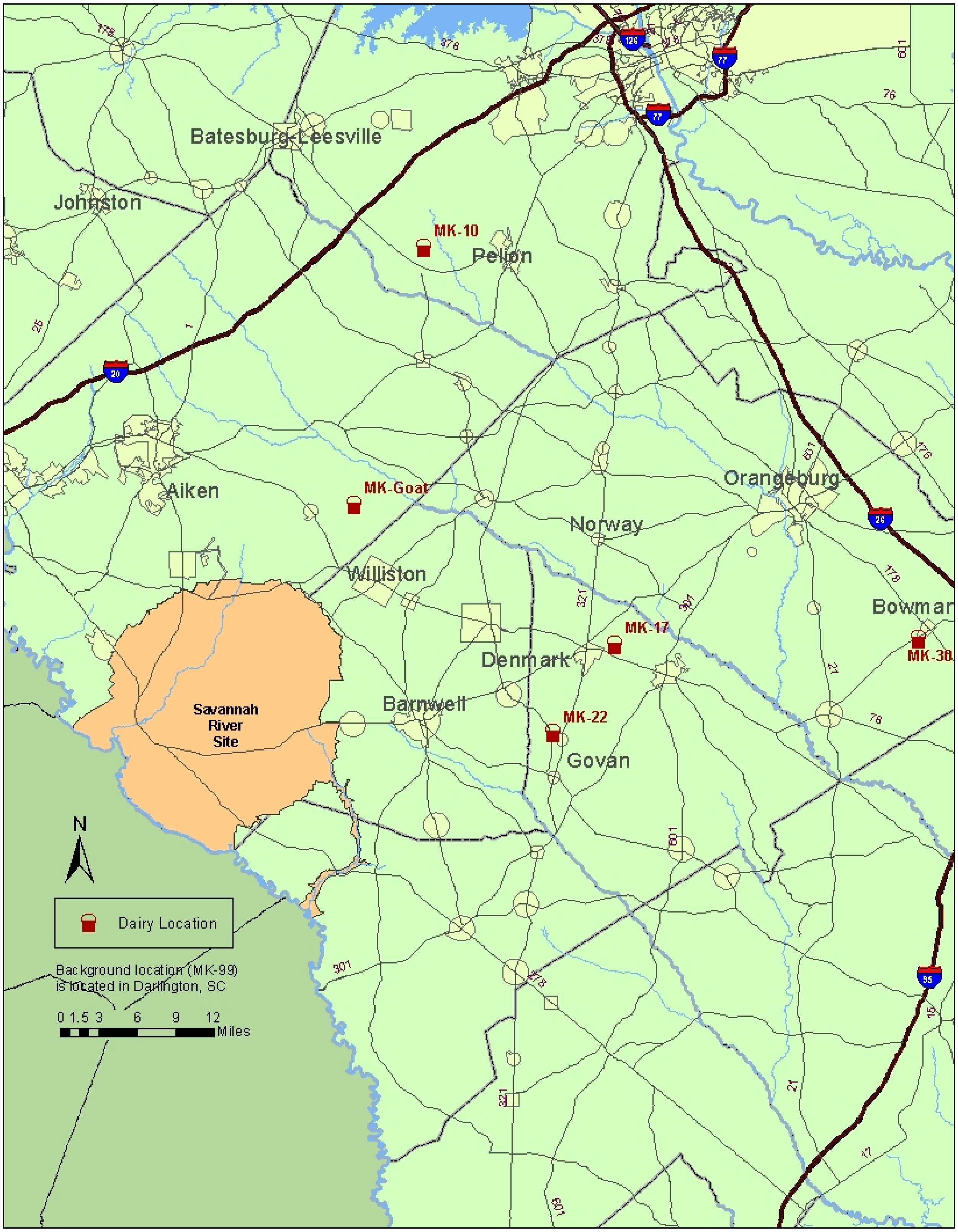
Sampling results for 2011 show a continued trend of decreasing detections of tritium in milk samples. As shown in Section 5.0 Figure 1, tritium has not been detected in any SCDHEC milk sample since 2008 when there was only one detection. Gamma results also continue a trend of non-detections since 2004, with the exception of the I-131 anomally in 2011. Samples collected after the occurrence show that I-131 was again no longer being detected, however SCDHEC will continue monitoring for any changes. The 2011 Sr-89/90 results continue to show no distinct trend. The statistical analysis shows that Sr-89/90 concentrations in SRS perimeter samples were less than the concentration in background samples. This is true for various measures of central tendency, including the average and the median. An evaluation of average concentrations by sampling location is included in Section 7.0.

A large portion of the radiological activity observed in milk samples can be attributed to fallout from past nuclear testing. Also, radionuclides within soil and plants can potentially be redistributed as a result of farming practices and prescribed burns. SCDHEC will continue to monitor tritium, gamma-emitting radionuclides that can affect human health, and strontium in milk to ensure the safety of milk consumption by the public.

The dairies in the ESOP South Carolina study area and background locations appear to be stable with no indication of closing in the foreseeable future. ESOP has had no indication of any new dairies opening within the study area. Additional dairy sources will be added to the network if and when they become available.

4.0 RADIOLOGICAL MONITORING OF DAIRY MILK

Map 1. 2011 SCDHEC Radiological Monitoring Locations for Dairy Milk



5.0 Tables and Figures

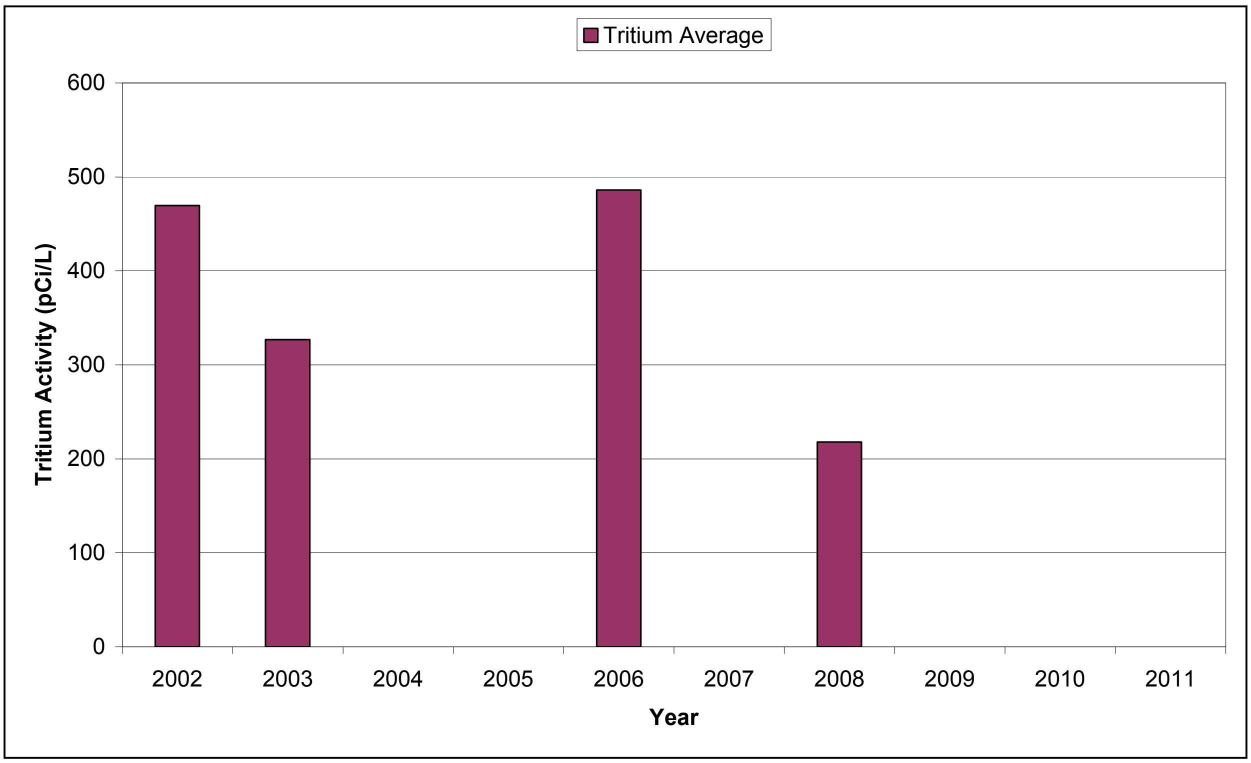
Radiological Monitoring of Dairy Milk

Table 1. 2011 SCDHEC and DOE-SR Dairy Milk Sampling Locations

SCDHEC Cow Dairy Locations	DOE-SR Cow Dairy Locations
Denmark, SC, MK-17	Barnwell: SC Dairy
Leesville, SC, MK-10	Denmark: SC Dairy
Govan, SC, MK-22	Ehrhardt Road: Govan: SC Dairy
Windsor, SC, MK-goat	HWY 23 Girard: GA Dairy
Bowman, SC*, MK-30	Hwy 23: McBean GA Dairy
Darlington, SC*, MK-99	Partridge Rd: Govan: SC Dairy

*Background Locations

Figure 1. Average Tritium Detections in SCDHEC Milk, 2002-2011

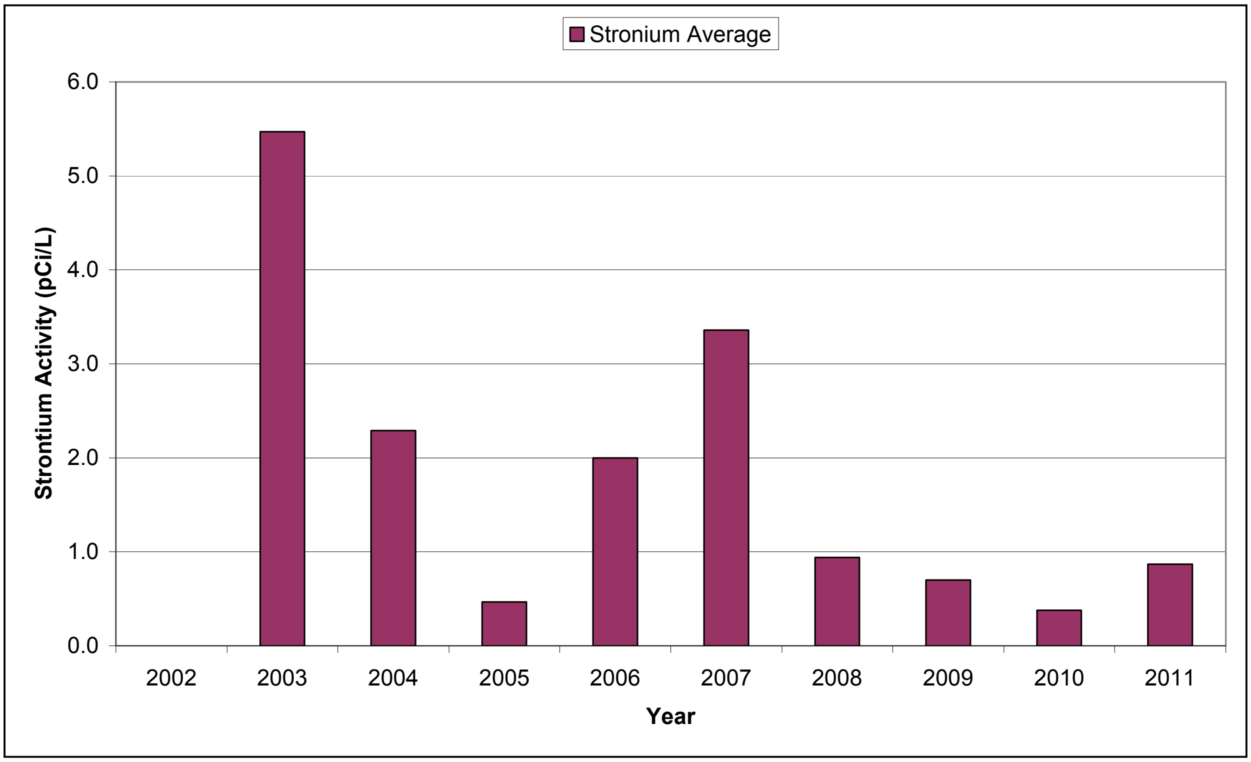


Average detections are well below the USEPA MCL of 20,000 pCi/L for drinking water.
No detections above the MDA were observed in 2004, 2005, 2007, 2009, 2010 and 2011.

Tables and Figures

Radiological Monitoring of Dairy Milk

Figure 2. Strontium-89/90 Detection Averages, 2002-2011



Average detections are below the USEPA MCL of 8.0 pCi/L for drinking water.
No detections above the MDA were observed in 2002.

6.0 Data

Radiological Monitoring of Dairy Milk

2011 TRITIUM AND GAMMA-EMITTING MILK DATA 10

2011 STRONTIUM MILK DATA 12

Notes:

1. LLD - Lower Limit of Detection
2. MDA - Minimum Detectable Activity
3. SC - South Carolina
4. NA - Not Applicable
5. 8 HLE - More than 8 Half-Lives have Elapsed
6. * Indicates a background sampling location

RADIOLOGICAL MONITORING OF DAIRY MILK DATA

2011 Tritium and Gamma-emitting Milk Data

Sample Location		MK-goat Windsor, SC			
Collection Date		No Sample	No Sample	7/11/2011	No Sample
Radionuclides:	Tritium (pCi/L)			<LLD	
	+/- 2 sigma			NA	
	LLD			226	
	Co-60 (pCi/L)			<MDA	
	+/- 2 sigma			NA	
	MDA			2.86	
	I-131 (pCi/L)			8 HLE	
	+/- 2 sigma			NA	
	MDA			NA	
	Cs-137 (pCi/L)			<MDA	
	+/- 2 sigma			NA	
	MDA			2.12	

Sample Location		MK-10 Leesville, SC			
Collection Date		3/2/2011	4/5/2011	7/7/2011	10/26/2011
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma	NA	NA	NA	NA
	LLD	207	215	229	201
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	2.49	2.23	2.61	2.39
	I-131 (pCi/L)	<MDA	<MDA	8 HLE	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	101.90	8.50	NA	62.69
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	2.70	2.70	2.62	2.70

Sample Location		MK-17 Denmark, SC			
Collection Date		3/11/2011	4/7/2011	7/6/2011	10/25/2011
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma	NA	NA	NA	NA
	LLD	206	215	226	202
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	2.46	2.25	2.42	2.83
	I-131 (pCi/L)	<MDA	<MDA	8 HLE	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	53.79	8.39	NA	42.81
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	2.70	2.70	2.68	3.21

Radiological Monitoring of Dairy Milk Data

2011 Tritium and Gamma-emitting Milk Data

Sample Location		MK-22 Govan, SC			
Collection Date		3/11/2011	4/7/2011	7/6/2011	10/25/2011
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma	NA	NA	NA	NA
	LLD	205	217	227	200
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	2.66	2.32	2.39	2.39
	I-131 (pCi/L)	<MDA	**16.49**	8 HLE	<MDA
	+/- 2 sigma	NA	7.839	NA	NA
	MDA	81.52	7.97	NA	64.39
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	3.05	2.70	2.29	2.70

Sample Location		MK-30 Bowman, SC*			
Collection Date		3/3/2011	4/8/2011	7/6/2011	10/25/2011
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma	NA	NA	NA	NA
	LLD	205	216	225	200
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	3.16	2.70	2.63	2.52
	I-131 (pCi/L)	<MDA	<MDA	8 HLE	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	141.10	9.49	NA	56.63
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	3.55	3.03	3.05	2.69

Sample Location		MK-99 Darlington, SC*			
Collection Date		3/3/2011	4/5/2011	7/7/2011	10/26/2011
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma	NA	NA	NA	NA
	LLD	204	215	224	200
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	2.36	2.49	2.61	2.29
	I-131 (pCi/L)	<MDA	<MDA	8 HLE	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	100.30	10.13	NA	69.78
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma	NA	NA	NA	NA
	MDA	2.70	2.78	2.75	2.63

Radiological Monitoring of Dairy Milk Data

2011 Strontium Milk Data
Units are in picocuries per Liter (pCi/L)

Sample Location	MK-goat Windsor, SC			
Collection Date	No Sample	No Sample	7/11/2011	No Sample
Sr - 89/90 (pCi/L)			**0.403**	
+/- 2 sigma			0.166	
MDA			0.276	

Sample Location	MK-10 Leesville, SC			
Collection Date	3/2/2011	4/5/2011	7/7/2011	10/26/2011
Sr - 89/90 (pCi/L)	**0.419**	**1.14**	**1.96**	<MDA
+/- 2 sigma	0.191	0.416	0.702	NA
MDA	0.400	0.360	0.402	0.359

Sample Location	MK-17 Denmark, SC			
Collection Date	3/11/2011	4/7/2011	7/6/2011	10/25/2011
Sr - 89/90 (pCi/L)	<MDA	<MDA	**1.08**	<MDA
+/- 2 sigma	NA	NA	0.397	NA
MDA	0.459	0.474	0.355	0.360

Sample Location	MK-22 Govan, SC			
Collection Date	3/11/2011	4/7/2011	7/6/2011	10/25/2011
Sr - 89/90 (pCi/L)	<MDA	**0.474**	<MDA	<MDA
+/- 2 sigma	NA	0.200	NA	NA
MDA	0.485	0.360	0.330	0.393

Sample Location	MK-30 Bowman, SC*			
Collection Date	3/3/2011	4/8/2011	7/6/2011	10/25/2011
Sr - 89/90 (pCi/L)	<MDA	<MDA	**1.06**	<MDA
+/- 2 sigma	NA	NA	0.391	NA
MDA	0.383	0.424	0.388	0.371

Sample Location	MK-99 Darlington, SC*			
Collection Date	3/3/2011	4/5/2011	7/7/2011	10/26/2011
Sr - 89/90 (pCi/L)	<MDA	**0.504**	**0.778**	<MDA
+/- 2 sigma	NA	0.214	0.299	NA
MDA	0.449	0.396	0.390	0.407

7.0 SUMMARY STATISTICS

Radiological Monitoring of Dairy Milk Data

2011 STRONTIUM SUMMARY STATISTICS FOR ALL MILK SAMPLE DETECTIONS 14

2011 STRONTIUM SUMMARY STATISTICS COMPARISON OF PERIMETER AND BACKGROUND LOCATIONS 14

Notes:

1. N - Number of detections used for statistical analysis
2. TN - Total Number of samples including non-detections
3. Avg - Average
4. St Dev - Standard Deviation
5. Min - Minimum
6. Max - Maximum
7. <MDA - All samples below the Minimum Detectable Activity
8. NA - Not Applicable

Radiological Monitoring of Dairy Milk Data

2011 Strontium Summary Statistics for all Milk Sample Detections
Units are in picocuries per liter (pCi/L)

Radionuclide:		Total Strontium					
Statistical Analysis:		**N (TN)**	**Avg**	**St Dev**	**Median**	**Min**	**Max**
All Sample Locations	**MK-goat**	1 (1)	0.40	NA	0.40	0.40	0.40
	MK-10	3 (4)	1.17	0.77	1.14	0.42	1.96
	MK-17	1 (4)	1.08	NA	1.08	1.08	1.08
	MK-22	1 (4)	0.47	NA	0.47	0.47	0.47
	MK-30	1 (4)	1.06	NA	1.06	1.06	1.06
	MK-99	2 (4)	0.64	0.19	0.64	0.50	0.78
Yearly Average			0.80				
Standard Deviation			0.34				
Median			0.85				

Radionuclide:		Total Strontium					
Statistical Analysis:		**N (TN)**	**Avg**	**St Dev**	**Median**	**Min**	**Max**
Perimeter System Number:	**MK-goat**	1 (1)	0.40	NA	0.40	0.40	0.40
	MK-10	3 (4)	1.17	0.77	1.14	0.42	1.96
	MK-17	1 (4)	1.08	NA	1.08	1.08	1.08
	MK-22	1 (4)	0.47	NA	0.47	0.47	0.47
Yearly Average of Detectable Sr-89/90			0.78				
Standard Deviation			0.40				
Median			0.78				

Radionuclide:		Total Strontium					
Statistical Analysis:		**N (TN)**	**Avg**	**St Dev**	**Median**	**Min**	**Max**
Background System Number:	**MK-30**	1 (4)	1.06	NA	1.06	1.06	1.06
	MK-99	2 (4)	0.64	0.19	0.64	0.50	0.78
Yearly Average of Detectable Sr-89/90			0.85				
Standard Deviation			0.29				
Median			0.85				

2011 Strontium Summary Statistics Comparison of Perimeter and Background Locations
Units are in picocuries per liter (pCi/L)

	Perimeter Locations (<50 Miles)			Background Locations (>50 Miles)			Perimeter minus Background	
	Avg	**St Dev**	**Median**	**Avg**	**St Dev**	**Median**	**Average**	**Median**
Sr-89/90	0.78	0.40	0.78	0.85	0.29	0.85	-0.07	-0.07

LIST OF ACRONYMS

Cs-137	Cesium-137
Co-60	Cobalt-60
DIL	Derived Intervention Level
DOE-SR	Department of Energy – Savannah River
ESOP	Environmental Surveillance and Oversight Program
GA	Georgia
H-3	Tritium
I-131	Iodine-131
LLD	Lower Limit of Detection
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
NA	Not Applicable
NPS	Nuclear Power Station
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
Sr-89/90	Strontium-89/90
Sr-90	Strontium-90
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
USEPA	**United States Environmental Protection Agency**

Units of Measure

pCi/L	picocuries per liter
8HLE	More than 8 Half-Lives have Elapsed
±	plus or minus; used with standard deviations unless otherwise noted

REFERENCES

Argonne National Laboratory (ANL), 2005. Human Health Fact Sheet: Iodine. Environmental Science Division, Chicago, IL.

Centers for Disease Control and Prevention (CDC), 2001. Savannah River Site Environmental Dose Reconstruction Project. Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval Evaluation of Materials Released from the Savannah River Site. 1-CDC-SRS-1999-Final. Risk Assessment Corporation, No. 200-95-0904.

Kathren, R.L., 1984. Radioactivity in the Environment: Sources, Distribution and Surveillance. Gordon and Breach Publishing Group, Newark, NJ. 271-275.

Larson, B.L. and K. E. Ebner, 1958. Significance of Strontium-90 in Milk. A Review. Journal of Diary Science. 41(12):1647-1662.

MacKenzie, Debora, 2011. *Fukushima Radioactive Fallout nears Chernobyl Levels*. http://www.newscientist.com/article/dn20285-fukushima-radioactive-fallout-nears-chernobyl-level

McMahon, Jeff, 2011. *EPA: New Radiation Highs in Little Rock Milk, Philadelphia Drinking Water*. Forbes Business Leadership Forum. Las Vagas, NV.

Savannah River Nuclear Solutions, LLC (SRNS), 2012. Savannah River Site Environmental Report for 2011. Savannah River Site, Aiken, South Carolina. SRNS-STI-2012-00200.

South Carolina Department of Health and Environmental Control (SCDHEC), 2003. 2002 Radiological Monitoring of Milk from Dairies Surrounding the Savannah River Site. Bureau of Environmental Services, Environmental Surveillance and Oversight Program.

SCDHEC, 2011. 2010 Radiological Monitoring of Dairy Milk. Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, SC.

United States Environmental Protection Agency (USEPA), 2002. EPA Facts About Cobalt-60. www.epa.gov/superfund/health/contaminants/radiation/pdfs/cobalt.pdf

USEPA, 2002b. EPA Facts About Strontium-90. http://www.epa.gov/superfund/health/contaminants/radiation/pdfs/strontium.pdf

Westinghouse Savannah River Company (WSRC), 1998. Assessment of Radionuclides in the Savannah River Site Environment-Summary (U). WSRC-TR-98-00162. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC.

This Page Intentionally Left Blank

Section 4 2011 Biological Monitoring

Chapter 11 **Radiological Monitoring of Fish Associated with the Savannah River Site**

Chapter 12 **Radiological Game Animal Monitoring Adjacent to SRS**

2011 Fish Monitoring Associated with the Savannah River Site

Environmental Surveillance and Oversight Program

96FM001
Jeffrey Joyner, Project Manager
January 1, 2011 – December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street NE,
Aiken, SC 29801

DHEC
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 2
- **TRITIUM RESULTS** 2
- **GAMMA RESULTS** 3
- **STRONTIUM RESULTS** 4
- **MERCURY AND METALS ANALYSES** 4
- **SCDHEC AND DOE-SR DATA COMPARISON** 5

3.0 CONCLUSIONS AND RECOMMENDATIONS 6

4.0 MAP 8

5.0 TABLES AND FIGURES 9

6.0 DATA 16
- **2011 RADIONUCLIDES DATA** 17
- **SCDHEC HISTORICAL DATA, 2007-2011** 29
- **2011 MERCURY DATA** 34
- **2011 SCDHEC AND DOE-SR DATA COMPARISON** 37

7.0 SUMMARY STATISTICS 42
- **2011 FISH MONITORING SUMMARY STATISTICS** 43

LIST OF ACRONYMS AND UNITS OF MEASURE 44

REFERENCES 45

1.0 PROJECT SUMMARY

The Department of Energy-Savannah River (DOE-SR) has historically monitored the uptake of radionuclides in fish. However, DOE-SR reported results were not routinely evaluated by an independent monitoring source. Because of the size, scope, and complexity of the activities at the Savannah River Site (SRS), the Environmental Surveillance and Oversight Program (ESOP) of the South Carolina Department of Health and Environmental Control (SCDHEC) was tasked with providing a non-regulatory independent monitoring and surveillance program at the SRS.

Radiocesium, released from 1954-1975, has been reported by DOE-SR as one of the most significant radionuclides related to human exposure (WSRC 1997). At SRS, the majority of liquid releases of cesium-137 (Cs-137) were due to leaking fuel rods in the 1950s and 1960s. Fuel rods were stored in basins, and Cs-137 was released to SRS streams when the basins were purged. In the early 1970s, physical and administrative controls were implemented to control the releases of most fission and activation products. During subsequent years, tritium, which cannot be filtered from effluent streams, became more significant than cesium (WSRC 1999).

ESOP conducts fish monitoring for radionuclide activity in an effort to determine the magnitude, extent, and trends of radionuclide levels. Largemouth bass (*Micropterus salmoides)* and catfish (*Ameiurus catus* or *Ictalurus punctatus*) were collected from nine sample locations on the Savannah River, and a background station established on the Edisto River between Colleton and Charleston counties. Studies have shown these species bioaccumulate measurable amounts of radionuclides (Cummins 1994; USEPA 2000). Red drum (*Sciaenops ocellatus*) and striped mullet (*Cynoscion nebulosus***)** were collected near Savannah, Georgia. Stations sampled in 2011 are shown in Map 1 Section 4.0, and location descriptions can be found in the Monitoring of Fish in the Savannah River Quality Assurance Project Plan, (SCDHEC 2011a).

Fish were collected using boat-mounted electrofishing equipment. Samples were collected at five stations where creeks from the SRS meet the Savannah River (Upper Three runs Creek SV-2011, Beaver Dam Creek SV-2013, Fourmile Branch SV-2015, Steel Creek SV-2017, Lower Three Runs Creek SV-2020). Samples were also collected from the Edisto River as a background location (MD-119), one Savannah River station upstream of the SRS, New Savannah Bluff Lock and Dam (SV-2028), and four stations downstream of the SRS (Highway 301 SV-118, Stokes Bluff SV-355, Highway 17 fresh water SV-2090, Highway 17 saltwater SV-2091). All these locations are accessible to the public. Typically, five fish of each species were collected at each sample location. Analysis of right-side fillets from each fish for mercury and selected metals was initiated in 2010. The remainder for each species was separated into edible and non-edible portions, and the portions were combined into homogeneous composites for radionuclide analyses. Edible composites were analyzed for gamma-emitting isotopes and tritium. Non-edible composites were analyzed for gamma-emitters and strontium. Detailed procedures can be found in the Quality Assurance Project Plan (SCDHEC 2011a).

Four locations did not produce samples with detectable tritium activity in 2011: the background location on the Edisto River, New Savannah Bluff Lock and Dam (NSBLD), Beaver Dam Creek, and Stokes Bluff. All other locations adjacent to and downstream of SRS exhibited detectable tritium activity. Four locations did not exhibit Cs-137 activity: (NSBLD), Highway 17, Stokes Bluff, and the Edisto River. Activities of strontium-89,90 (Sr-89,90) were reported from all locations.

The DOE-SR also conducts fish monitoring to assess the environmental effects of current and historical releases of radionuclides. SCDHEC data were compared to DOE-SR reported results. Dissimilarities in these results could be attributed to the natural variation of radionuclide levels. Although there are differences between reported values, the data is consistent with historically reported data. In the past, samples have been collected and split between SCDHEC and DOE-SR for analyses, and no great variations in the data results were found. This would potentially rule out methodology differences and substantiate that differences result from the variability in samples analyzed by the two programs.

Independent monitoring of radionuclides and metals in Savannah River fish will continue along with evaluating the DOE-SR Radiological Fish Monitoring Program. The information provided will assist in advising, informing, and protecting the people at risk, and in comparing current and historical data.

2.0 RESULTS AND DISCUSSION

The following radionuclides were not detected above the minimum detectable activity (MDA) in 2011: beryllium-7 (Be-7), sodium-22 (Na-22), manganese-54 (Mn-54), cobalt-58 (Co-58), cobalt-60 (Co-60), zinc-65 (Zn-65), yttrium-88 (Y-88), zirconium-95 (Zr-95), ruthenium-103 (Ru-103), antimony-125 (Sb-125), iodine-131(I-131), cesium-134 (Cs-134), cerium-144 (Ce-144), europium-152 (Eu-152), europium-154 (Eu-154), europium-155 (Eu-155), radium-226 (Ra-226), actinium-228 (Ac-228), uranium/thorium-238 (U/Th-238), and americium-241 (Am-241).

Fish collections were conducted from March through October of 2011. Five fish of each species were caught at all river locations. Largemouth bass and channel catfish were collected from all Savannah River locations and the Edisto River background site. Five red drum and five stripped mullet were collected from the saltwater location.

A total of 110 fish were collected. Fourty-four composites were processed in 2011. The SCDHEC Region 5 tritium laboratory analyzed aliquots from all edible samples. Edible and non-edible samples were sent to the SCDHEC Radiological Environmental Monitoring Division in Columbia, South Carolina for radiological analysis of gamma-emitting radionuclides. Portions of non-edible samples were sent to Eberline Services for strontium analysis. Graphic presentations of 2011 and 2007-2011 activity levels of tritium, Cs-137, and Sr-89,90 are reported in Section 5.0. Activity levels of Cs-137 for all samples and SCDHEC historical trending data from 2007–2011 are reported in Section 6.0. Summary statistics are presented in Section 7.0. Tritium results represent the activity level in the water distilled from the fish tissue. Cesium and strontium results represent the activity level in the wet sample itself.

Tritium Results

Tritium is a naturally occurring radioisotope, although in very low concentrations (USEPA 2007). Sources of man-made tritium include nuclear reactors and government weapons production plants. Tritium releases at SRS include both atmospheric and liquid contributions (SRNS 2011). Although the United States Environmental Protection Agency (USEPA) has not established a Maximum Contaminant Level (MCL) for tritium in solid media (e.g. fish, vegetation), the MCL for drinking water has been set at 20,000 picocuries per liter (pCi/L) (USEPA 2008).

Activity levels of tritium were analyzed in 22 edible composites. Five of the nine freshwater stations exhibited detectable tritium activity in 2011 (Section 5.0, Figure 1a); the saltwater sampling location (SV-2091) produced detections in both species sampled. The Edisto River background location did not produce tritium activity. The uppermost Savannah River location near the NSBLD, (SV-2028), the location near Beaver Dam Creek (SV-2013), Highway 301 (SV-118) and the down stream location Stokes Bluff (SV-355) had no detectable tritium activity.

Five of nine bass samples from the Savannah River exhibited detectable tritium activity, with an average of 516 (± 364) pCi/L. The composite from the Four Mile Branch location (SV-2015) had the highest reported tritium activity, 1162 pCi/L. Three of nine Savannah River catfish samples exhibited tritium activity, with an average of 694 (± 381) pCi/L. The highest tritium level observed in the catfish composites, 967 pCi/L was from the Steel Creek.

With the exception of the Four Mile Branch location, samples from downstream of SRS exhibited little tritium activity in 2011. The 2011 data are generally similar to SCDHEC historically reported data (Section 5.0, Figures 1b and 1c; SCDHEC 2011a). Although results can be quite variable between years, tritium levels tend to be highest at locations adjacent to SRS (creek mouth stations) and decrease with distance downstream. Tritium has been detected upstream of SRS only occasionally, and at low levels.

Gamma Results

The naturally occurring isotope of potassium-40 (K-40) was detected from all stations where gamma samples were collected in 2011. The lead isotopes Pb-212 and Pb-214 were also detected, but not from all locations. Because these are naturally occurring isotopes, the results will not be discussed in this report.

Cesium-137 is a man-made fission product, and was a constituent of air and water releases on SRS, mainly from F- and H-Areas. Liquid releases also occurred from the production reactors as a result of leaking fuel elements in the 1950s and 1960s, and reactor basin purges were discharged to SRS streams, including Fourmile Branch, Steel Creek, and Lower Three Runs (WSRC 1999).

Activity levels of Cs-137 were analyzed in 22 edible and non-edible portions of bass, catfish, red drum, and mullet composites. The NSBLD, Upper three Runs Creek, Stokes Bluff, and the Hwy. 17 saltwater locations did not exhibit Cs-137 activity in any sample.

Six of nine edible bass composites from Savannah River locations exhibited detectable levels of Cs-137, ranging from 0.05 to 0.74 pCi/g, with an average of 0.23 (± 0.26) pCi/g (Section 5.0, Figure 2a). The sample from Beaver Dam Creek location had the highest reported activity level. Cesium-137 levels reported above the MDA were observed in edible bass composites from four-creek mouth locations adjacent to SRS and one of three locations downstream of the SRS. Cesium-137 activity was detected in non-edible bass composites from three creek mouth locations and one downstream location. The background location on the Edisto River exhibited detectable Cs-137 activity in the edible samples.

Two of nine edible catfish composites exhibited detectable levels of Cs-137, ranging from 0.09 to 0.30 pCi/g, with an average of 0.195 (± 0.15) pCi/g (Section 5.0, Figure 3a). Only one non-edible catfish composite produced detectable Cs-137 level of 0.13 pCi/g. The Lower Three Runs location (SV-2020) exhibited the highest activity for the non-edible samples.

Consistent with historically reported SCDHEC data, higher levels of Cs-137 were reported from locations adjacent to the SRS, especially Steel Creek and Lower Three Runs (Section 5.0, Figure 2b and 2c, 3b and 3c) (SCDHEC 2009). Higher activity levels in samples from these locations are not unexpected based on historical releases to these streams and the Savannah River swamp, and the Cs-137 contamination still present.

Strontium Results

Strontium-89 and -90 are present around the world as a result of fallout from past atmospheric nuclear weapons tests (MII 2008). Strontium-90 behaves like calcium in the body, and tends to deposit in bone and bone marrow. Internal exposure is linked to several forms of cancer (USEPA 2007).

Portions of 22 non-edible composites were analyzed for Sr-89,90 analysis in 2011. All locations produced detectable strontium activity, including the background station (Section 5.0, Figure 4a). Sr-89,90 levels reported are for wet results, from analysis of whole fish composites. Averages noted below are for Savannah River freshwater species only, excluding the Edisto River location.

Levels of Sr-89,90, in bass, ranged from 0.030 to 0.470 pCi/g, with an average of 0.109 (± 0.138) pCi/g. The sample from the Beaver Dam Creek location had the highest activity level. Strontium levels in catfish samples ranged from 0.020 to 0.070 pCi/g, with an average of 0.56 (± 0.015) pCi/g. New Savannah Bluff Lock and Dam and Upper Three Runs location exhibited the highest activity.

Section 5.0, Figures 4b and 4c show historically reported SCDHEC data for Sr-89,90 (SCDHEC 2011a). The data from 2007-2011 represents calculated wet results using a dry/wet conversion ratio from the actual dry analyses. The 2008, 2009, and 2010 data were reported as wet results by the contract laboratory that year. Results are highly variable, but Sr-89,90 appears to be widespread.

<u>Mercury and Metals Analyses</u>

In 2011 SCDHEC initiated analysis of edible fish samples for mercury and selected metals. A total of 110 samples were analyzed. The metals (antimony, arsenic, cadmium, and manganese) were selected for analysis for direct comparison to DOE-SR data. Samples were also analyzed for chromium, copper, lead, nickel, and zinc.

Mercury is a naturally occurring element that is found in air, water and soil. It exists in several forms: elemental or metallic mercury, inorganic mercury compounds, and organic mercury compounds. Coal-burning power plants are the largest human-caused source of mercury emissions to the air in the United States, accounting for over 50 percent of all domestic human-caused mercury emissions. EPA has estimated that about one quarter of U.S. emissions from coal-burning power plants are deposited within the contiguous U.S. and the remainder enters the

global cycle. Current estimates are that less than half of all mercury deposition within the U.S. comes from U.S. sources (USEPA 2010).
Mercury in the air eventually settles into water or onto land where it can be washed into water. Once deposited, certain microorganisms can change it into methylmercury, a highly toxic form that builds up in fish, shellfish and animals that eat fish. Fish and shellfish are the main sources of methylmercury exposure to humans. Methylmercury builds up more in some types of fish and shellfish than others. The levels of methylmercury in fish and shellfish depend on what they eat, how long they live and how high they are in the food chain.

Mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. Research shows that most people's fish consumption does not cause a health concern. However, it has been demonstrated that high levels of methylmercury in the bloodstream of unborn babies and young children may harm the developing nervous system, making the child less able to think and learn (USEPA 2010).

Mercury was detected in fish, primarily bass, from all locations except the upstream-most Savannah River location near Augusta, Georgia (Section 6.0). Samples from the background location on the Edisto River exhibited detectable mercury in all four bass samples. Mercury was detected in four of five bass samples and from three of five catfish samples from the Edisto River.

Mercury was detected in 38 of 45 bass samples from all nine Savannah River locations, ranging from 0.10 to 0.84 milligrams per kilogram (mg/kg), with an average of 0.37 (± 0.20) mg/kg (Section 5.0, Figure 5). The Lower Three Runs Creek location exhibited the highest mercury concentration in an individual fish and the Stokes Bluff location had the highest average among the locations sampled.

Only five of 45 Savannah River catfish samples, from two locations, exhibited detectable mercury concentrations, ranging from 0.10 to 0.33 mg/kg, with an average of 0.21 (± 0.08) mg/kg (Section 5.0, Figure 5). The Lower Three Runs location had the highest average mercury concentration.

The following metals were not detected in any samples in 2011: arsenic, cadmium, lead, and nickel. Antimony and chromium was detected in only one sample, manganese in thirty-two. Copper was detected in 96 samples. Zinc was detected in all 91 samples analyzed.

SCDHEC and DOE-SR Data Comparison

SCDHEC bass and catfish data collected for this project in 2011 were compared to DOE-SR reported information (SRNS 2012). Data comparison summaries are located in Section 6.0. One difference between the two programs is that ESOP analyzes one composite type from each species for each location, whereas the DOE-SR program analyzes three composite types per location. Therefore, a single composite for an ESOP location was compared to the average of the three DOE-SR composites reported, although DOE-SR uses results below the Minimum Detectable Concentration (MDC) when calculating averages.

ESOP largemouth bass samples from five locations and DOE-SR bass samples from nine locations exhibited tritium activity. ESOP detected tritium in catfish samples from three sites, DOE-SR from eight. Cesium-137 was detected in edible fish from most locations by both programs in 2011. Cesium-137 results for edible bass and catfish from ESOP and DOE-SR were less than 1.00 pCi/g. Strontium-89,90 was detected at all locations by both programs, although all values were less than 1.00 pCi/g. (SRNS 2012).

Average results of tritium, Cs-137, and Sr-89,90 analyses were used for direct comparisons of data between the two programs. Averages were calculated using only detections, including from separate DOE-SR composite analyses. For tritium in bass and catfish, DOE-SR results were within one standard deviation of the ESOP results. For Cs-137 in bass samples, DOE-SR results were within three standard deviation of the ESOP results. For Cs-137 in catfish samples, DOE-SR results were within six standard deviations of the ESOP results, although it is noteworthy that most samples were below the minimum detectable concentration. DOE-SR and ESOP results for bass and catfish were five standard deviations apart for Sr-89,90, but the detections were at very low levels. Both DOE-SR and ESOP had aSr-89/90 average of 0.07 pCi/g for catfish. DOE-SR had a average of 0.05 pCi/g for bass, while ESOP had a average of 0.23 pCi/g.

Mercury was the only metal detected by both programs, DOE-SR results were within one standard deviation of the ESOP results. Although sample sizes from each program were different average mercury concentrations for both organizations were essentially the same for catfish and largemouth bass samples.

3.0 CONCLUSIONS AND RECOMMENDATIONS

A review of SCDHEC data indicates that DOE-SR operations have impacted fish. Higher levels of radionuclides are found in Savannah River fish collected adjacent to and downstream of SRS compared to upstream. Previous studies have shown that tritium and cesium in the SRS environment from historical and continuing releases can be manifested in the SRS biota (Cummins 1994; WSRC 1997). Fish from background locations tend not to exhibit detectable levels of man-made radionuclides, except for Sr-89,90, which is present worldwide from past nuclear weapons testing (USEPA 2007).

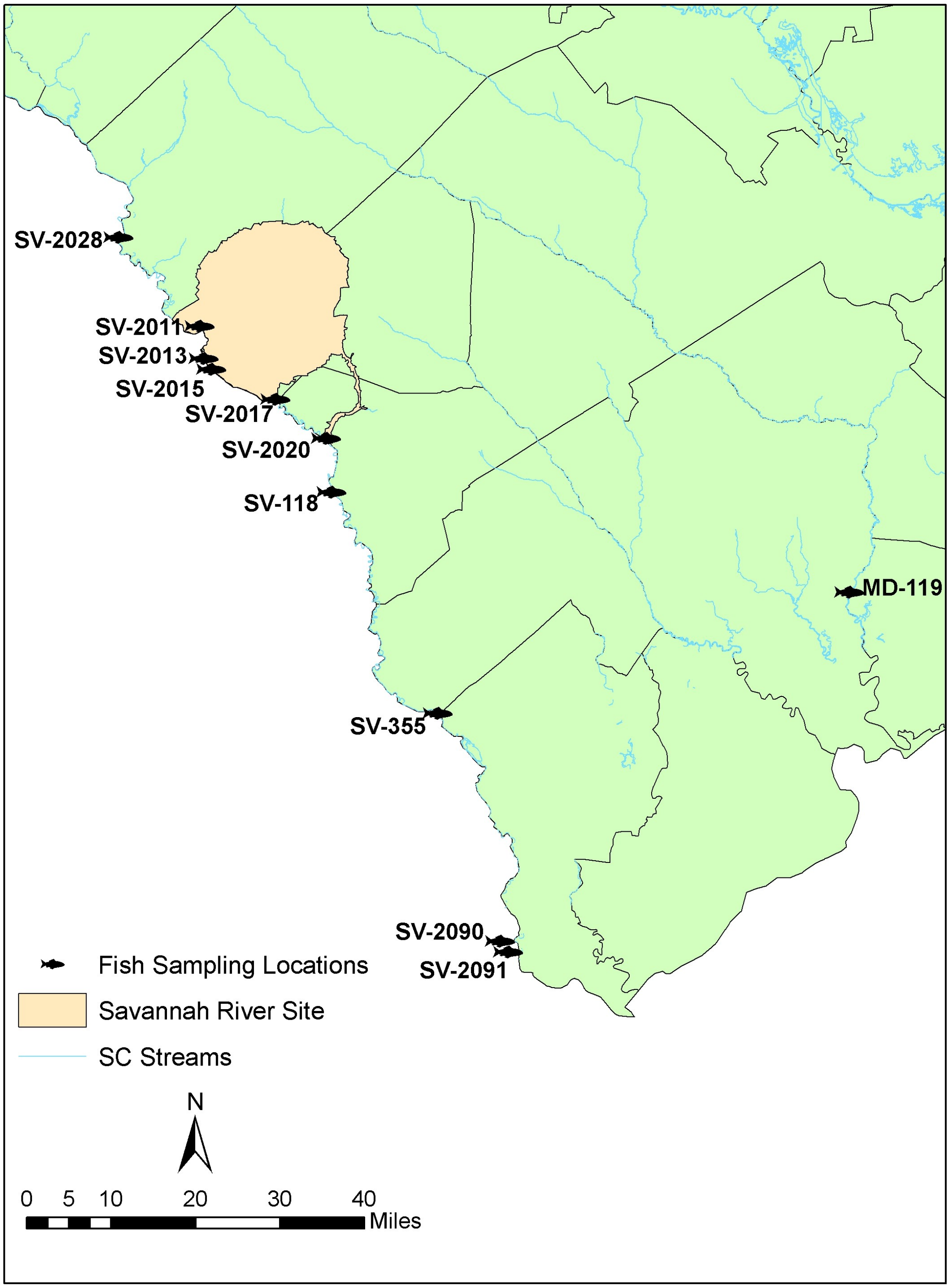
SCDHEC project data was compared to DOE-SR reported information (SRNS 2012). Based on standard deviations, tritium, Cs-137, Sr-89,90, and mercury data were generally similar and at or near the minimum detectable concentration. Differences in results could be due to the natural variation of contaminant levels in individual fish. Both programs detected Sr-89,90, and mercury at all locations.

Independent monitoring of radionuclide levels in Savannah River fish will continue along with evaluating the DOE-SR Radiological Fish Monitoring Program. Continued monitoring will provide a better understanding of actual radionuclide levels, their extent, and trends. This data will allow SCDHEC to better advise, inform, and protect those people at risk. Although Cs-137 and Sr-89,90 are found in some Savannah River fish, the levels are low and have decreased over time. If the public follows the SCDHEC mercury advisories for consumption of fish from the river, the health risk from these radioactive elements is very low (SCDHEC 2010b). Another benefit will be the ability to compare this data with historical data. Data comparison will also be part of the further evaluation of the DOE-SR program. This independent evaluation will provide credibility and confidence in the DOE-SR data and its uses.

Future analyses of the target species will continue to include mercury and selected metals analyses. This will augment the existing data on Savannah River fish, provide information for human health assessment, and provide another basis for comparison of results with DOE-SR data.

4.0 Fish Monitoring Associated with the Savannah River Site

Map 1. ESOP Fish Sampling Locations, 2011

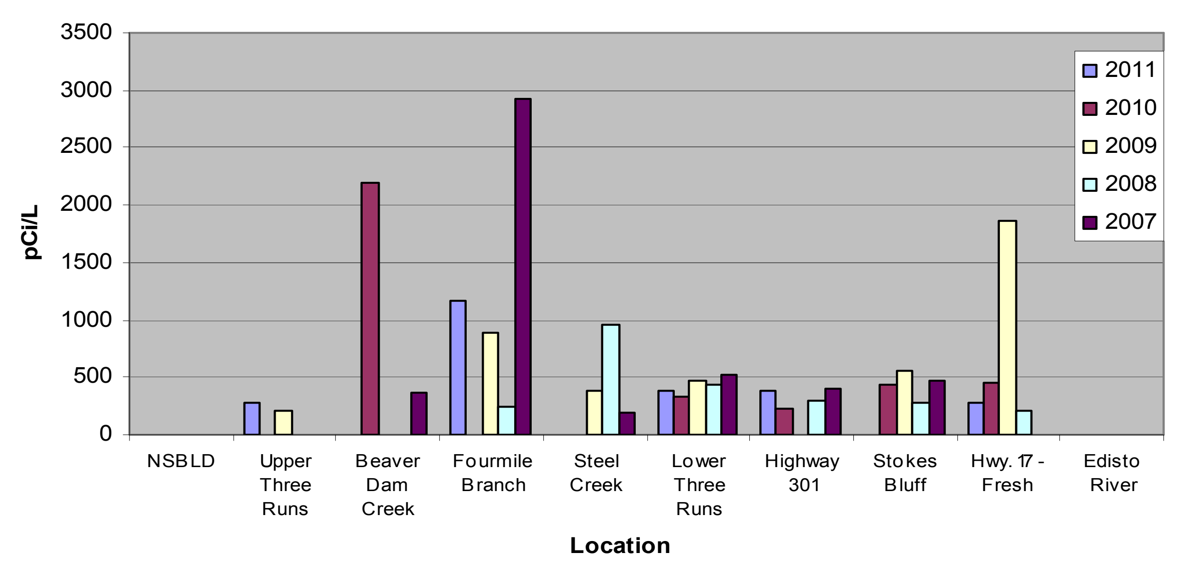


5.0 Tables and Figures

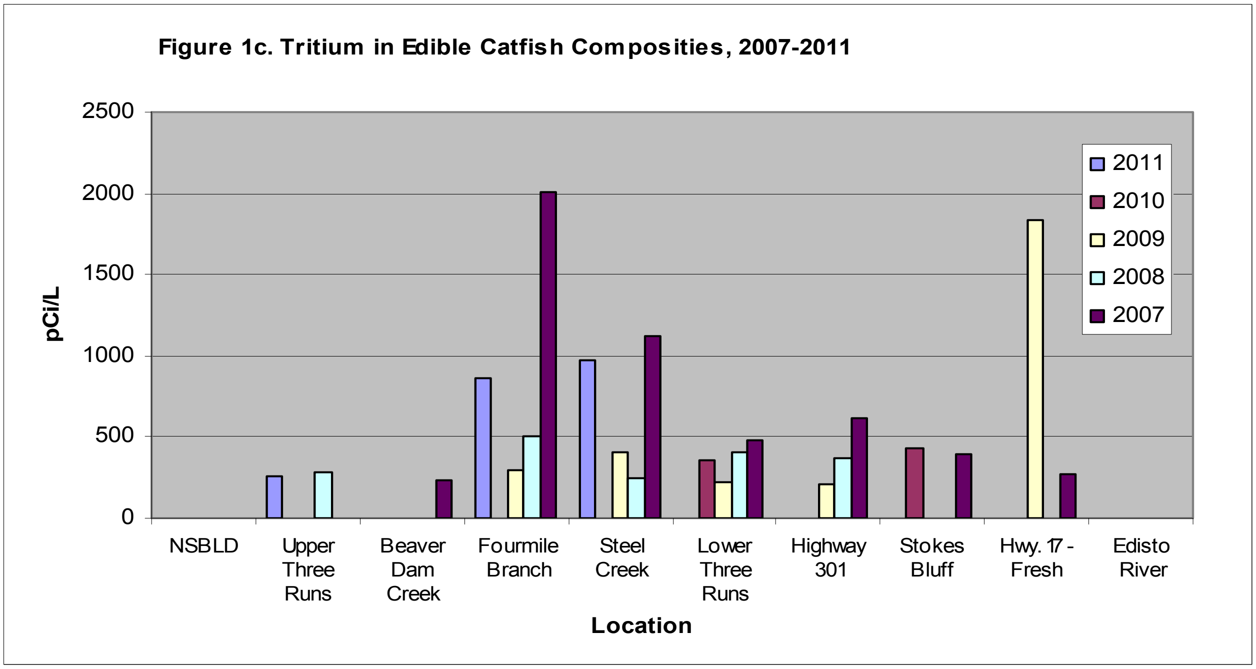
Fish Monitoring Associated with the Savannah River Site

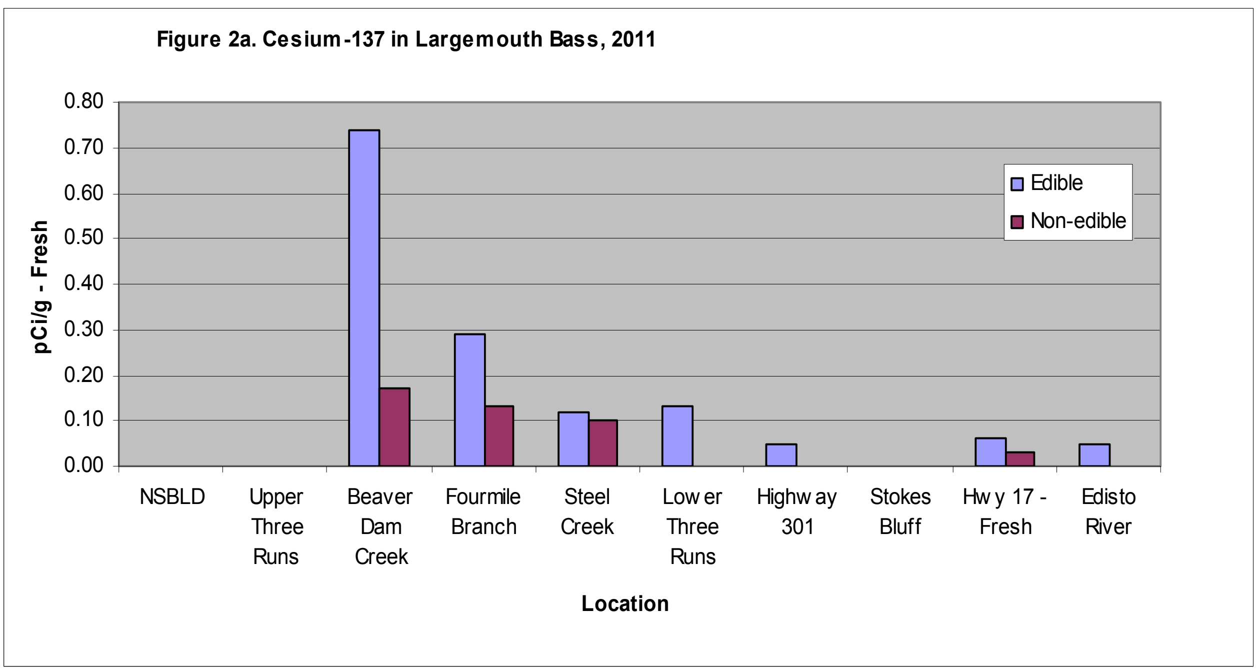
Figure 1a. Tritium in Fish Composites, 2011

Figure 1b. Tritium in Edible Bass Composities, 2007-2011

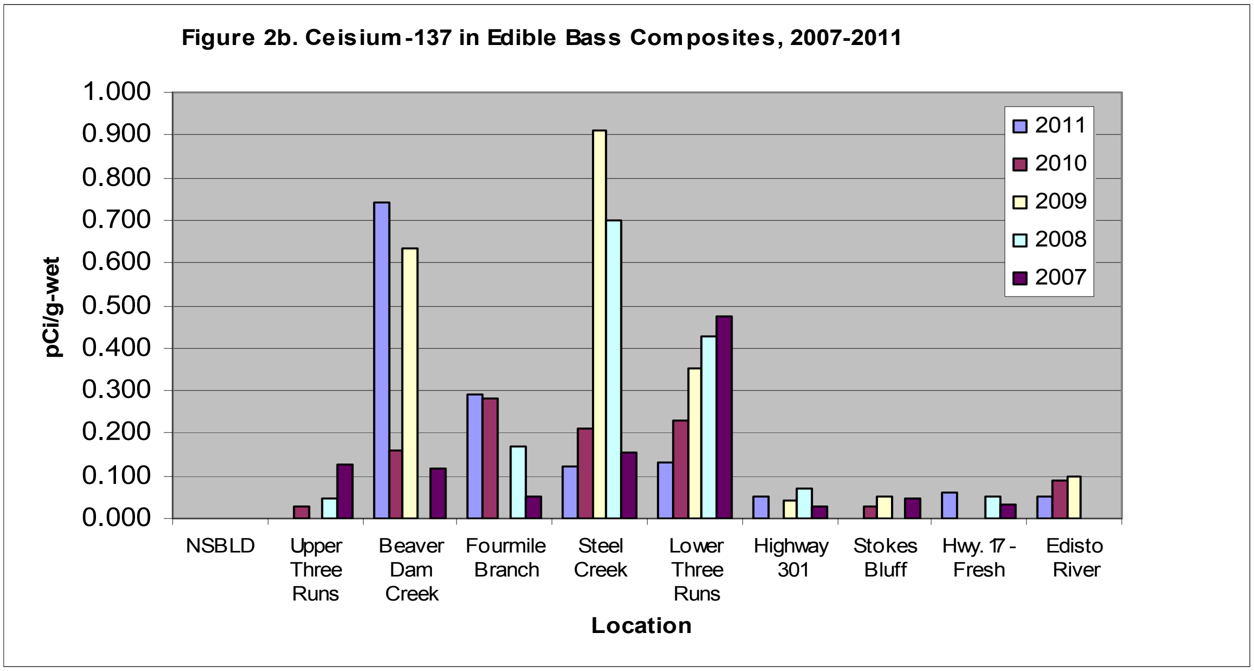


Tables and Figures
Fish Monitoring Associated with the Savannah River Site

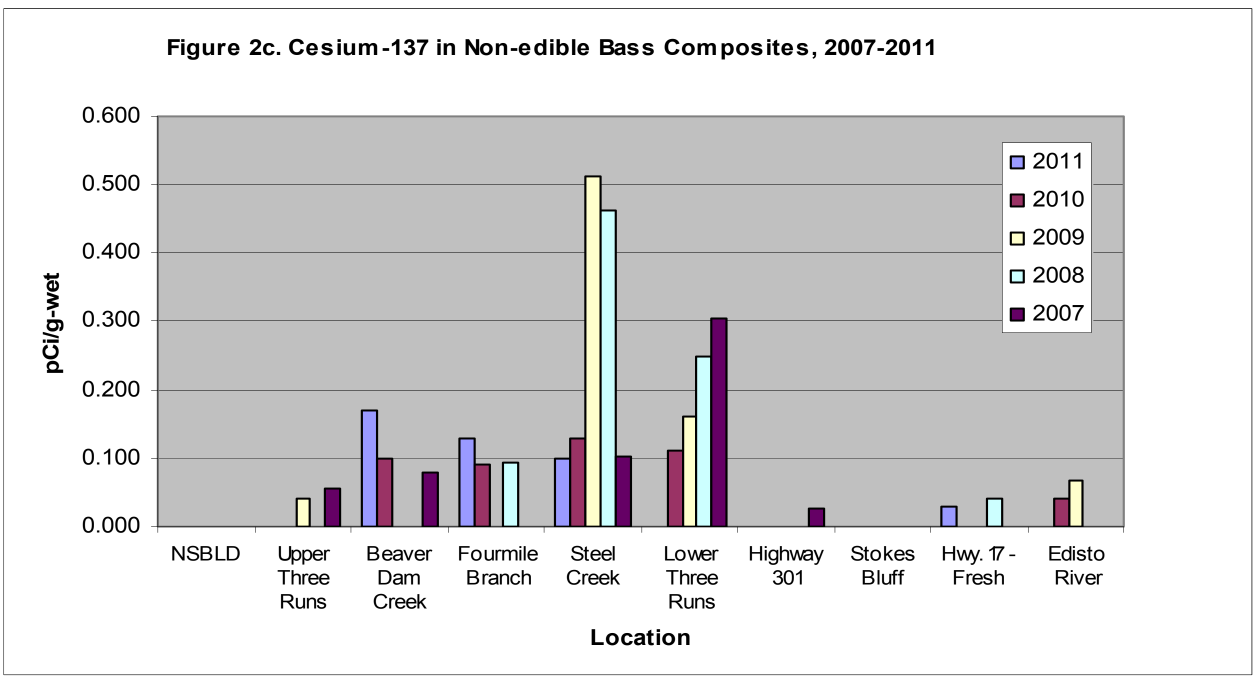




Tables and Figures
Fish Monitoring Associated with the Savannah River Site



Note: Sampling at the Edisto River location started in 2009



Note: Sampling at the Edisto River location started in 2009

Tables and Figures
Fish Monitoring Associated with the Savannah River Site

Figure 3a. Cesium-137 in Catfish, 2011

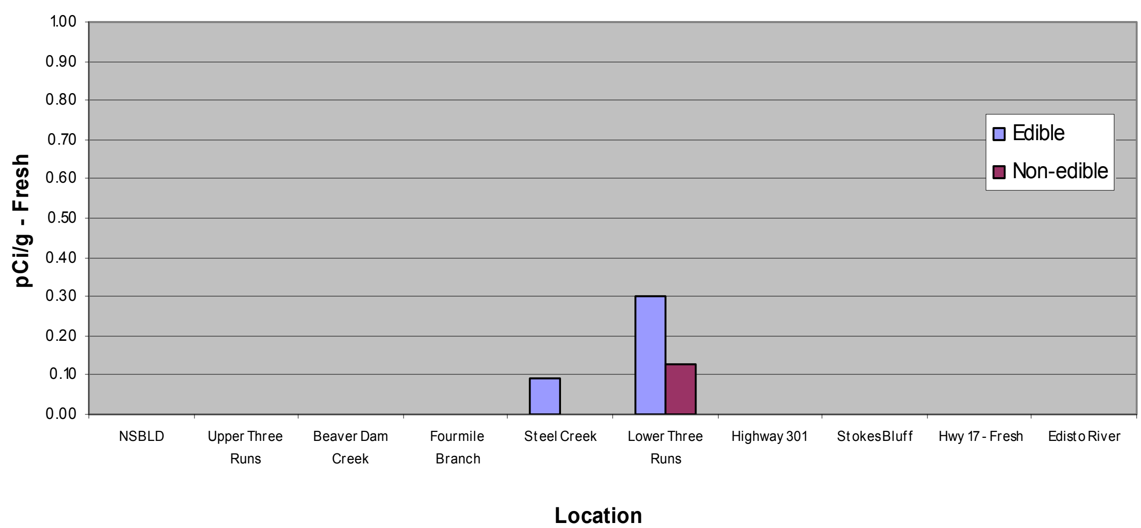
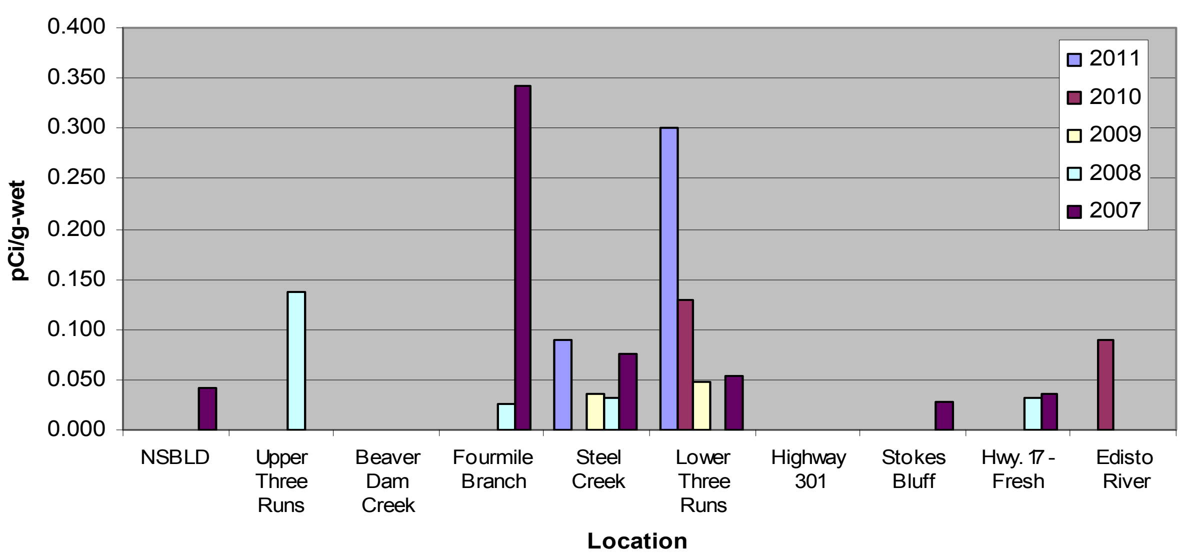
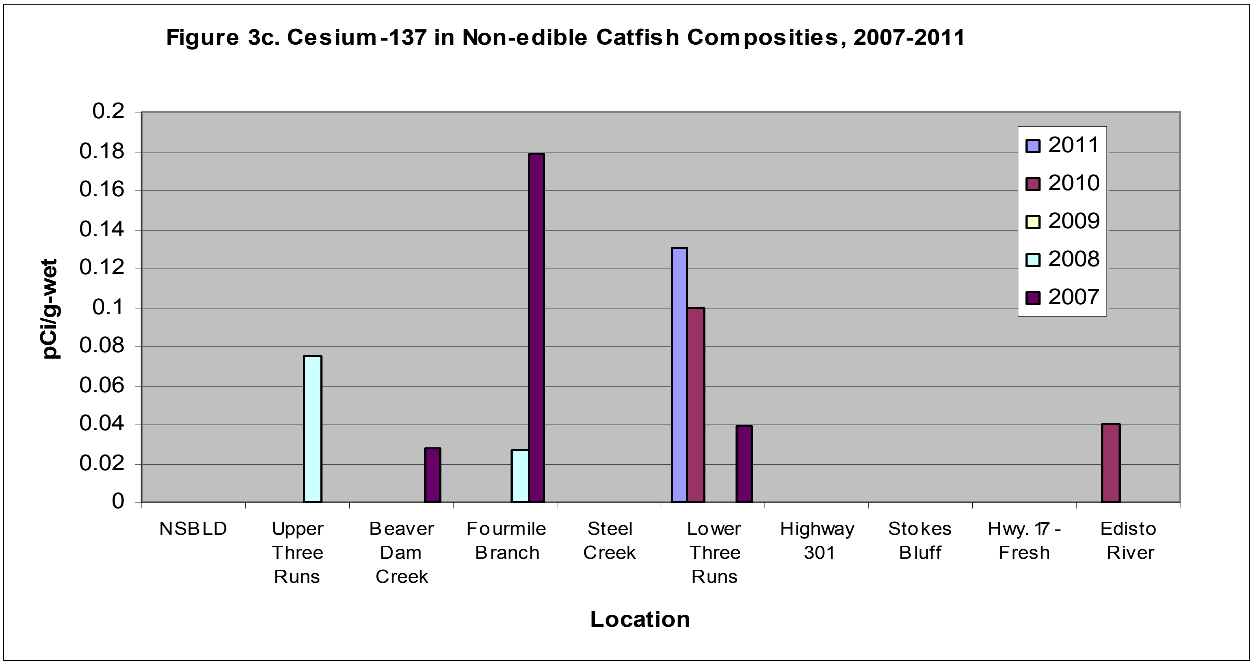


Figure 3b. Cesium-137 in Edible Catfish Composites, 2007-2011

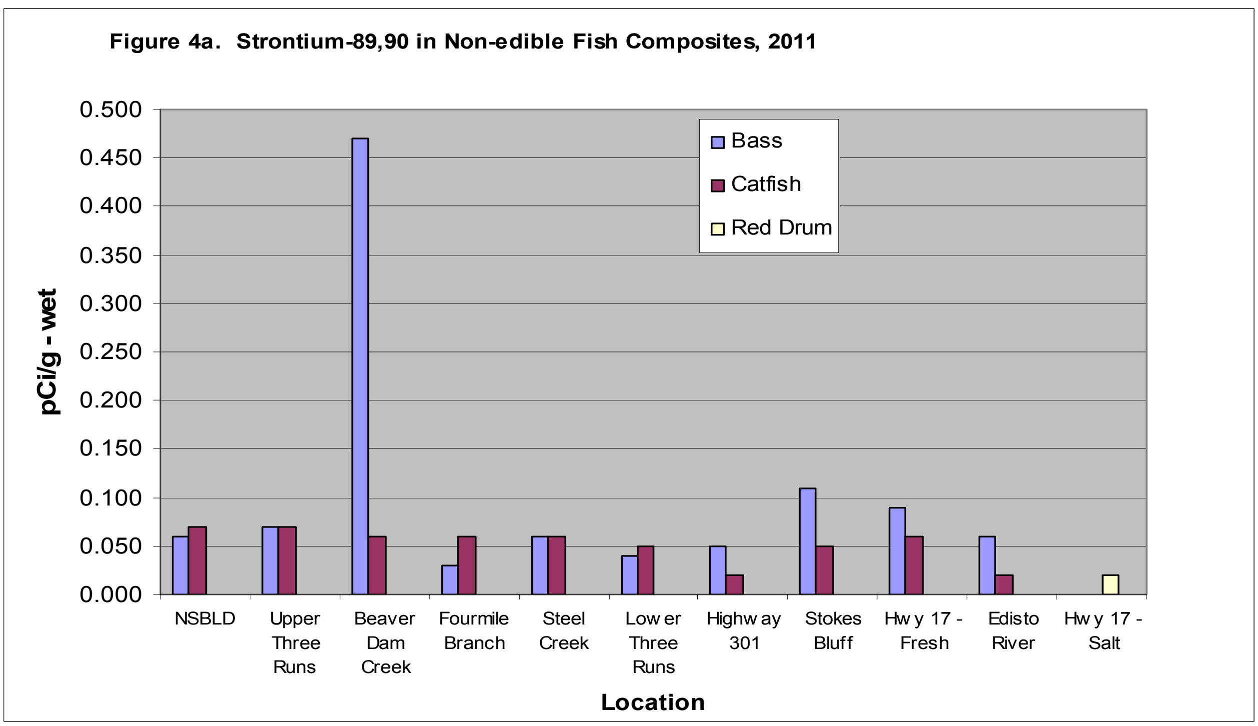


Note: Sampling at the Edisto River location started in 2009

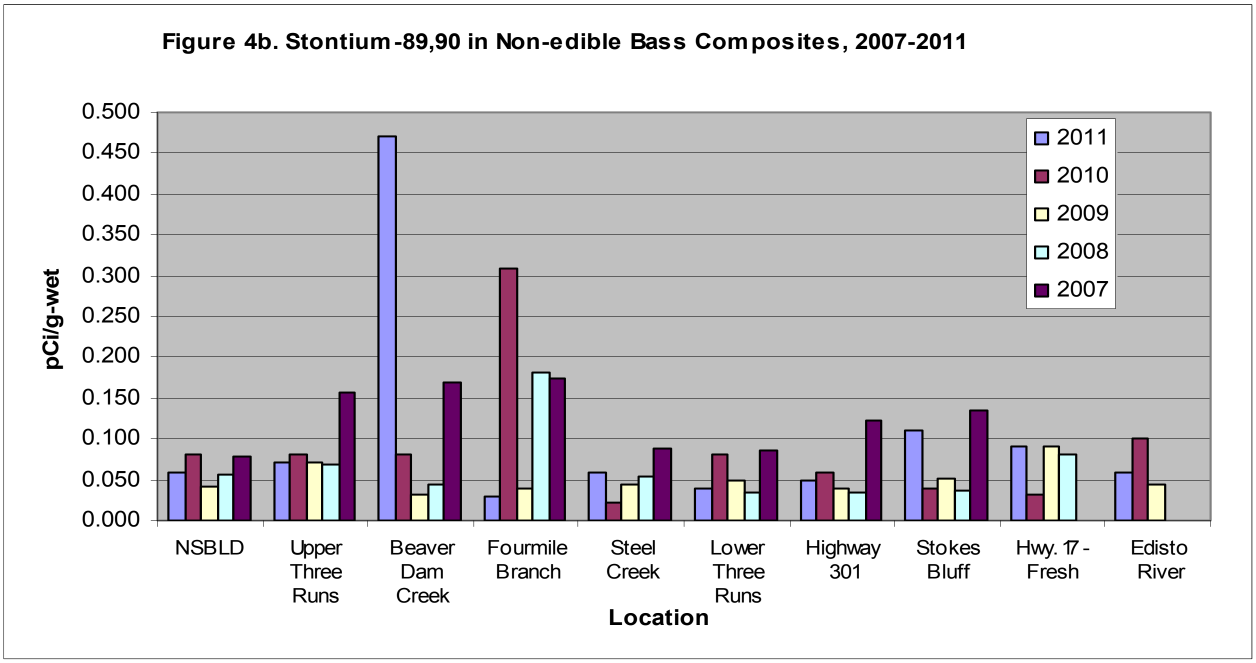
Tables and Figures
Fish Monitoring Associated with the Savannah River Site



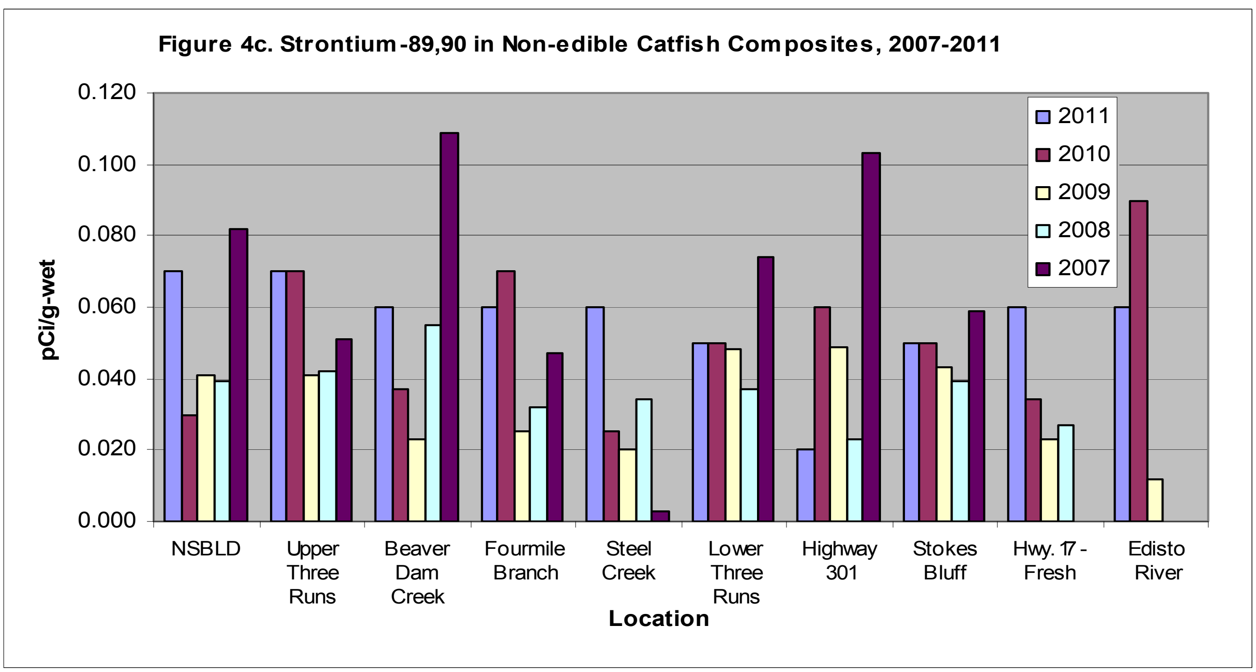
Note: Sampling at the Edisto River location started in 2009



Tables and Figures
Fish Monitoring Associated with the Savannah River Site



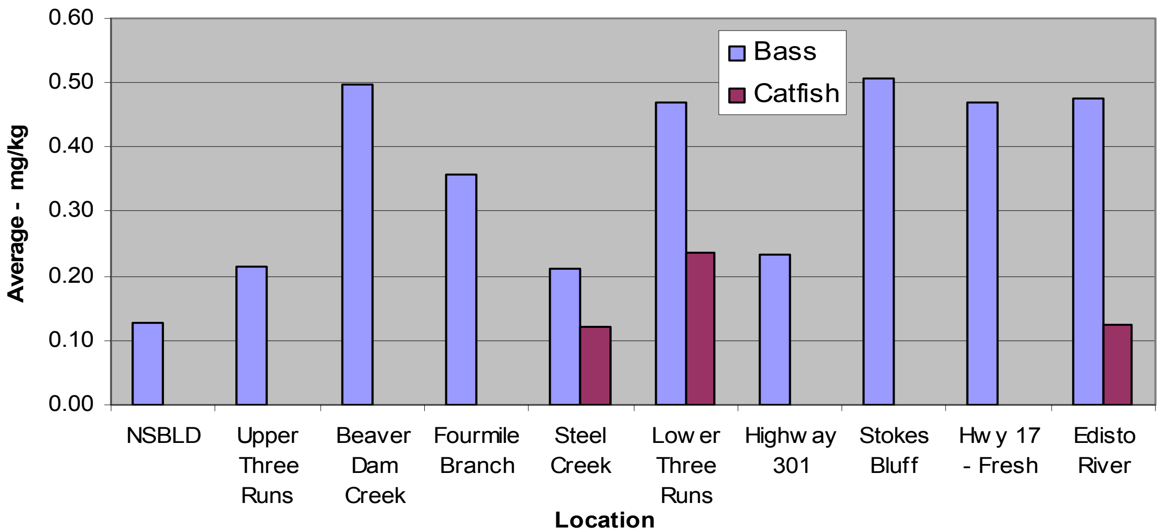
Note: Hwy. 17 not analyzed in 2007



Note: Hwy. 17 not analyzed in 2007

Tables and Figures
Fish Monitoring Associated with the Savannah River Site

Figure 5. Mercury in Fish, 2011



6.0 Data

Fish Monitoring Associated with the Savannah River Site

2011 Radionuclides Data **17**
SCDHEC Historical Radiological Data, 2007-2011 .... **29**
2011 Mercury Data **34**
2011 SCDHEC and DOE-SR Data Comparison **37**

Notes:

1. FM denotes Fish Monitoring project
2. LLD - Lower Limit of Detection
3. NA – Not Applicable
4. MDA - Minimum Detectable Activity
5. Hwy. 301 - Savannah River at U.S. Highway 301
6. Hwy. 17 - Savannah River at U.S. Highway 17

Fish Monitoring Data
2011 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
New Sav. Bluff	FMSV-2028A	Tritium Activity	6/28/2011	<LLD
Lock & Dam	FMSV-2028A	Tritium Confidence Interval	6/28/2011	NA
Bass	FMSV-2028A	Tritium LLD	6/28/2011	206
New Sav. Bluff	FMSV-2028C	Tritium Activity	6/28/2011	<LLD
Lock & Dam	FMSV-2028C	Tritium Confidence Interval	6/28/2011	NA
Catfish	FMSV-2028C	Tritium LLD	6/28/2011	206
Upper	FMSV-2011A	Tritium Activity	3/22/2011	384
Three Runs	FMSV-2011A	Tritium Confidence Interval	3/22/2011	101
Bass	FMSV-2011A	Tritium LLD	3/22/2011	206
Upper	FMSV-2011C	Tritium Activity	3/22/2011	259
Three Runs	FMSV-2011C	Tritium Confidence Interval	3/22/2011	96
Catfish	FMSV-2011C	Tritium LLD	3/22/2011	206
Beaver	FMSV-2013A	Tritium Activity	3/22/2011	<LLD
Dam Creek	FMSV-2013A	Tritium Confidence Interval	3/22/2011	NA
Bass	FMSV-2013A	Tritium LLD	3/22/2011	236
Beaver	FMSV-2013C	Tritium Activity	3/22/2011	NS
Dam Creek	FMSV-2013C	Tritium Confidence Interval	3/22/2011	Lab
Catfish	FMSV-2013C	Tritium LLD	3/22/2011	Error
Fourmile	FMSV-2015A	Tritium Activity	4/18/2011	1162
Branch	FMSV-2015A	Tritium Confidence Interval	4/18/2011	125
Bass	FMSV-2015A	Tritium LLD	4/18/2011	206
Fourmile	FMSV-2015C	Tritium Activity	4/18/2011	856
Branch	FMSV-2015C	Tritium Confidence Interval	4/18/2011	116
Catfish	FMSV-2015C	Tritium LLD	4/18/2011	206

Fish Monitoring Data
2011 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
Steel Creek Bass	FMSV-2017A	Tritium Activity	3/29/2011	<LLD
	FMSV-2017A	Tritium Confidence Interval	3/29/2011	NA
	FMSV-2017A	Tritium LLD	3/29/2011	236
Steel Creek Catfish	FMSV-2017C	Tritium Activity	3/29/2011	967
	FMSV-2017C	Tritium Confidence Interval	3/29/2011	120
	FMSV-2017C	Tritium LLD	3/29/2011	206
Lower Three Runs Bass	FMSV-2020A	Tritium Activity	4/20/2011	383
	FMSV-2020A	Tritium Confidence Interval	4/20/2011	101
	FMSV-2020A	Tritium LLD	4/20/2011	206
Lower Three Runs Catfish	FMSV-2020C	Tritium Activity	4/20/2011	<LLD
	FMSV-2020C	Tritium Confidence Interval	4/20/2011	NA
	FMSV-2020C	Tritium LLD	4/20/2011	206
Hwy. 301 Bass	FMSV-118A	Tritium Activity	5/3/2011	380
	FMSV-118A	Tritium Confidence Interval	5/3/2011	101
	FMSV-118A	Tritium LLD	5/3/2011	206
Hwy. 301 Catfish	FMSV-118C	Tritium Activity	5/3/2011	<LLD
	FMSV-118C	Tritium Confidence Interval	5/3/2011	NA
	FMSV-118C	Tritium LLD	5/3/2011	206
Stokes Bluff Bass	FMSV-355A	Tritium Activity	5/5/2011	<LLD
	FMSV-355A	Tritium Confidence Interval	5/5/2011	NA
	FMSV-355A	Tritium LLD	5/5/2011	223
Stokes Bluff Catfish	FMSV-355C	Tritium Activity	5/5/2011	<LLD
	FMSV-355C	Tritium Confidence Interval	5/5/2011	NA
	FMSV-355C	Tritium LLD	5/5/2011	223

Fish Monitoring Data
2011 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
Hwy. 17 Freshwater Bass	FMSV-2090A	Tritium Activity	6/14/2011	270
	FMSV-2090A	Tritium Confidence Interval	6/14/2011	97
	FMSV-2090A	Tritium LLD	6/14/2011	206
Hwy. 17 Freshwater Catfish	FMSV-2090C	Tritium Activity	6/14/2011	<LLD
	FMSV-2090C	Tritium Confidence Interval	6/14/2011	NA
	FMSV-2090C	Tritium LLD	6/14/2011	206
Hwy. 17 Saltwater Red drum	FMSV-2091A	Tritium Activity	6/14/2011	228
	FMSV-2091A	Tritium Confidence Interval	6/14/2011	95
	FMSV-2091A	Tritium LLD	6/14/2011	206
Hwy. 17 Saltwater Mullet	FMSV-2091E	Tritium Activity	6/14/2011	1191
	FMSV-2091E	Tritium Confidence Interval	6/14/2011	135
	FMSV-2091E	Tritium LLD	6/14/2011	236
Edisto River Bass	FMSV-119A	Tritium Activity	10/15/2011	<LLD
	FMSV-119A	Tritium Confidence Interval	10/15/2011	NA
	FMSV-119A	Tritium LLD	10/15/2011	223
Edisto River Catfish	FMSV-119C	Tritium Activity	6/17/2011	<LLD
	FMSV-119C	Tritium Confidence Interval	6/17/2011	NA
	FMSV-119C	Tritium LLD	6/17/2011	223

Fish Monitoring Data
2011 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff	FMSV-2028A	Cs-137 Activity	6/28/2011	<MDA
Lock & Dam	FMSV-2028A	Cs-137 Confidence Interval	6/28/2011	NA
Bass	FMSV-2028A	Cs-137 MDA	6/28/2011	0.02
New Sav. Bluff	FMSV-2028C	Cs-137 Activity	6/28/2011	<MDA
Lock & Dam	FMSV-2028C	Cs-137 Confidence Interval	6/28/2011	NA
Catfish	FMSV-2028C	Cs-137 MDA	6/28/2011	0.02
Upper	FMSV-2011A	Cs-137 Activity	3/21/2011	<MDA
Three Runs	FMSV-2011A	Cs-137 Confidence Interval	3/21/2011	NA
Bass	FMSV-2011A	Cs-137 MDA	3/21/2011	0.04
Upper	FMSV-2011C	Cs-137 Activity	3/21/2011	<MDA
Three Runs	FMSV-2011C	Cs-137 Confidence Interval	3/21/2011	NA
Catfish	FMSV-2011C	Cs-137 MDA	3/21/2011	0.03
Beaver	FMSV-2013A	Cs-137 Activity	3/21/2011	0.74
Dam Creek	FMSV-2013A	Cs-137 Confidence Interval	3/21/2011	0.06
Bass	FMSV-2013A	Cs-137 MDA	3/21/2011	0.02
Beaver	FMSV-2013C	Cs-137 Activity	3/21/2011	<MDA
Dam Creek	FMSV-2013C	Cs-137 Confidence Interval	3/21/2011	NA
Catfish	FMSV-2013C	Cs-137 MDA	3/21/2011	0.03
Fourmile	FMSV-2015A	Cs-137 Activity	4/18/2011	0.29
Branch	FMSV-2015A	Cs-137 Confidence Interval	4/18/2011	0.04
Bass	FMSV-2015A	Cs-137 MDA	4/18/2011	0.02
Fourmile	FMSV-2015C	Cs-137 Activity	4/18/2011	<MDA
Branch	FMSV-2015C	Cs-137 Confidence Interval	4/18/2011	NA
Catfish	FMSV-2015C	Cs-137 MDA	4/18/2011	0.02

Fish Monitoring Data
2011 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel Creek Bass	FMSV-2017A	Cs-137 Activity	3/29/2011	0.12
	FMSV-2017A	Cs-137 Confidence Interval	3/29/2011	0.03
	FMSV-2017A	Cs-137 MDA	3/29/2011	0.02
Steel Creek Catfish	FMSV-2017C	Cs-137 Activity	3/29/2011	0.09
	FMSV-2017C	Cs-137 Confidence Interval	3/29/2011	0.02
	FMSV-2017C	Cs-137 MDA	3/29/2011	0.02
Lower Three Runs Bass	FMSV-2020A	Cs-137 Activity	4/20/2011	0.13
	FMSV-2020A	Cs-137 Confidence Interval	4/20/2011	0.03
	FMSV-2020A	Cs-137 MDA	4/20/2011	0.02
Lower Three Runs Catfish	FMSV-2020C	Cs-137 Activity	4/20/2011	0.30
	FMSV-2020C	Cs-137 Confidence Interval	4/20/2011	0.04
	FMSV-2020C	Cs-137 MDA	4/20/2011	0.02
Hwy. 301 Bass	FMSV-118A	Cs-137 Activity	5/3/2011	0.05
	FMSV-118A	Cs-137 Confidence Interval	5/3/2011	0.02
	FMSV-118A	Cs-137 MDA	5/3/2011	0.02
Hwy. 301 Catfish	FMSV-118C	Cs-137 Activity	5/3/2011	<MDA
	FMSV-118C	Cs-137 Confidence Interval	5/3/2011	NA
	FMSV-118C	Cs-137 MDA	5/3/2011	0.02
Stokes Bluff Bass	FMSV-355A	Cs-137 Activity	5/5/2011	<MDA
	FMSV-355A	Cs-137 Confidence Interval	5/5/2011	NA
	FMSV-355A	Cs-137 MDA	5/5/2011	0.02
Stokes Bluff Catfish	FMSV-355C	Cs-137 Activity	5/5/2011	<MDA
	FMSV-355C	Cs-137 Confidence Interval	5/5/2011	NA
	FMSV-355C	Cs-137 MDA	5/5/2011	0.02

Fish Monitoring Data
2011 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17 Freshwater Bass	FMSV-2090A	Cs-137 Activity	6/14/2011	0.06
	FMSV-2090A	Cs-137 Confidence Interval	6/14/2011	0.02
	FMSV-2090A	Cs-137 MDA	6/14/2011	0.02
Hwy. 17 Freshwater Catfish	FMSV-2090C	Cs-137 Activity	6/14/2011	<MDA
	FMSV-2090C	Cs-137 Confidence Interval	6/14/2011	NA
	FMSV-2090C	Cs-137 MDA	6/14/2011	0.03
Edisto River Bass	FMMD-119A	Cs-137 Activity	10/15/2011	0.05
	FMMD-119A	Cs-137 Confidence Interval	10/15/2011	0.02
	FMMD-119A	Cs-137 MDA	10/15/2011	0.02
Edisto River Catfish	FMMD-119C	Cs-137 Activity	10/15/2011	0.06
	FMMD-119C	Cs-137 Confidence Interval	10/15/2011	0.02
	FMMD-119C	Cs-137 MDA	10/15/2011	0.02
Hwy. 17 Saltwater Red drum	FMSV-2091A	Cs-137 Activity	6/14/2011	<MDA
	FMSV-2091A	Cs-137 Confidence Interval	6/14/2011	NA
	FMSV-2091A	Cs-137 MDA	6/14/2011	0.02
Hwy. 17 Saltwater Mullet	FMSV-2091C	Cs-137 Activity	6/14/2011	<MDA
	FMSV-2091C	Cs-137 Confidence Interval	6/14/2011	NA
	FMSV-2091C	Cs-137 MDA	6/14/2011	0.03

Fish Monitoring Data
2011 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff Lock & Dam Bass	FMSV-2028B	Cs-137 Activity	6/28/2011	<MDA
	FMSV-2028B	Cs-137 Confidence Interval	6/28/2011	NA
	FMSV-2028B	Cs-137 MDA	6/28/2011	0.02
New Sav. Bluff Lock & Dam Catfish	FMSV-2028D	Cs-137 Activity	6/28/2011	<MDA
	FMSV-2028D	Cs-137 Confidence Interval	6/28/2011	NA
	FMSV-2028D	Cs-137 MDA	6/28/2011	0.02
Upper Three Runs Bass	FMSV-2011B	Cs-137 Activity	3/21/2011	<MDA
	FMSV-2011B	Cs-137 Confidence Interval	3/21/2011	NA
	FMSV-2011B	Cs-137 MDA	3/21/2011	0.02
Upper Three Runs Catfish	FMSV-2011D	Cs-137 Activity	3/21/2011	<MDA
	FMSV-2011D	Cs-137 Confidence Interval	3/21/2011	NA
	FMSV-2011D	Cs-137 MDA	3/21/2011	0.02
Beaver Dam Creek Bass	FMSV-2013B	Cs-137 Activity	3/21/2011	0.17
	FMSV-2013B	Cs-137 Confidence Interval	3/21/2011	0.03
	FMSV-2013B	Cs-137 MDA	3/21/2011	0.02
Beaver Dam Creek Catfish	FMSV-2013D	Cs-137 Activity	3/21/2011	<MDA
	FMSV-2013D	Cs-137 Confidence Interval	3/21/2011	NA
	FMSV-2013D	Cs-137 MDA	3/21/2011	0.02
Fourmile Branch Bass	FMSV-2015B	Cs-137 Activity	4/18/2011	0.13
	FMSV-2015B	Cs-137 Confidence Interval	4/18/2011	0.03
	FMSV-2015B	Cs-137 MDA	4/18/2011	0.02
Fourmile Branch Catfish	FMSV-2015D	Cs-137 Activity	4/18/2011	<MDA
	FMSV-2015D	Cs-137 Confidence Interval	4/18/2011	NA
	FMSV-2015D	Cs-137 MDA	4/18/2011	0.02

Fish Monitoring Data
2011 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel Creek Bass	FMSV-2017B	Cs-137 Activity	3/29/2011	0.10
	FMSV-2017B	Cs-137 Confidence Interval	3/29/2011	0.02
	FMSV-2017B	Cs-137 MDA	3/29/2011	0.02
Steel Creek Catfish	FMSV-2017D	Cs-137 Activity	3/29/2011	<MDA
	FMSV-2017D	Cs-137 Confidence Interval	3/29/2011	NA
	FMSV-2017D	Cs-137 MDA	3/29/2011	0.02
Lower Three Runs Bass	FMSV-2020B	Cs-137 Activity	4/20/2011	<MDA
	FMSV-2020B	Cs-137 Confidence Interval	4/20/2011	NA
	FMSV-2020B	Cs-137 MDA	4/20/2011	0.02
Lower Three Runs Catfish	FMSV-2020D	Cs-137 Activity	4/20/2011	0.13
	FMSV-2020D	Cs-137 Confidence Interval	4/20/2011	0.03
	FMSV-2020D	Cs-137 MDA	4/20/2011	0.02
Hwy. 301 Bass	FMSV-118B	Cs-137 Activity	5/3/2011	<MDA
	FMSV-118B	Cs-137 Confidence Interval	5/3/2011	NA
	FMSV-118B	Cs-137 MDA	5/3/2011	0.01
Hwy. 301 Catfish	FMSV-118D	Cs-137 Activity	5/3/2011	<MDA
	FMSV-118D	Cs-137 Confidence Interval	5/3/2011	NA
	FMSV-118D	Cs-137 MDA	5/3/2011	0.01
Stokes Bluff Bass	FMSV-355B	Cs-137 Activity	5/5/2011	<MDA
	FMSV-355B	Cs-137 Confidence Interval	5/5/2011	NA
	FMSV-355B	Cs-137 MDA	5/5/2011	0.01
Stokes Bluff Catfish	FMSV-355D	Cs-137 Activity	5/5/2011	<MDA
	FMSV-355D	Cs-137 Confidence Interval	5/5/2011	NA
	FMSV-355D	Cs-137 MDA	5/5/2011	0.01

Fish Monitoring Data
2011 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17 Freshwater Bass	FMSV-2090B	Cs-137 Activity	6/14/2011	0.03
	FMSV-2090B	Cs-137 Confidence Interval	6/14/2011	0.01
	FMSV-2090B	Cs-137 MDA	6/14/2011	0.01
Hwy. 17 Freshwater Catfish	FMSV-2090D	Cs-137 Activity	6/14/2011	<MDA
	FMSV-2090D	Cs-137 Confidence Interval	6/14/2011	NA
	FMSV-2090D	Cs-137 MDA	6/14/2011	0.01
Edisto River Bass	FMMD-119B	Cs-137 Activity	10/15/2011	<MDA
	FMMD-119B	Cs-137 Confidence Interval	10/15/2011	NA
	FMMD-119B	Cs-137 MDA	10/15/2011	0.01
Edisto River Catfish	FMMD-119D	Cs-137 Activity	10/15/2011	<MDA
	FMMD-119D	Cs-137 Confidence Interval	10/15/2011	NA
	FMMD-119D	Cs-137 MDA	10/15/2011	0.02
Hwy. 17 Saltwater Red drum	FMSV-2091B	Cs-137 Activity	6/14/2011	<MDA
	FMSV-2091B	Cs-137 Confidence Interval	6/14/2011	NA
	FMSV-2091B	Cs-137 MDA	6/14/2011	0.03
Hwy. 17 Saltwater Mullet	FMSV-2091D	Cs-137 Activity	6/14/2011	<MDA
	FMSV-2091D	Cs-137 Confidence Interval	6/14/2011	NA
	FMSV-2091D	Cs-137 MDA	6/14/2011	0.02

Fish Monitoring Data
2011 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff Lock & Dam Bass	FMSV-2028B	Strontium-89,90	6/28/2011	0.060
	FMSV-2028B	Strontium Uncertainty	6/28/2011	0.020
	FMSV-2028B	Strontium MDA	6/28/2011	0.020
New Sav. Bluff Lock & Dam Catfish	FMSV-2028D	Strontium-89,90	6/28/2011	0.070
	FMSV-2028D	Strontium Uncertainty	6/28/2011	0.030
	FMSV-2028D	Strontium MDA	6/28/2011	0.020
Upper Three Runs Bass	FMSV-2011B	Strontium-89,90	3/21/2011	0.070
	FMSV-2011B	Strontium Uncertainty	3/21/2011	0.030
	FMSV-2011B	Strontium MDA	3/21/2011	0.020
Upper Three Runs Catfish	FMSV-2011D	Strontium-89,90	3/21/2011	0.070
	FMSV-2011D	Strontium Uncertainty	3/21/2011	0.030
	FMSV-2011D	Strontium MDA	3/21/2011	0.030
Beaver Dam Creek Bass	FMSV-2013B	Strontium-89,90	3/21/2011	0.470
	FMSV-2013B	Strontium Uncertainty	3/21/2011	0.160
	FMSV-2013B	Strontium MDA	3/21/2011	0.020
Beaver Dam Creek Catfish	FMSV-2013D	Strontium-89,90	3/21/2011	0.060
	FMSV-2013D	Strontium Uncertainty	3/21/2011	0.020
	FMSV-2013D	Strontium MDA	3/21/2011	0.020
Fourmile Branch Bass	FMSV-2015B	Strontium-89,90	4/18/2011	0.030
	FMSV-2015B	Strontium Uncertainty	4/18/2011	0.020
	FMSV-2015B	Strontium MDA	4/18/2011	0.020
Fourmile Branch Catfish	FMSV-2015D	Strontium-89,90	4/18/2011	0.060
	FMSV-2015D	Strontium Uncertainty	4/18/2011	0.030
	FMSV-2015D	Strontium MDA	4/18/2011	0.030

Fish Monitoring Data
2011 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel Creek Bass	FMSV-2017B	Strontium-89,90	3/29/2011	0.060
	FMSV-2017B	Strontium Uncertainty	3/29/2011	0.020
	FMSV-2017B	Strontium MDA	3/29/2011	0.020
Steel Creek Catfish	FMSV-2017D	Strontium-89,90	3/29/2011	0.060
	FMSV-2017D	Strontium Uncertainty	3/29/2011	0.020
	FMSV-2017D	Strontium MDA	3/29/2011	0.020
Lower Three Runs Bass	FMSV-2020B	Strontium-89,90	4/20/2011	0.040
	FMSV-2020B	Strontium Uncertainty	4/20/2011	0.020
	FMSV-2020B	Strontium MDA	4/20/2011	0.020
Lower Three Runs Catfish	FMSV-2020D	Strontium-89,90	4/20/2011	0.050
	FMSV-2020D	Strontium Uncertainty	4/20/2011	0.020
	FMSV-2020D	Strontium MDA	4/20/2011	0.020
Hwy. 301 Bass	FMSV-118B	Strontium-89,90	5/3/2011	0.050
	FMSV-118B	Strontium Uncertainty	5/3/2011	0.020
	FMSV-118B	Strontium MDA	5/3/2011	0.030
Hwy. 301 Catfish	FMSV-118D	Strontium-89,90	5/3/2011	0.020
	FMSV-118D	Strontium Uncertainty	5/3/2011	0.010
	FMSV-118D	Strontium MDA	5/3/2011	0.020
Stokes Bluff Bass	FMSV-355B	Strontium-89,90	5/5/2011	0.110
	FMSV-355B	Strontium Uncertainty	5/5/2011	0.040
	FMSV-355B	Strontium MDA	5/5/2011	0.020
Stokes Bluff Catfish	FMSV-355D	Strontium-89,90	5/5/2011	0.050
	FMSV-355D	Strontium Uncertainty	5/5/2011	0.020
	FMSV-355D	Strontium MDA	5/5/2011	0.020

Fish Monitoring Data
2011 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17	FMSV-2090B	Strontium-89,90	6/14/2011	0.090
Freshwater	FMSV-2090B	Strontium Uncertainty	6/14/2011	0.030
Bass	FMSV-2090B	Strontium MDA	6/14/2011	0.020
Hwy. 17	FMSV-2090D	Strontium-89,90	6/14/2011	0.060
Freshwater	FMSV-2090D	Strontium Uncertainty	6/14/2011	0.020
Catfish	FMSV-2090D	Strontium MDA	6/14/2011	0.020
Edisto	FMMD-119B	Strontium-89,90	10/15/2011	0.060
River	FMMD-119B	Strontium Uncertainty	10/15/2011	0.020
Bass	FMMD-119B	Strontium MDA	10/15/2011	0.020
Edisto	FMMD-119D	Strontium-89,90	10/15/2011	0.020
River	FMMD-119D	Strontium Uncertainty	10/15/2011	0.010
Catfish	FMMD-119D	Strontium MDA	10/15/2011	0.020
Hwy. 17	FMSV-2091H	Strontium-89,90	6/14/2011	0.020
Saltwater	FMSV-2091H	Strontium Uncertainty	6/14/2011	0.010
Red drum	FMSV-2091H	Strontium MDA	6/14/2011	0.020
Hwy. 17	FMSV-2091J	Strontium-89,90	6/14/2011	<MDA
Saltwater	FMSV-2091J	Strontium Uncertainty	6/14/2011	NA
Mullet	FMSV-2091J	Strontium MDA	6/14/2011	0.020

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2007-2011

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Bass	Bass	Bass	Bass	Bass
2011	Radionuclide	Tritium (pCi/L)	ND	384	ND	1162	ND
2010			NS	ND	2187	ND	ND
2009			ND	209	ND	893	383
2008			ND	ND	ND	240	954
2007			ND	ND	359	2,930	183

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Bass	Bass	Bass	Bass	Bass
2011	Radionuclide	Tritium (pCi/L)	383	380	ND	270	ND
2010			329	218	434	447	ND
2009			468	ND	550	1870	ND
2008			436	301	279	215	NS
2007			518	396	477	ND	NS

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Bass	Bass	Bass	Bass	Bass
2011	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	0.740	0.290	0.120
2010			ND	0.03	0.160	0.28	0.210
2009			ND	ND	0.634	ND	0.910
2008			ND	0.047	ND	0.167	0.700
2007			ND	0.129	0.117	0.052	0.155

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Bass	Bass	Bass	Bass	Bass
2011	Radionuclide	Cs-137 (pCi/g wet)	0.130	0.050	ND	0.060	0.050
2010			0.230	ND	0.030	ND	0.090
2009			0.353	0.041	0.053	ND	0.097
2008			0.427	0.071	ND	0.050	NS
2007			0.473	0.027	0.045	0.031	NS

Notes:
ND - Non-Detect
NA - Not Analyzed
NS - Not Sampled
NR - Not Reported
NSBLD - New Sav. Bluff Lock & Dam
UTR - Upper Three Runs
BDC - Beaver Dam Creek
FMB - Fourmile Branch
STC - Steel Creek
LTR - Lower Three Runs
Stokes - Stokes Bluff
Edisto R. - Edisto River

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2007-2011

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Bass	Bass	Bass	Bass	Bass
2011	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	0.170	0.130	0.100
2010			ND	ND	0.100	0.090	0.130
2009			ND	0.042	ND	ND	0.512
2008			ND	ND	ND	0.094	0.463
2007			ND	0.057	0.079	ND	0.102

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Bass	Bass	Bass	Bass	Bass
2011	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	ND	0.030	ND
2010			0.110	ND	ND	ND	0.040
2009			0.160	ND	ND	ND	0.066
2008			0.248	ND	ND	0.041	NS
2007			0.303	0.026	ND	ND	NS

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Bass	Bass	Bass	Bass	Bass
2011	Radionuclide	Sr-89,90 (pCi/g Wet)	0.060	0.070	0.470	0.030	0.060
2010			0.080	0.080	0.080	0.310	0.022
2009			0.041	0.072	0.032	0.038	0.045
2008			0.056	0.069	0.044	0.182	0.053
2007			0.078	0.156	0.170	0.173	0.089

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Bass	Bass	Bass	Bass	Bass
2011	Radionuclide	Sr-89,90 (pCi/g Wet)	0.040	0.050	0.110	0.090	0.060
2010			0.080	0.060	0.040	0.033	0.100
2009			0.050	0.040	0.051	0.091	0.044
2008			0.034	0.035	0.036	0.080	NS
2007			0.085	0.123	0.134	NA	NS

Notes:
ND - Non-Detect
NA - Not Analyzed
NS - Not Sampled
NR - Not Reported
NSBLD - New Sav. Bluff Lock & Dam
UTR - Upper Three Runs
BDC - Beaver Dam Creek
FMB - Fourmile Branch
STC - Steel Creek
LTR - Lower Three Runs
Stokes - Stokes Bluff
Edisto R. - Edisto River

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2007-2011

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2011	Radionuclide	Tritium (pCi/L)	ND	259	NS	856	967
2010			NS	ND	ND	NS	NS
2009			ND	ND	ND	298	405
2008			ND	278	ND	507	247
2007			ND	ND	233	2,010	1,120

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Catfish	Catfish	Catfish	Catfish	Bass
2011	Radionuclide	Tritium (pCi/L)	ND	ND	ND	ND	ND
2010			363	ND	427	ND	ND
2009			216	205	ND	1832	ND
2008			406	373	ND	ND	NS
2007			484	621	396	273	NS

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2011	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	ND	ND	0.090
2010			ND	ND	ND	ND	ND
2009			ND	ND	ND	ND	0.036
2008			ND	0.138	ND	0.026	0.032
2007			0.041	ND	ND	0.342	0.075

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2011	Radionuclide	Cs-137 (pCi/g wet)	0.300	ND	ND	ND	ND
2010			0.130	ND	ND	ND	0.090
2009			0.048	ND	ND	ND	ND
2008			ND	ND	ND	0.032	NS
2007			0.053	ND	0.028	0.035	NS

Notes:

ND - Non-Detect	NSBLD - New Sav. Bluff Lock & Dam	STC - Steel Creek
NA - Not Analyzed	UTR - Upper Three Runs	LTR - Lower Three Runs
NS - Not Sampled	BDC - Beaver Dam Creek	Stokes - Stokes Bluff
NR - Not Reported	FMB - Fourmile Branch	Edisto R. - Edisto River

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2007-2011

	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2011	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	ND	ND	ND
2010			ND	ND	ND	ND	ND
2009			ND	ND	ND	ND	ND
2008			ND	0.075	ND	0.027	ND
2007			ND	ND	0.028	0.178	ND

Year	**Sample Location**		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2011	Radionuclide	Cs-137 (pCi/g wet)	0.130	ND	ND	ND	ND
2010			0.100	ND	ND	ND	0.040
2009			ND	ND	ND	ND	ND
2008			ND	ND	ND	ND	NS
2007			0.039	ND	ND	ND	NS

Year	**Sample Location**		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2011	Radionuclide	Sr-89,90 (pCi/g Wet)	0.070	0.070	0.060	0.060	0.060
2010			0.030	0.070	0.037	0.070	0.025
2009			0.041	0.041	0.023	0.025	0.020
2008			0.039	0.042	0.055	0.032	0.034
2007			0.082	0.051	0.109	0.047	0.003

Year	**Sample Location**		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2011	Radionuclide	Sr-89,90 (pCi/g Wet)	0.050	0.020	0.050	0.060	0.060
2010			0.050	0.060	0.050	0.034	0.090
2009			0.048	0.049	0.043	0.023	0.012
2008			0.037	0.023	0.039	0.027	NS
2007			0.074	0.103	0.059	NA	NS

Notes:
ND - Non-Detect
NS - Not Sampled
NA - Not Analyzed
NR - Not Reported

NSBLD - New Sav. Bluff Lock & Dam
UTR - Upper Three Runs
BDC - Beaver Dam Creek
FMB - Fourmile Branch

STC - Steel Creek
LTR - Lower Three Runs
Stokes - Stokes Bluff
Edisto R. - Edisto River

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2007-2011

Year	Sample Location		Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091
	Sample Cut		Edible	Edible
	Species		Red drum	Mullet
2011	Radionuclide	Tritium (pCi/L)	228	1191
2010			300	221
2009			378	414
2008			ND	ND
2007			ND	ND

Year	Sample Location		Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091
	Sample Cut		Edible	Edible
	Species		Red drum	Mullet
2011	Radionuclide	Cs-137 (pCi/g wet)	ND	ND
2010			ND	ND
2009			ND	ND
2008			ND	ND
2007			ND	ND

Year	Sample Location		Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091
	Sample Cut		Non-edible	Non-edible
	Species		Red drum	Mullet
2011	Radionuclide	Cs-137 (pCi/g wet)	ND	ND
2010			ND	ND
2009			ND	ND
2008			NA	ND
2007			ND	NA

Year	Sample Location		Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091
	Sample Cut		Non-edible	Non-edible
	Species		Red drum	Mullet
2011	Radionuclide	Sr-89,90 (pCi/g Wet)	0.020	ND
2010			0.140	0.009
2009			0.017	0.004
2008			0.010	ND
2007			NA	NA

Notes: ND - Non-Detect
NA - Not Analyzed
NS - Not Sampled

Fish Monitoring Data
2011 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
New Sav. Bluff Lock & Dam Bass	FMSV-2028A-1	Mercury in Fish	6/28/2011	0.15
	FMSV-2028A-2	Mercury in Fish	6/28/2011	0.12
	FMSV-2028A-3	Mercury in Fish	6/28/2011	<0.10
	FMSV-2028A-4	Mercury in Fish	6/28/2011	0.11
	FMSV-2028A-5	Mercury in Fish	6/28/2011	<0.10
New Sav. Bluff Lock & Dam Catfish	FMSV-2028C-1	Mercury in Fish	6/28/2011	<0.10
	FMSV-2028C-2	Mercury in Fish	6/28/2011	<0.10
	FMSV-2028C-3	Mercury in Fish	6/28/2011	<0.10
	FMSV-2028C-4	Mercury in Fish	6/28/2011	<0.10
	FMSV-2028C-5	Mercury in Fish	6/28/2011	<0.10
Upper Three Runs Bass	FMSV-2011A-1	Mercury in Fish	3/21/2011	<0.10
	FMSV-2011A-2	Mercury in Fish	3/21/2011	<0.10
	FMSV-2011A-3	Mercury in Fish	3/21/2011	<0.10
	FMSV-2011A-4	Mercury in Fish	3/21/2011	0.23
	FMSV-2011A-5	Mercury in Fish	3/21/2011	0.20
Upper Three Runs Catfish	FMSV-2011C-1	Mercury in Fish	3/21/2011	<0.10
	FMSV-2011C-2	Mercury in Fish	3/21/2011	<0.10
	FMSV-2011C-3	Mercury in Fish	3/21/2011	<0.10
	FMSV-2011C-4	Mercury in Fish	3/21/2011	<0.10
	FMSV-2011C-5	Mercury in Fish	3/21/2011	<0.10
Beaver Dam Creek Bass	FMSV-2013A-1	Mercury in Fish	3/21/2011	0.42
	FMSV-2013A-2	Mercury in Fish	3/21/2011	0.69
	FMSV-2013A-3	Mercury in Fish	3/21/2011	0.36
	FMSV-2013A-4	Mercury in Fish	3/21/2011	0.63
	FMSV-2013A-5	Mercury in Fish	3/21/2011	0.39
Beaver Dam Creek Catfish	FMSV-2013C-1	Mercury in Fish	3/21/2011	<0.10
	FMSV-2013C-2	Mercury in Fish	3/21/2011	<0.10
	FMSV-2013C-3	Mercury in Fish	3/21/2011	<0.10
	FMSV-2013C-4	Mercury in Fish	3/21/2011	<0.10
	FMSV-2013C-5	Mercury in Fish	3/21/2011	<0.10
Fourmile Branch Bass	FMSV-2015A-1	Mercury in Fish	3/29/2011	0.42
	FMSV-2015A-2	Mercury in Fish	3/29/2011	0.40
	FMSV-2015A-3	Mercury in Fish	3/29/2011	<0.10
	FMSV-2015A-4	Mercury in Fish	3/29/2011	0.22
	FMSV-2015A-5	Mercury in Fish	3/29/2011	0.39
Fourmile Branch Catfish	FMSV-2015C-1	Mercury in Fish	4/18/2011	<0.10
	FMSV-2015C-2	Mercury in Fish	4/18/2011	<0.10
	FMSV-2015C-3	Mercury in Fish	4/18/2011	<0.10
	FMSV-2015C-4	Mercury in Fish	4/18/2011	<0.10
	FMSV-2015C-5	Mercury in Fish	4/18/2011	<0.10

Fish Monitoring Data
2011 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
Steel Creek Bass	FMSV-2017A-1	Mercury in Fish	3/29/2011	0.14
	FMSV-2017A-2	Mercury in Fish	3/29/2011	0.11
	FMSV-2017A-3	Mercury in Fish	3/29/2011	0.11
	FMSV-2017A-4	Mercury in Fish	3/29/2011	<0.10
	FMSV-2017A-5	Mercury in Fish	3/29/2011	0.48
Steel Creek Catfish	FMSV-2017C-1	Mercury in Fish	3/29/2011	<0.10
	FMSV-2017C-2	Mercury in Fish	3/29/2011	<0.10
	FMSV-2017C-3	Mercury in Fish	3/29/2011	<0.10
	FMSV-2017C-4	Mercury in Fish	3/29/2011	<0.10
	FMSV-2017C-5	Mercury in Fish	3/29/2011	0.12
Lower Three Runs Bass	FMSV-2020A-1	Mercury in Fish	4/20/2011	0.25
	FMSV-2020A-2	Mercury in Fish	4/20/2011	0.37
	FMSV-2020A-3	Mercury in Fish	4/20/2011	0.38
	FMSV-2020A-4	Mercury in Fish	4/20/2011	0.50
	FMSV-2020A-5	Mercury in Fish	4/20/2011	0.84
Lower Three Runs Catfish	FMSV-2020C-1	Mercury in Fish	4/20/2011	0.23
	FMSV-2020C-2	Mercury in Fish	4/20/2011	<0.10
	FMSV-2020C-3	Mercury in Fish	4/20/2011	0.33
	FMSV-2020C-4	Mercury in Fish	4/20/2011	0.23
	FMSV-2020C-5	Mercury in Fish	4/20/2011	0.15
Hwy. 301 Bass	FMSV-118A-1	Mercury in Fish	5/3/2011	0.27
	FMSV-118A-2	Mercury in Fish	5/3/2011	0.20
	FMSV-118A-3	Mercury in Fish	5/3/2011	0.46
	FMSV-118A-4	Mercury in Fish	5/3/2011	0.12
	FMSV-118A-5	Mercury in Fish	5/3/2011	0.11
Hwy. 301 Catfish	FMSV-118C-1	Mercury in Fish	5/3/2011	<0.10
	FMSV-118C-2	Mercury in Fish	5/3/2011	<0.10
	FMSV-118C-3	Mercury in Fish	5/3/2011	<0.10
	FMSV-118C-4	Mercury in Fish	5/3/2011	<0.10
	FMSV-118C-5	Mercury in Fish	5/3/2011	<0.10
Stokes Bluff Bass	FMSV-355A-1	Mercury in Fish	5/5/2011	0.48
	FMSV-355A-2	Mercury in Fish	5/5/2011	0.83
	FMSV-355A-3	Mercury in Fish	5/5/2011	0.33
	FMSV-355A-4	Mercury in Fish	5/5/2011	0.51
	FMSV-355A-5	Mercury in Fish	5/5/2011	0.39
Stokes Bluff Catfish	FMSV-355C-1	Mercury in Fish	5/5/2011	<0.10
	FMSV-355C-2	Mercury in Fish	5/5/2011	<0.10
	FMSV-355C-3	Mercury in Fish	5/5/2011	<0.10
	FMSV-355C-4	Mercury in Fish	5/5/2011	<0.10
	FMSV-355C-5	Mercury in Fish	5/5/2011	<0.10

Fish Monitoring Data
2011 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
Hwy. 17 Bass	FMSV-2090A-1	Mercury in Fish	6/14/2011	0.42
	FMSV-2090A-2	Mercury in Fish	6/14/2011	0.60
	FMSV-2090A-3	Mercury in Fish	6/14/2011	0.44
	FMSV-2090A-4	Mercury in Fish	6/14/2011	0.29
	FMSV-2090A-5	Mercury in Fish	6/14/2011	0.60
Hwy. 17 Catfish	FMSV-2090C-1	Mercury in Fish	6/14/2011	<0.10
	FMSV-2090C-2	Mercury in Fish	6/14/2011	<0.10
	FMSV-2090C-3	Mercury in Fish	6/14/2011	<0.10
	FMSV-2090C-4	Mercury in Fish	6/14/2011	<0.10
	FMSV-2090C-5	Mercury in Fish	6/14/2011	<0.10
Hwy. 17 Red Drum	FMSV-2091A-1	Mercury in Fish	6/14/2011	<0.10
	FMSV-2091A-2	Mercury in Fish	6/14/2011	<0.10
	FMSV-2091A-3	Mercury in Fish	6/14/2011	<0.10
	FMSV-2091A-4	Mercury in Fish	6/14/2011	<0.10
	FMSV-2091A-5		6/14/2011	<0.10
Hwy. 17 Flounder	FMSV-2091C-1	Mercury in Fish	6/14/2011	<0.10
	FMSV-2091C-2	Mercury in Fish	6/14/2011	<0.10
	FMSV-2091C-3	Mercury in Fish	6/14/2011	<0.10
	FMSV-2091C-4	Mercury in Fish	6/14/2011	<0.10
	FMSV-2091C-5	Mercury in Fish	6/14/2011	<0.10
Edisto River Bass	FMMD-119A-1	Mercury in Fish	10/15/2011	0.65
	FMMD-119A-2	Mercury in Fish	10/15/2011	0.59
	FMMD-119A-3	Mercury in Fish	10/15/2011	0.11
	FMMD-119A-4	Mercury in Fish	10/15/2011	0.56
	FMMD-119A-5	Mercury in Fish	10/15/2011	<0.10
Edisto River Catfish	FMMD-119C-1	Mercury in Fish	10/15/2011	<0.10
	FMMD-119C-2	Mercury in Fish	10/15/2011	<0.10
	FMMD-119C-3	Mercury in Fish	10/15/2011	0.13
	FMMD-119C-4	Mercury in Fish	10/15/2011	<0.10
	FMMD-119C-5	Mercury in Fish	10/15/2011	0.12

Fish Monitoring Data
2011 SCDHEC and DOE-SR Data Comparison

Table 1
Tritium Activity Levels in Edible Bass
pCi/g[1]

Location	Agency	# of samples	Result
NSBLD	ESOP	1	<LLD
	DOE-SR	3	0.11*
Upper Three Runs	ESOP	1	384
	DOE-SR	3	0.20
Beaver Dam Creek	ESOP	1	<LLD
	DOE-SR	3	0.08**
Fourmile Branch	ESOP	1	1162.00
	DOE-SR	3	0.29*
Steel Creek	ESOP	1	<LLD
	DOE-SR	3	0.17
Lower Three Runs	ESOP	1	383
	DOE-SR	3	0.12*
Hwy. 301	ESOP	1	380
	DOE-SR	3	0.10*
Stokes Bluff	ESOP	1	<LLD
	DOE-SR	3	0.30
Hwy. 17	ESOP	1	270
	DOE-SR	3	0.29
Average[2]	ESOP	5	516
	DOE-SR	9	0.22
Standard Deviation[2]	ESOP	5	364
	DOE-SR	9	0.09

Table 2
Tritium Activity Levels in Edible Catfish
pCi/g[1]

Location	Agency	# of samples	Result
NSBLD	ESOP	1	<LLD
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	259
	DOE-SR	3	0.14
Beaver Dam Creek	ESOP	1	<LLD
	DOE-SR	3	0.09**
Fourmile Branch	ESOP	1	856.00
	DOE-SR	3	0.08**
Steel Creek	ESOP	1	967.00
	DOE-SR	3	0.12*
Lower Three Runs	ESOP	1	<LLD
	DOE-SR	3	0.03**
Hwy. 301	ESOP	1	<LLD
	DOE-SR	3	0.15*
Stokes Bluff	ESOP	1	<LLD
	DOE-SR	3	0.16
Hwy. 17	ESOP	1	<LLD
	DOE-SR	3	0.20
Average[2]	ESOP	3	694
	DOE-SR	9	0.16
Standard Deviation[2]	ESOP	3	381.00
	DOE-SR	9	0.03

Notes:
[1]ESOP - per gram of water in fish tissue
DOE-SR data from SRNS 2012
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only
N/A - Not Applicable
NS - No Sample

Fish Monitoring Data
2011 SCDHEC and DOE-SR Data Comparison

Table 3 Cesium-137 Activity Levels in Edible Bass pCi/g			
Location	Agency	# of samples	Result
NSBLD	ESOP	1	<MDA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<MDA
	DOE-SR	3	0.05*
Beaver Dam Creek	ESOP	1	0.74
	DOE-SR	3	0.06*
Fourmile Branch	ESOP	1	0.29
	DOE-SR	3	0.06
Steel Creek	ESOP	1	0.12
	DOE-SR	3	0.07
Lower Three Runs	ESOP	1	0.13
	DOE-SR	3	0.06**
Hwy. 301	ESOP	1	0.050
	DOE-SR	3	0.02*
Stokes Bluff	ESOP	1	<MDA
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	0.06
	DOE-SR	3	0.02**
Average[2]	ESOP	6	0.23
	DOE-SR	7	0.06
Standard Deviation[2]	ESOP	6	0.26
	DOE-SR	7	0.03

Table 4 Cesium-137 Activity Levels in Edible Catfish pCi/g			
Location	Agency	# of samples	Result
NSBLD	ESOP	1	<MDA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<MDA
	DOE-SR	3	0.05*
Beaver Dam Creek	ESOP	1	<MDA
	DOE-SR	3	0.05**
Fourmile Branch	ESOP	1	<MDA
	DOE-SR	3	<MDC
Steel Creek	ESOP	1	0.09
	DOE-SR	3	0.04**
Lower Three Runs	ESOP	1	0.30
	DOE-SR	3	0.04*
Hwy. 301	ESOP	1	<MDA
	DOE-SR	3	0.02*
Stokes Bluff	ESOP	1	<MDA
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	<MDA
	DOE-SR	3	<MDC
Average[2]	ESOP	2	0.20
	DOE-SR	5	0.06
Standard Deviation[2]	ESOP	2	0.15
	DOE-SR	5	0.04

Notes: DOE-SR data from SRNS 2012
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

Fish Monitoring
2011 SCDHEC and DOE-SR Data Comparison

Table 5
Cesium-137 Activity Levels in Non-edible Bass
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	<MDA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<MDA
	DOE-SR	3	<MDC
Beaver Dam Creek	ESOP	1	0.17
	DOE-SR	3	0.04**
Fourmile Branch	ESOP	1	0.13
	DOE-SR	3	0.04*
Steel Creek	ESOP	1	0.10
	DOE-SR	3	0.05*
Lower Three Runs	ESOP	1	<MDA
	DOE-SR	3	0.06**
Hwy. 301	ESOP	1	<MDA
	DOE-SR	3	0.02*
Stokes Bluff	ESOP	1	<MDA
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	0.03
	DOE-SR	3	<MDC
Average[2]	ESOP	3	0.11
	DOE-SR	5	0.06
Standard Deviation[2]	ESOP	3	0.06
	DOE-SR	5	0.04

Table 6
Cesium-137 Activity Levels in Non-edible Catfish
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	<MDA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<MDA
	DOE-SR	3	<MDC
Beaver Dam Creek	ESOP	1	<MDA
	DOE-SR	3	<MDC
Fourmile Branch	ESOP	1	<MDA
	DOE-SR	3	<MDC
Steel Creek	ESOP	1	<MDA
	DOE-SR	3	0.05**
Lower Three Runs	ESOP	1	0.13
	DOE-SR	3	<MDC
Hwy. 301	ESOP	1	<MDA
	DOE-SR	3	0.01*
Stokes Bluff	ESOP	1	<MDA
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	<MDA
	DOE-SR	3	0.02**
Average[2]	ESOP	1	0.13
	DOE-SR	3	0.05
Standard Deviation[2]	ESOP	1	N/A
	DOE-SR	3	0.03

Notes: DOE-SR data from SRNS 2012
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

Fish Monitoring Data
2011 SCDHEC and DOE-SR Data Comparison

Table 7
Strontium-89,90 Activity Levels in Non-edible Bass
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	0.06
	DOE-SR	3	0.12
Upper Three Runs	ESOP	1	0.07
	DOE-SR	3	0.12
Beaver Dam Creek	ESOP	1	0.47
	DOE-SR	3	0.17
Fourmile Branch	ESOP	1	0.03
	DOE-SR	3	0.13
Steel Creek	ESOP	1	0.06
	DOE-SR	3	0.12
Lower Three Runs	ESOP	1	0.04
	DOE-SR	3	0.06
Hwy. 301	ESOP	1	0.05
	DOE-SR	3	0.13
Stokes Bluff	ESOP	1	0.11
	DOE-SR	3	0.11
Hwy. 17	ESOP	1	0.09
	DOE-SR	3	0.08
Average[2]	ESOP	9	0.11
	DOE-SR	9	0.12
Standard Deviation[2]	ESOP	9	0.14
	DOE-SR	9	0.03

Table 8
Strontium-89,90 Activity Levels in Non-edible Catfish
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	0.07
	DOE-SR	3	0.07*
Upper Three Runs	ESOP	1	0.07
	DOE-SR	3	0.06
Beaver Dam Creek	ESOP	1	0.06
	DOE-SR	3	0.05
Fourmile Branch	ESOP	1	0.06
	DOE-SR	3	0.07
Steel Creek	ESOP	1	0.06
	DOE-SR	3	0.09
Lower Three Runs	ESOP	1	0.05
	DOE-SR	3	0.04
Hwy. 301	ESOP	1	0.02
	DOE-SR	3	0.07
Stokes Bluff	ESOP	1	0.05
	DOE-SR	3	0.07
Hwy. 17	ESOP	1	0.06
	DOE-SR	3	0.07
Average[2]	ESOP	9	0.07
	DOE-SR	9	0.07
Standard Deviation[2]	ESOP	9	0.02
	DOE-SR	9	0.02

Notes: DOE-SR data from SRNS 2012
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only
NA - Not Analyzed

Fish Monitoring Data
2011 SCDHEC and DOE-SR Data Comparison

Table 9 Mercury Levels in Edible Bass mg/kg			
Location	Agency	# of samples	Result
NSBLD	ESOP	5 (3)	0.13
	DOE-SR	15(15)	0.35
Upper Three Runs	ESOP	5 (2)	0.22
	DOE-SR	15(15)	0.42
Beaver Dam Creek	ESOP	5 (5)	0.50
	DOE-SR	15(15)	0.26
Fourmile Branch	ESOP	5 (4)	0.36
	DOE-SR	15(15)	0.30
Steel Creek	ESOP	5 (54)	0.21
	DOE-SR	15(15)	0.33
Lower Three Runs	ESOP	5 (5)	0.47
	DOE-SR	15(15)	0.39
Hwy. 301	ESOP	5 (5)	0.23
	DOE-SR	15(15)	0.46
Stokes Bluff	ESOP	5 (5)	0.51
	DOE-SR	15(15)	0.68
Hwy. 17	ESOP	5 (5)	0.47
	DOE-SR	15(15)	0.18
Average[2]	ESOP	45 (38)	0.34
	DOE-SR	135(135)	0.38
Standard Deviation[2]	ESOP	45 (38)	0.18
	DOE-SR	135(135)	0.14

Table 10 Mercury Levels in Edible Catfish mg/kg			
Location	Agency	# of samples	Result
NSBLD	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.11
Upper Three Runs	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.14
Beaver Dam Creek	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.14
Fourmile Branch	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.13
Steel Creek	ESOP	5 (1)	0.12
	DOE-SR	11(11)	0.12
Lower Three Runs	ESOP	5 (4)	0.24
	DOE-SR	19(19)	0.20
Hwy. 301	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.16
Stokes Bluff	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.20
Hwy. 17	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.27
Average[2]	ESOP	45 (5)	0.18
	DOE-SR	135(135)	0.16
Standard Deviation[2]	ESOP	45 (5)	0.08
	DOE-SR	135(135)	0.05

Notes:
DOE-SR data from SRNS 2012
( ) denotes number of detections
Results are averages, unless ( ) = 1
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

PQL - Practical Quantitation Limit
mg/kg - milligrams per kilogram
DOE-SR results converted from ug/g (microgram per gram)

7.0 Summary Statistics

Fish Monitoring Associated with the Savannah River Site

2011 Fish Monitoring Summary Statistics..43

Notes:
1. N - denotes number of samples
2. ND – denotes non-detections
2. Tritium results (pCi/L) represent the activity level in water distilled from the fish tissue.
3. Cs-137 results (pCi/g) represent the activity level in natural fish tissue.
4. Strontium results (pCi/g) represent the activity level in an aliquot of wet fish tissue.

2011 Fish Monitoring Summary Statistics

Tritium Levels (pCi/L) in Savannah River Fish, 2011

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	5 (4)	516	364	383	1162	270
Catfish	3 (6)	694	381	856	967	259

Non-detections (ND) excluded from computations
Tritium reported as activity in the water extracted from fish tissue

Cesium-137 Levels (pCi/g - Wet) in Savannah River Fish, 2011

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	6 (3)	0.23	0.26	0.13	0.74	0.05
Catfish	2 (7)	0.20	0.15	0.02	0.30	0.09
Non-edible	**N (ND)**	**Average**	**Standard Deviation**	**Median**	**Maximum**	**Minimum**
Bass	4 (5)	0.11	0.06	0.12	0.17	0.03
Catfish	1 (8)	0.13	N/A	0.13	0.13	0.13

Non-detections (ND) excluded from computations
Non-edible pickerel not analyzed

Strontium-89,90 Levels (pCi/g - Wet) in Savannah River Fish, 2011

Non-edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	9 (0)	0.109	0.138	0.060	0.470	0.030
Catfish	9 (0)	0.056	0.015	0.060	0.070	0.020

Mercury Levels (mg/kg) in Savannah River Fish, 2011

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	36 (9)	0.37	0.20	0.39	0.10	0.84
Catfish	5 (40)	0.21	0.08	0.23	0.10	0.33

Non-detections (ND) excluded from computations

List of Acronyms

BDC	Beaver Dam Creek
DOE-SR	Department of Energy-Savannah River
ESOP	Environmental Surveillance and Oversight Program
FMB	Fourmile Branch
Hwy. 17	United States Highway 17
LLD	Lower Limit of Detection
LTR	Lower Three Runs creek
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
NSBLD	New Savannah Bluff Lock & Dam
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
STC	Steel Creek
STOKES	Stokes Bluff Landing
Hwy. 301	United States Highway 301
USEPA	United States Environmental Protection Agency
UTR	Upper Three Runs creek

Units of Measure

mg/kg	milligrams/kilogram
pCi/g	picocuries/gram
pCi/L	picocuries/liter
±	plus or minus (one standard deviation unless stated otherwise)

REFERENCES

Cummins, C.L. 1994. Radiological Bioconcentration Factors for Aquatic, Terrestrial, and Wetland Ecosystems at the Savannah River Site (U). Prepared for the United States Department of Energy, Savannah River Site. Aiken, South Carolina.

Mineral Information Institute (MII). 2008. www.mii.org/Minerals/photostrontium

Savannah River Nuclear Solutions, LLC (SRNS). 2012. Savannah River Site Environmental Report for 2011. Savannah River Site Aiken, SC. SRNS-STI-2012-00200.

South Carolina Department of Health and Environmental Control (SCDHEC). 2009. 2008 Radiological Monitoring of Fish Associated with the Savannah River Site, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2011a. Monitoring of Fish in the Savannah River Quality Assurance Project Plan, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2010b. 2010 South Carolina Fish Consumption Advisories. Division of Health Hazard Evaluation. Columbia, South Carolina.

United States Environmental Protection Agency (USEPA). 2000. Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories, Vol. 1.

USEPA. 2007. US EPA Information. www.epa.gov/radiation/radionuclides.

USEPA. 2008. National Primary Drinking Water Regulations; Radionuclides; Final Rule.Updated October, 2008.

USEPA. 2010. US EPA Information. www.epa.gov/mercury/.

Westinghouse Savannah River Company (WSRC). 1997. Assessment of SRS Radiological Liquid and Airborne Contaminants and Pathways. Jannik, G.T., Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-TR-970152.

WSRC. 1999. Radionuclides in the Savannah River Site Environment. Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-MS-99-00667.

This Page Intentionally Left Blank

2011 Game Animal Radiological Monitoring Adjacent to SRS

Environmental Surveillance and Oversight Program

98GA001
Jeffrey Joyner, Project Manager
January 01, 2011 - December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

DHEC
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 2
CESIUM-137 2
SCDHEC AND DOE-SR DATA COMPARISON 2

3.0 CONCLUSIONS AND RECOMMENDATIONS 2

4.0 MAP 4

5.0 TABLES AND FIGURES 5

6.0 DATA 6
2011 PERIMETER CESIUM-137 DATA 7
2011 BACKGROUND DATA 9

7.0 SUMMARY STATISTICS 10

LIST OF ACRONYMS AND UNITS OF MEASURE 12

REFERENCES 13

1.0 PROJECT SUMMARY

Since the initiation of nuclear testing, concern has grown over the accumulation of radionuclides in the environment. The Savannah River Site (SRS) has historically been a nuclear weapons material production, separation, and research facility located along the Savannah River within Aiken, Allendale, and Barnwell counties in South Carolina. The operation of production reactors, waste storage sites, and other nuclear facilities at SRS has resulted in the release of cesium-137 (Cs-137) to the environment for the past 50 years. Routine operations at the SRS have released Cs-137 to the regional environment surrounding the SRS. The most significant releases occurred during the early years of site operation when Cs-137 was released to seepage basins and site streams. The SRS facilities that have documented Cs-137 releases are the production reactors, separation areas, liquid waste facilities, solid waste disposal facility, central shops, heavy water rework facility, and the Savannah River National Laboratory. A number of other facilities handled material containing Cs-137, but releases, if any, are not documented (Till et al 2001). As part of the environmental monitoring program, the Department of Energy - Savannah River (DOE-SR) investigates a variety of mammalian species for the presence of contaminants. White-tailed deer and feral hogs have shown the highest potential of the mammalian species for a human exposure pathway from Cs-137 (Haselow 1991).

DOE-SR has annual hunts open to members of the general public to control the site's deer and feral hog population and to reduce animal/vehicle accidents. Before any animal is released to a hunter, SRS personnel monitor3 Cs-137 levels for exposure limit considerations to ensure established administrative dose limits are not exceeded. DOE-SR does not collect game animal samples within the South Carolina Department of Health and Environmental Control (SCDHEC) study area, and off-site hunter doses are based on DOE-SR models. Therefore, no direct comparisons could be made between SCDHEC and DOE-SR data. The SCDHEC Critical Pathway Dose report addresses dose based on collected samples and is compared to DOE-SR modeled dose for off-site hunters.

The precise ranging behavior of individual deer and hogs on the SRS is unknown. White-tailed deer and feral hogs have access to a number of contaminated areas on the SRS and are a vector for the redistribution of contaminants, primarily Cs-137, to off-site locations. Consumption of these wildlife species can result in the transfer of contaminants to humans. Cesium-137 is of concern because of the 30 year half-life, its availability to game animals, and associated health risk to humans. (Haselow 1991).

Cesium-137 is readily incorporated into the human body because of its similarity to potassium-40 (K-40) in physiological processes (Davis 1963). Cesium-137 concentrates in animal skeletal muscles, that are selectively consumed by hunters (Brisbin et al. 1975). Cesium-137 emits both beta and gamma radiation, contributing to both internal and external radiation exposure, which may be associated with gastrointestinal, genetic, hematopoietic, and central nervous system damage (Bond et al. 1965). Because of these concerns, Cs-137 will be the only isotope discussed in this report.

The Environmental Surveillance and Oversight Program (ESOP) of the SCDHEC conducts independent non-regulatory oversight of game animal monitoring activities at the SRS. The game animal project addresses concerns of potentially contaminated white-tailed deer and feral hogs migrating off the SRS and can provide valuable information concerning the potential off-site exposure to Cs-137 by analyzing samples collected off-site. SCDHEC analyzed muscle tissue collected in 2011 for Cs-137 from 54 deer and six hogs collected from area hunters via hunting clubs, plantations, and Crackerneck Wildlife Management Area within a five-mile study area adjacent to the SRS (Section 4.0, Map 1). Additionally, five deer tissue samples were collected and analyzed from a background location 55 miles east of the SRS in Bamberg County, South Carolina. Sample size, location, and collection dates were dependent on the participating hunters.

2.0 RESULTS AND DISCUSSION

Cesium-137

Cesium-137 and the naturally occurring isotopes K-40 and lead-214 (Pb-214) were the only isotopes detected in game samples collected in 2011. Naturally occurring isotopes will not be discussed in this report. Cesium-137 concentrations from deer collected in the SRS perimeter study area are shown in (Section 5.0, Figure 1). Analytical results are listed under each zone in Section 6.0.

Cesium-137 activities from the 54 SCDHEC perimeter deer samples ranged from < Minimum Detectible Activity (MDA) to 4.31 pCi/g, with an average of 0.85 (± 1.00) pCi/g (Section 7.0). Cesium-137 activities from the six SCDHEC perimeter hog samples ranged from <MDA to 0.59 pCi/g with an average of 0.51 (± 0.12) pCi/g (Section 7.0). All SCDHEC hunt zone averages were within one standard deviation of the overall perimeter average. Results from the five background samples (Section 6.0) ranged from 0.11 pCi/g to 0.40 pCi/g, with an average of 0.27 (± 0.11) pCi/g.

SCDHEC and DOE-SR Data Comparison

DOE-SR reported an approximate field measurement range of 1.00 pCi/g to 11.5 pCi/g with an average of 1.46 pCi/g from 564 deer and 1.75 pCi/g from 156 feral hogs harvested on the SRS in 2011 (SRNS 2012). The DOE-SR field average was within one standard deviation of the SCDHEC perimeter average. Average perimeter, background, and DOE-SR on-site Cs-137 levels for the past five years (Section 7.0) are indicated in Section 5.0, Figure 2. The five-year Cs-137 averages between SCDHEC and DOE-SR may differ for various reasons. The DOE-SR data is acquired in the field by using a portable sodium iodide detector while SCDHEC data are analytical results. Also, the SCDHEC data presents a challenge for direct comparisons to DOE-SR data because the perimeter area is heavily baited. Therefore, the uptake of Cs-137 by these animals will be reduced based on the increased K-40 levels in the corn from fertilizers (Heckman 1992).

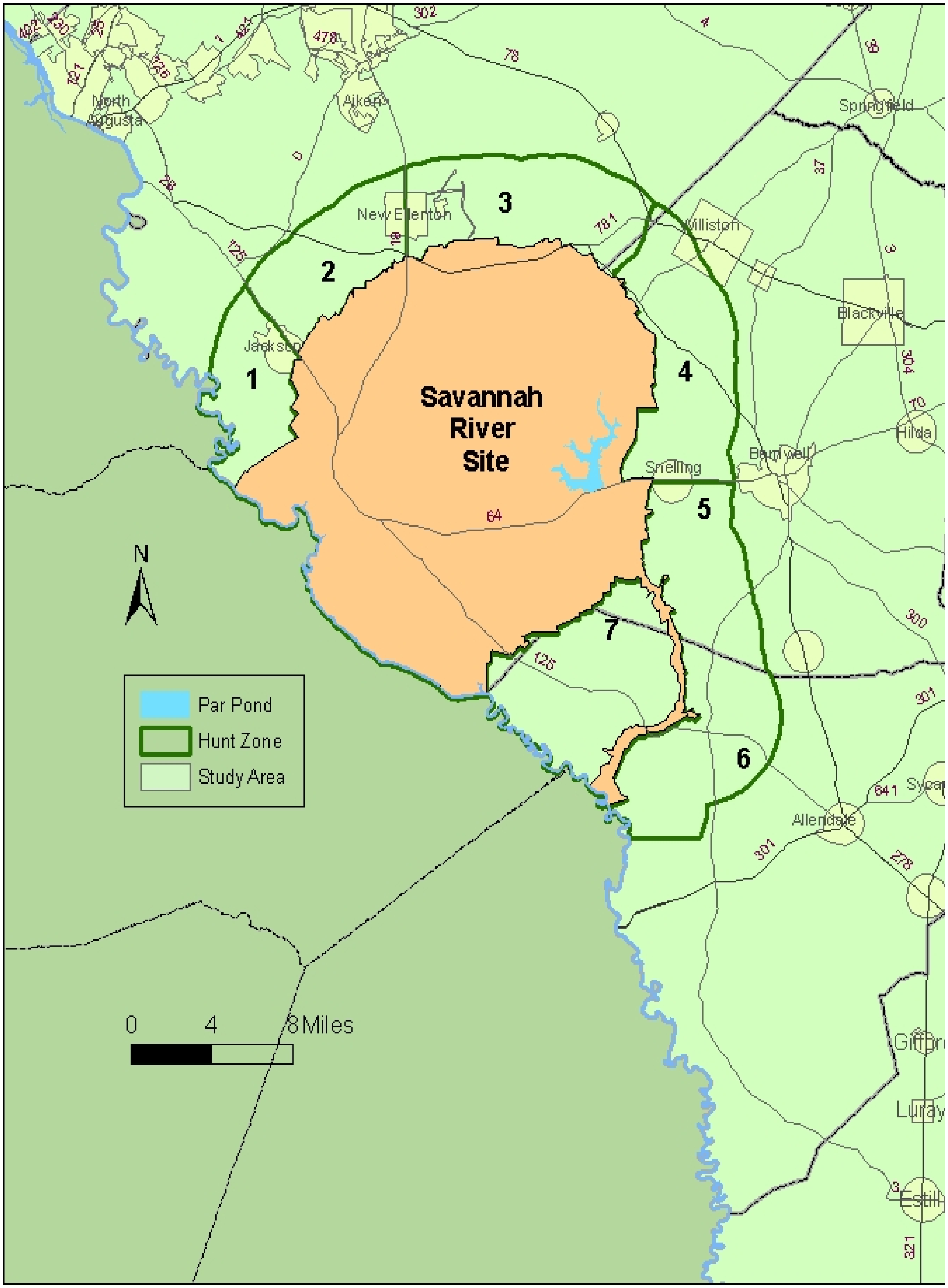
3.0 CONCLUSIONS AND RECOMMENDATIONS

Historic SRS operations released known Cs-137 contamination to Steel Creek, Par Pond, and Lower Three Runs, their floodplains, and the Savannah River swamp (Till et al 2001), all of which impact hunt zones four, five, six and seven (Section 4.0, Map 1). Although a portion of Cs-137 was deposited on the SRS from site operations, levels found in the study area and background location are likely results of above ground nuclear weapons testing (Haselow 1991). DOE-SR does not collect game animal samples within the SCDHEC study area, and off-site hunter doses are based on DOE-SR models from animals collected on SRS. Further research may be needed to help determine why elevated Cs-137 activities are found in other hunt units.

Age, sex, body weight, soil type, diet and collection location may affect the Cs-137 activities found in white-tailed deer and hogs (Haselow 1991). The differences in average activities (Section 5.0, Figure 2) are possibly a combination of one or more of the above factors. A hunter consuming deer from SRS, the study area, or background locations would most likely ingest a portion of the activity associated with these animals. Refer to the ESOP Critical Pathway Dose report for a better understanding of the contamination found in game versus other food sources.

SCDHEC is currently working with the United States Environmental Protection Agency, DOE-SR, and Eastern Illinois University in an effort to achieve background levels for SRS deer. Investigators from Eastern Illinois University are using SCDHEC game animal data for a comparison of Cs-137 body burdens in SRS deer. ESOP will continue to work with all involved parties until a scientific determination of SRS background levels are determined. Also, ESOP will continue to monitor Cs-137 levels in deer and hogs within the estabished study area and background locations to assess trends and human health impacts.

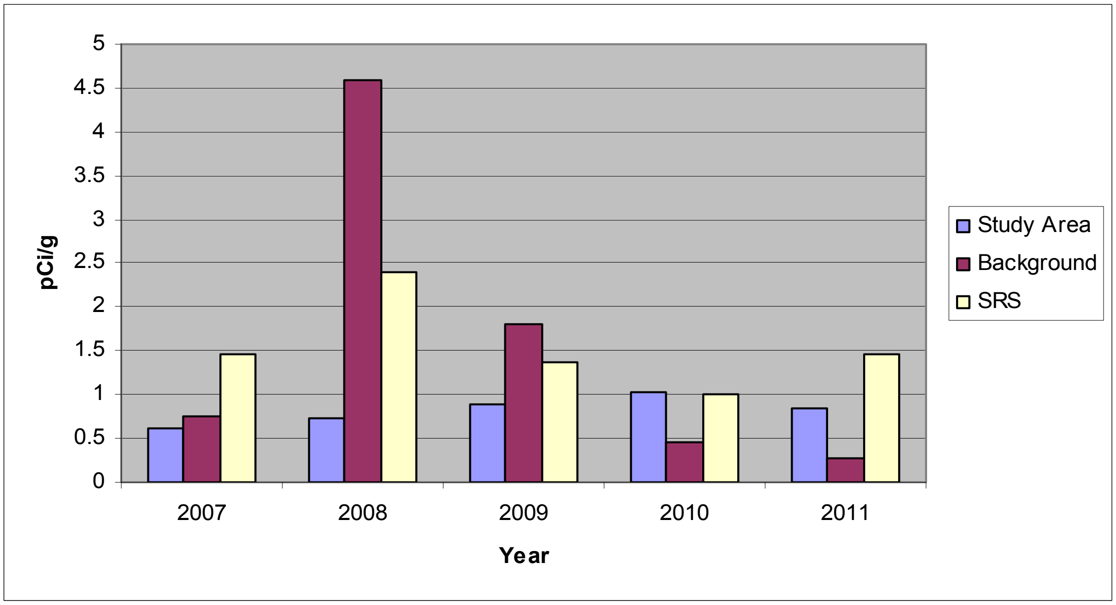
4.0 Game Animal Radiological Monitoring Adjacent to SRS
Map 1. ESOP Hunt Zones Adjacent to SRS, 2011



5.0 Tables and Figures

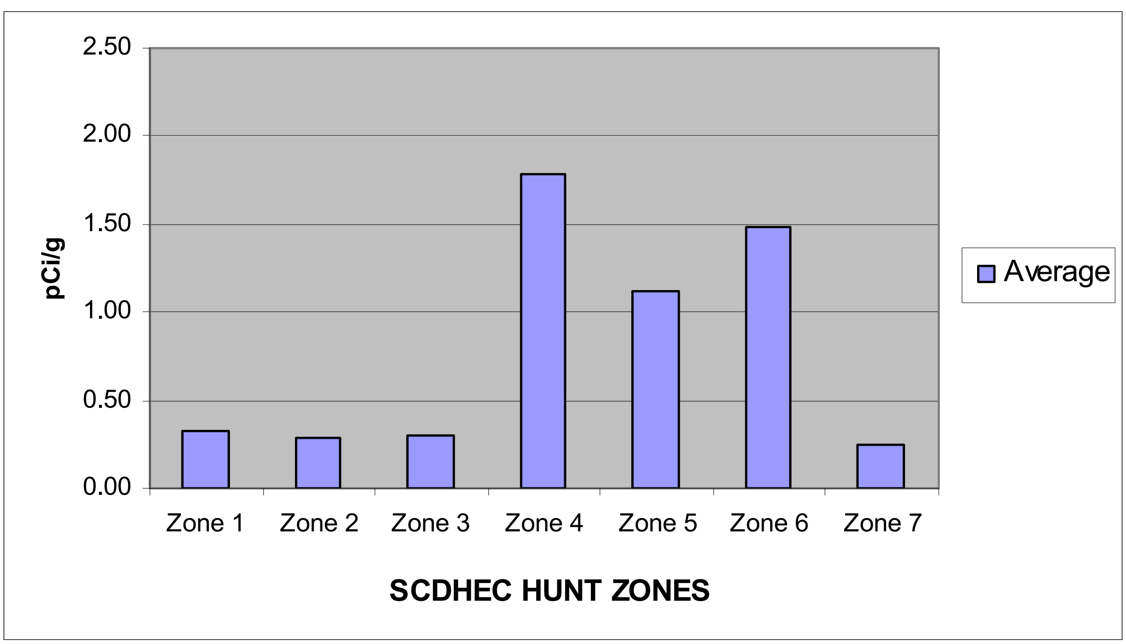
Game Animal Radiological Monitoring Adjacent to SRS

Figure 1. Average Cs-137 Concentration In Deer, 2007-2011



Background Locations
2007 - 2011 - Carolina Sandhills National Wildlife Refuge
2010 - 2011 - Bamberg County

Figure 2. SCDHEC Hunt Zone Average Cs-137 Concentration In Deer, 2011



6.0 Data

Game Animal Radiological Monitoring Adjacent to SRS

2011 Perimeter Cs-137 Data **7**
2011 Background Data **9**

Notes:
1. MDA - Minimum Detectable Activity
2. Sig - Sigma

Game Animal Radiological Monitoring Adjacent to SRS Project Data

2011 Perimeter Cs-137 Data

Sample Location		Zone-1	Zone-1	Zone-1	Zone-1	Zone-1
Sample Date		10/21/2011	10/21/2011	10/21/2011	10/21/2011	10/21/2011
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Buck	Buck	Buck	Doe
Weight	Pounds	130	120	135	150	95
Cesium-137	(pCi/g) wet	0.11	0.31	0.28	<MDA	0.76
Uncertainty	(+/- 2sig)	0.03	0.04	0.04	NA	0.07
MDA	(pCi/g) wet	0.02	0.02	0.03	0.02	0.02

Sample Location		Zone-1	Zone-1	Zone-1	Zone-1	Zone-1
Sample Date		10/21/2011	10/21/2011	10/21/2011	10/21/2011	10/21/2011
Species		Deer	Hog	Hog	Hog	Hog
Sex		Buck	Boar	Sow	Sow	Sow
Weight	Pounds	145	75	100	85	75
Cesium-137	(pCi/g) wet	0.18	<MDA	<MDA	<MDA	<MDA
Uncertainty	(+/- 2sig)	0.03	NA	NA	NA	NA
MDA	(pCi/g) wet	0.02	0.03	0.02	0.02	0.02

Sample Location		Zone-2	Zone-2	Zone-2	Zone-2	Zone-2
Sample Date		10/19/2011	10/19/2011	10/19/2011	10/19/2011	10/19/2011
Species		Deer	Deer	Deer	Deer	Deer
Sex		Doe	Doe	Doe	Buck	Doe
Weight	Pounds	110	115	95	130	110
Cesium-137	(pCi/g) wet	0.04	0.26	0.32	0.55	0.21
Uncertainty	(+/- 2sig)	0.02	0.04	0.04	0.05	0.03
MDA	(pCi/g) wet	0.01	0.02	0.02	0.02	0.02

Sample Location		Zone-3	Zone-3	Zone-3	Zone-3	Zone-3
Sample Date		10/19/2011	10/19/2011	10/19/2011	10/19/2011	12/15/2011
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Doe	Buck	Doe	Doe
Weight	Pounds	125	95	140	100	85
Cesium-137	(pCi/g) wet	0.71	0.06	0.26	0.25	0.23
Uncertainty	(+/- 2sig)	0.06	0.03	0.03	0.06	0.04
MDA	(pCi/g) wet	0.02	0.02	0.02	0.04	0.02

Sample Location		Zone-4	Zone-4	Zone-4	Zone-4	Zone-4
Sample Date		10/19/2011	10/26/2011	10/26/2011	10/26/2011	11/10/2011
Species		Deer	Deer	Deer	Deer	Deer
Sex		Doe	Buck	Doe	Buck	Doe
Weight	Pounds	115	125	115	60	55
Cesium-137	(pCi/g) wet	0.34	1.64	2.76	2.08	2.11
Uncertainty	(+/- 2sig)	0.04	0.15	0.24	0.18	0.19
MDA	(pCi/g) wet	0.02	0.02	0.02	0.03	0.02

Game Animal Radiological Monitoring Adjacent to SRS Project Data

2011 Perimeter Cs-137 Data

Sample Location		**Zone-5**	**Zone-5**	**Zone-5**	**Zone-5**	**Zone-5**
Sample Date		9/1/2011	9/1/2011	9/1/2011	9/11/2011	11/20/2011
Species		Deer	Deer	Deer	Deer	Hog
Sex		Buck	Buck	Buck	Buck	Boar
Weight	Pounds	130	110	120	115	60
Cesium-137	(pCi/g) wet	0.82	1.47	3.38	0.32	0.59
Uncertainty	(+/- 2sig)	0.07	0.13	0.29	0.04	0.06
MDA	(pCi/g) wet	0.01	0.02	0.02	0.02	0.02

Sample Location		**Zone-5**	**Zone-5**	**Zone-5**	**Zone-5**	**Zone-5**
Sample Date		9/17/2011	9/17/2011	9/17/2011	9/27/2011	11/29/2011
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Doe	Buck	Buck	Buck
Weight	Pounds	130	90	105	135	160
Cesium-137	(pCi/g) wet	0.20	0.47	0.15	2.73	0.99
Uncertainty	(+/- 2sig)	0.03	0.05	0.03	0.24	0.09
MDA	(pCi/g) wet	0.02	0.02	0.03	0.02	0.02

Sample Location		**Zone-5**	**Zone-5**	**Zone-5**	**Zone-5**
Sample Date		11/24/2011	11/26/2011	11/30/2011	12/29/2011
Species		Deer	Deer	Deer	Hog
Sex		Doe	Doe	Buck	Sow
Weight	Pounds	110	100	130	85
Cesium-137	(pCi/g) wet	2.02	0.57	0.31	0.42
Uncertainty	(+/- 2sig)	0.18	0.06	0.04	0.05
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02

Sample Location		**Zone-6**	**Zone-6**	**Zone-6**	**Zone-6**	**Zone-6**
Sample Date		9/17/2011	9/21/2011	9/16/2011	10/13/2011	11/22/2011
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Doe	Doe	Buck	Doe
Weight	Pounds	130	100	75	110	90
Cesium-137	(pCi/g) wet	1.33	0.94	0.75	4.31	0.09
Uncertainty	(+/- 2sig)	0.10	0.09	0.08	0.38	0.03
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02

Sample Location		**Zone-7**	**Zone-7**	**Zone-7**	**Zone-7**	**Zone-7**
Sample Date		11/19/2011	11/19/2011	11/19/2011	11/19/2011	11/19/2011
Species		Deer	Deer	Deer	Deer	Deer
Sex		Doe	Buck	Doe	Doe	Buck
Weight	Pounds	115	120	50	105	180
Cesium-137	(pCi/g) wet	0.35	0.14	0.24	0.34	0.18
Uncertainty	(+/- 2sig)	0.05	0.03	0.03	0.04	0.03
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02

Game Animal Radiological Monitoring Adjacent to SRS Project Data

2011 Background Cs-137 Data

Sample Location		**Background**	**Background**	**Background**	**Background**	**Background**
Sample Date		10/1/2011	10/1/2011	10/1/2011	10/1/2011	10/1/2011
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Buck	Buck	Buck	Buck
Weight	Pounds	180	125	120	130	100
Cesium-137	(pCi/g) wet	0.40	0.11	0.29	0.27	0.31
Uncertainty	(+/- 2sig)	0.05	0.03	0.04	0.04	0.04
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02

7.0 Summary Statistics

Game Animal Radiological Monitoring Adjacent to SRS

2011 Game Animal Radiological Monitoring Statistics 11

Notes:

1. N - Number of Samples
2. Std.Dev. - Standard Deviation
3. Min - Minimum
4. Max - Maximum
5. MDA - Minimum Detectable Activity
6. Average, Std.Dev., and Median calculated using detections only
7. NA - Not Available

Game Animal Radiological Monitoring Adjacent to SRS Summary Statistics

Cs-137 concentration (pCi/g wet weight) in deer and hogs collected in 2011

	N	Average	Std. Dev.	Median	Min.	Max
Study Area Deer	54	0.85	1.00	0.34	<MDA	4.31
Study Area Hogs	6	0.51	0.12	0.51	<MDA	0.59
Background Deer	5	0.27	0.11	0.29	0.11	0.40

Cs-137 concentration (pCi/g wet weight) in deer and hogs collected in 2011 SCDHEC Hunt Zones

Hunt Zone	N	Average	Std. Dev.	Median	Min.	Max
Zone 1 Deer	16	0.33	0.25	0.28	0.11	0.76
Zone 1 Hogs	4	<MDA	NA	NA	<MDA	<MDA
Zone 2 Deer	5	0.28	0.18	0.26	0.04	0.55
Zone 3 Deer	5	0.30	0.24	0.25	0.06	0.71
Zone 4 Deer	5	1.79	0.90	2.08	0.34	2.76
Zone 5 Deer	12	1.12	1.07	0.69	0.15	3.38
Zone 5 Hogs	2	0.51	0.12	0.51	0.42	0.59
Zone 6 Deer	5	1.48	1.64	0.94	0.09	4.31
Zone 7 Deer	5	0.49	0.56	0.32	0.11	1.49

Cs-137 concentration (pCi/g wet weight) in deer and hogs collected from 2007 - 2011

	Year	N	Average	Std.Dev	Median	Min.	Max.
Study Area	2007	65	0.62	0.61	0.36	< MDA	3.30
Background	2007	20	0.75	0.58	0.57	0.15	2.09
SRS	2007	388	1.46	NA	NA	1.00	8.70
Study Area	2008	51	0.72	0.83	0.38	<MDA	4.60
Background	2008	10	4.59	2.45	4.11	1.91	10.59
SRS	2008	432	2.40	NA	NA	1.00	12.65
Study Area Deer	2009	47	0.89	0.81	0.63	<MDA	3.13
Study Area Hogs	2009	7	0.05	0.01	0.05	<MDA	0.05
Background	2009	12	1.81	0.88	1.58	0.77	3.60
SRS Deer	2009	396	1.38	NA	NA	1.00	9.17
SRS Hogs	2009	78	1.06	NA	NA	1.00	2.78
Study Area Deer	2010	30	1.02	1.93	0.34	<MDA	9.96
Study Area Hogs	2010	4	1.33	1.23	1.26	<MDA	2.49
Background	2010	5	0.46	0.66	0.18	0.05	1.63
SRS Deer	2010	502	1.00	NA	NA	1.00	2.99
SRS Hogs	2010	107	1.00	NA	NA	1.00	2.14
Study Area Deer	2011	54	0.85	1.00	0.34	<MDA	4.31
Study Area Hogs	2011	6	0.51	0.12	0.51	<MDA	0.59
Background	2011	5	0.27	0.11	0.29	0.11	0.40
SRS Deer	2011	564	1.46	NA	NA	1.00	10.50
SRS Hogs	2011	156	1.75	NA	NA	1.00	11.50
Study Area Deer	2007 -2011	247	0.82	0.26	0.89	< MDA	9.96
Study Area Hogs	2009 -2011	17	0.69	0.91	0.69	<MDA	2.49
Background Deer	2007 -2011	52	1.58	1.70	0.58	0.15	10.59
SRS Deer	2007 -2011	2282	1.54	0.52	1.46	1.00	12.65
SRS Hogs	2009 -2011	341	1.27	0.42	1.06	1.00	11.5

Background Locations
2007 - 2009 Carolina Sandhills National Wildlife Refuge
2010 - 2011 Bamberg County

LIST OF ACRONYMS

Cs-137	Cesium-137
DOE-SR	Department of Energy–Savannah River
ESOP	Environmental Surveillance and Oversight Program
MDA	Minimum Detectable Activity
Pb-214	Lead-214
K-40	Potassium-40
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site

UNITS OF MEASURE

pCi/g	picocuries per gram
±	plus or minus (one standard deviation unless stated otherwise)

REFERENCES

Bond, V.P., T.M. Fliedner, and J.O. Archambeau. 1965. Mammalian Radiation Lethality. Academic Press, New York, p. 340.

Brisbin, I.Lehr, Jr., and M.H. Smith. 1975. Radiocesium Concentrations in Whole-Body Homogenates and Several Body Compartments of Naturally Contaminated White-tailed Deer. In Mineral Cycling in the Southeastern Ecosystems, ERDA Symposium Series, CONF-740513, National Technical Information Service, Springfield, Virginia, p. 542.

Davis, J.J. 1963. Cesium and its Relationships to Potassium in Ecology, in Radioecology. Colorado State University, Fort Collins, Colorado, pp. 539-556.

Haselow, L.A. 1991. The Relationship of Radiocesium and Potassium In The Nutritional Ecology of White-tailed Deer From the Savannah River Site. Masters Thesis, Purdue University, p. 1.

Heckman JR, Kamprath EJ. 1992. Potassium Accumulation and Corn Yield Related to Potassium Fertilizer Rate and Placement. P141-149

SRNS. 2012. Savannah River Site Environmental Report for 2011. Savannah River Site Aiken, SC. SRNS-STI-2012- 00200.

Till JE, et al. 2001. Savannah River Site Environmental Dose Reconstruction Project, Phase II: SourceTerm Calculation in Ingestion Pathway Data Retrieval, Evaluation of Materials Released From the Savannah River Site. RAC Report No. 1-CDC-SRS-1999-Final. Risk Assessment Corporation (RAC).

This Page Intentionally Left Blank

Section 5 2011 Critical Pathway / Dose

Chapter 13 Critical Pathway / Dose Report

2011 Critical Pathway Dose Report

Environmental Surveillance and Oversight Program

01DM003 and 01CP001
Robert L. Adams, Project Manager
January 01, 2011 - December 31, 2011

Region 5
Environmental Quality Control
206 Beaufort Street N.E.
Aiken, SC 29801

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health
and Environmental Control

Table of Contents

1.0 PROJECT SUMMARY 1

2.0 RESULTS AND DISCUSSION 3
THE 2011 NON-SCENARIO BASIS 3
THE 2011 SCENARIO BASIS 6
THE 2011 OPTIONAL INDIVIDUAL PERSONAL SCENARIO 6
THE 2011 ADDED DOSE BASIS 7
DOE-SR AND SCDHEC 2011 COMPARISONS 8
CRITICAL PATHWAYS 2011 SUMMARY 17
1999-2011 STATISTICS 18
DOSE CRITIQUE 21

3.0 CONCLUSIONS AND RECOMMENDATIONS 23

4.0 TABLES AND FIGURES 26

5.0 DATA 36
2011 AVERAGE DOSE DETECTIONS IN FOOD MEDIA 37
2011 SINGLE HIGHEST DOSE DETECTIONS IN FOOD MEDIA 38
2011 AVERAGE DOSE DETECTIONS IN WATER MEDIA 39
2011 SINGLE HIGHEST DOSE DETECTIONS IN WATER MEDIA 40
2011 AVERAGE DOSE DETECTIONS IN SOIL AND AIR MEDIA 41
2011 SINGLE HIGHEST DOSE DETECTIONS IN SOIL AND AIR MEDIA 42

6.0 SUMMARY STATISTICS 43
TABLE 1. RADIONUCLIDES OF CONCERN (MILLIREM AND PERCENTAGES) 44
TABLE 2. THE 1999-2011 AEI MEDIA STATISTICS AND MAX SPECIAL CATEGORIES DOSE POTENTIAL (MREM/YR) 45
TABLE 3. 1999-2011 AEI CRITICAL PATHWAYS, SUBPATHWAYS, AND POTENTIAL 45
EXPOSURE SUMMARY 45
TABLE 4. Food Media, AEI, and MAX Food Basis 46

LIST OF ACRONYMS 47

UNITS OF MEASURE 48

REFERENCES 49

1.0 PROJECT SUMMARY

The Environmental Surveillance and Oversight Program (ESOP) of the South Carolina Department of Health and Environmental Control (SCDHEC) monitored the Savannah River Site (SRS) and perimeter areas under an Agreement in Principle with the United States Department of Energy (USDOE). Atmospheric pathway (APW) and liquid pathway (LPW) discharges from the SRS were monitored by the Department of Energy – Savannah River (DOE-SR) contractor Savannah River Nuclear Solutions (SRNS), Environmental Monitoring Section (EMS). DOE-SR and SCDHEC used data from these monitoring activities to calculate the potential radiation dose in millirem (mrem) to the surrounding public (WSRC 1999-2009, SRNS 2010-12 and SCDHEC 1999-2011). SCDHEC implemented a Radionuclide Dose Calculation Project and a Critical Pathway Project to calculate the potential exposure or dose to the public within 50-miles of an SRS center-point. Historical missions and data in previous years reports, primarily the SRS Environmental Reports (WSRC 1999-2007), the Risk Assessment Corporation report (Till 2001) and the Centers for Disease Control study (CDC 2004) helped to establish the SCDHEC (1999-2012) Critical Pathway Dose report basis. Radionuclide dose potential exposure to the public was calculated by SCDHEC from radionuclide concentration activities found in various media that may impact the public (Section 5.0). A comparison of similar SCDHEC and DOE-SR media resulted in an evaluation of both programs based on media potential exposure in millirems (Section 2.0). Summary statistics (Section 6.0) and tables and figures (Section 4.0) illustrate the trends and central tendencies in the critical pathway dose. The critical pathway dose is now calculated on a non-scenario and individual optional scenario (Section 4.0) basis allowing readers to select media or specific exposures that may have occurred due to their individual lifestyle choices.

It is important for the reader to note the differences in DOE-SR and SCDHEC critical pathway dose estimations. Some DOE-SR dose calculations use computer models based on estimates of known *releases within* the report *year* using source term data. SCDHEC annual dose estimates are based solely on field sample data that allow calculation of an average exposed individual (AEI) dose per radionuclide per media above background and represents *accumulated* dose *over several years*. Also, SCDHEC calculates an upper bound of potential dose based on the single highest maximum (MAX) dose per radionuclide per media that may result in exposure throughout the year as if that maximum is somehow stored and used throughout the year. A one time filling of a water cistern with Savannah River water during a MAX dose event is an example of storage dose potential MAX. The MAX calculation also represents an upper limit estimate of potential accumulated exposure that may not have been detected. The AEI data represents the typical potential dose levels above background and the MAX data represents the extreme data points or one time dose extreme that could occur through storage exposure, if possible. The MAX data is assigned to the maximally exposed individual (MEI) considered by SCDHEC as a survivalist who is exposed to all media maximums as if the MAX exposure occurred throughout the entire year. An alternate possibility existed that all potential exposure was not detected, but was allowed by the ESOP MAX calculation and any additional DOE-SR release estimates greater than the SCDHEC sample estimates (Section 4.0, Tables 1a and 3). The health of the public and environment are protected when all of these estimates are below established protective dose standards or limits for the various radionuclides and pathways of exposure.

The 2011 non-scenario media calculations were represented on an AEI basis (typical dose if exposed to all media sampled) and on a MAX (upper limit) basis of potential exposure per media per radionuclide above the average background (Section 4.0, Table 1a). The non-scenario table (1a) does not assign any result to an exposure scenario. The MAX (11.447 mrem in 2011) basis provides a radiation exposure limit based on the single highest potential dose in media. Exposures on a non-scenario basis should be less than or closer to the AEI media total (2.258 mrem in 2011). Individual exposures may be far less than the AEI total due to temporal factors and the lack of contact by an individual with all media collected.

The SCDHEC plus DOE-SR total (29.77 mrem) for applicable MAX assigned to the MEI is based on the total of the highest possible exposure from environmental media (MAX column, Section 4.0 Table 1a), plus all other dose modeled or detected by DOE-SR that has the potential to impact the public (Section 4.0, Table 3).

Public and survivor scenarios were developed based on selecting media results from Section 4.0 Table 1a that applied only to these hypothetical scenarios, which represent the minimum and maximum dose potentials from radionuclides accumulated in the media sampled. The media selections per scenario are defined under the 2011 Scenario heading. These scenarios calculate a dose relative to minimum (Public) and maximum (Survivalist) exposure activities in 2011 (Section 4.0, Table 2) and during a given period:

1) Public scenario - 0.228 mrem in 2011, and averaged 0.079 (± 0.067) mrem with a median of 0.068 mrem 1999-2011;
2) MAX Survivalist scenario – 11.447 mrem in 2011, and averaged 10.164 (± 4.874) mrem with a median of 11.447 mrem 1999-2011.

The median represents the central tendency of the bulk of the data when sampling is sufficiently large. The 2011 Public scenario was elevated due to a one time occurrence of I-131 in milk (0.202 pCi/L of dose) that occurred within three weeks of the radionuclide accidental releases from the Fukushima Daiichi nuclear facility (ANS 2011). Other scenarios provided in the past (e.g., farmer and sportsman) were judged no longer necessary since the reader can now calculate (add up) the exposures for the various media they were exposed to and determine their own unique scenario potential dose from Section 4.0 Table 1a.

The SCDHEC radionuclide detected dose that was not naturally occurring radioactive material (nonNORM) had contributions from 1999 through 2011 (22.311 mrem from cesium-137 (Cs-137), 1.539 mrem from all strontium–89/90 (Sr-89/90), and 1.014 mrem from tritium (H-3)) (Section 6.0, Table 1). These SCDHEC field collections represent an accumulated dose over many years and not yearly dose releases, which was the main reason for differences in dose estimates by SCDHEC and DOE-SR (see Dose Critique in Section 2.0). Any correlation between SCDHEC dose data (accumulated environmental dose) and DOE-SR dose data (annual releases) would be due to the dominant radionuclide dose contributors (Cs-137, Sr-90, H-3) to exposure via comparable media.

The following comparisons to DOE-SR annual release limits are not explicitly applicable since dose found in media represents many years of dose accumulation, but the comparison is made to show that even the accumulated dose in the environment is less than the annual DOE-SR standard release limits for the air, liquid, and all-pathway categories (SRNS 2012).

The SCDHEC 2011 conservative estimate for All-Sources AEI exposures from APW (1.690 mrem) and LPW (0.569 mrem, mostly tritium) accumulations were within the respective, 10 mrem and 4 mrem, annual DOE-SR release limits even though these limits to do not apply to field samples due to more than one years potential accumulation (Section 4.0, Table 1b). An upper bound MEI (excluding NORM detections) accumulated dose potential (29.77 mrem) calculated from the combined data of DOE-SR and SCDHEC was also strictly not applicable to the 100-mrem DOE-SR annual release limit to the public (SRNS 2012).

2.0 RESULTS AND DISCUSSION

The SCDHEC MEI is a subsistence and survivalist type of individual who resides in the downriver swamp area below all SRS contributions to the Savannah River, visits the entire 50-mile perimeter study area, and receives the MEI dose based on the single highest detection per radionuclide per media detected in the environment. Other tables and figures are derived from the Section 5.0 data tables. The 2011 data and dose results are discussed under the following headings in this section: the 2011 non-scenario basis, the 2011 scenario basis, the 2011 individual optional personal scenario, the 2011 added dose basis, the DOE-SR and SCDHEC comparisons, critical pathways summary, 1999-2011 statistical summary, and dose critique. The statistical summary covers the 1999-2011 period, whereas other headings discuss only 2011 data except for critical pathways and some DOE-SR comparisons.

The critical pathways were analyzed both on a millirem (mrem) basis and percentage (%) of dose basis. Percentages denote relative importance whereas mrem denotes potential exposure levels. The dose critique attempts to indicate the limits of this dose estimate and why any DOE-SR and SCDHEC estimates may or may not be similar.

The 2011 Non-Scenario Basis

The non-scenario Table 1a in Section 4.0 summarized all SCDHEC detections by media on an AEI and MAX detection basis without assigning any result to an exposure scenario. The 2011 non-scenario average media (AEI basis) results were added to past years results to establish the 1999-2011 media statistics summary Table 2 in section 6.0. The 2011 non-scenario media calculations were represented on an AEI and MAX basis per media above their respective radionuclide average backgrounds (Section 4.0, Table 1a). The MAX basis uses the single highest detection for a media radionuclide and calculates dose as if the high dose media was somehow stored and the MEI exposure continued throughout the year (Section 5.0 Data).

The two scenarios used only the non-scenario media results from Section 4.0 Table 1a that applied to the hypothetical persons exposure. The optional personal scenario shows how an individual can select only the media exposure data that applied to them for a personal dose estimate. Thus, the statistics for the non-scenario, scenario, and personal scenario could be very different. Radiation exposures to the single highest detection greater than background from each radionuclide exposure per media were assigned to the SCDHEC MEI. This MEI (11.447 mrem MAX in 2011) basis provides an offsite radiation exposure limit based on the single highest potential dose detections and represents an upper bound potential. However, the true MEI may be higher, since not all dose potential can be collected and measured. This was the reason for calculating the MEI based on the single highest detection per radionuclide per media at protective maximum exposure rates. This MEI dose was due mostly to single maximum food detections (11.095 mrem excluding incidental soil) that were theoretically consumed by one individual (Section 4.0 Table 4). Typical exposures on a non-scenario basis should be less than the AEI media totals in Table 1a, since a single individual could not be at all locations where and when all maximums occurred and sustain that exposure at a constant rate throughout the year. The MAX dose exposure was remotely possible only if the media containing the MAX dose were somehow stored and used by the MEI over the entire year. The MAX total perimeter dose will always be assigned as the maximum survivalist dose (the SCDHEC MEI).

Only specific radionuclide (speciated) doses were included in the estimated dose for 2011. The use of detections only in determining AEI dose above background per radionuclide per media, the calculation of dose based on the MAX detection for each radionuclide/media, and conservative consumption references provided a protective dose estimate. Each media radionuclide dose above background, excluding naturally occurring radioactive material (NORM), was considered as part of a different critical pathway lifestyle with contributions through the inhalation, ingestion, and direct exposure routes. The typical perimeter average dose exposure greater than background without regard to lifestyle (as if the individual were exsposed to all media collected) was represented on an AEI (2.258 mrem) basis (Section 4.0, Table 1a). Refer to the scenario basis for typical potential exposures by lifestyle. The SRS perimeter study area total dose exposure may be viewed either on an AEI (2.258 mrem) or MAX detection (11.447 mrem) basis that excludes probable NORM.

The SCDHEC MEI grand total (29.77 mrem) that includes added dose from DOE-SR (18.318 mrem) was based on the total of all SCDHEC MAX (11.447 mrem) detections (Section 4.0 Table 1a, MAX column) plus any additional exposure estimates by DOE-SR (Section 4.0, Table 3). These two elevated dose bases (AEI and MAX) were used because they were measured and protective without the inclusion of screening value assumptions for alpha and beta. The assumption of all alpha as plutonium-239 (Pu-239) and all beta as strontium-90 (Sr-90) may double the calculated dose without evidence for that assumption in speciated data, and was discontinued in 2008 and replaced by calculating a MAX dose potential from the single highest detection per radionuclide per media.

The All-Sources Dose

The All-Sources dose comes from a DOE-SR reference, which indicates direct annual releases to the atmospheric and liquid pathways (SRNS 2011 Table 6-4). All other dose sources are atypical in that the general public is usually not impacted, e.g., dose measured in an animal is the result of dose releases over more than one year and exposure to more than one source. An All-Sources Dose Upper Bound and a Perimeter Dose total are given in Section 4.0, Table 1b for the AEI and MAX column totals.

The SCDHEC All-Sources Dose Upper Bound totals for AEI (2.289 mrem) and MAX (11.503 mrem) are not the applicable totals because each drinking water source dose would require proportioning of consumption rates if there were more than one drinking water source (Section 4.0 Table 1a). Therefore, only one drinking water source (the highest media dose for the survivalist MAX and the highest PWS dose for the public) was used as the sole source for the entire year. The All-Sources Upper Bound dose total is not an achievable dose based on temporal and location conflicts, a 100% consumption factor used for all water sources, and single MAX detections treated as if they occurred at unvarying concentration activities throughout the entire year. The Perimeter Dose MEI (MAX total) is an applicable dose potential estimate (11.447 mrem) that includes the single highest media water ingestion dose plus ingestion potential for swimming at the most contaminated location.

The Perimeter Dose

Since only one drinking water maximum could be added to the final perimeter dose total, the highest AEI dose source (0.039 mrem) was used at 100% (underlined in Section 4.0, Table 1, DW Ingestion was not potable) instead of proportioning each water source. The AEI air inhalation (0.003 mrem), food ingestion (2.188 mrem), and direct exposure (0.005 mrem) totals were added to the highest drinking water dose (0.039 mrem from SR boat landings) and the swimming ingestion dose (0.023 mrem) to obtain the 2011 Perimeter Dose AEI results (2.258 mrem). The 2011 MAX perimeter dose potential used the same logic resulting in 0.006 mrem for air inhalation, 11.111 mrem for food ingestion, 0.371 mrem for water ingestion, 0.028 mrem for a swimming ingestion dose, and 0.015 mrem direct exposure for a total MAX perimeter dose rounded to 11.447 mrem (Section 4.0, Tables 1 and 4). The theoretical assumption was that a single MEI always received the maximum dose potential despite the high improbability. The AEI and MAX applicable Perimeter Dose totals used only the single highest drinking water source (underlined in Section 4.0, Table 1a) on an AEI and MAX basis, respectively. The highest detections did occur in surface water and was the basis for dose calculations that assume riverwater was sterilized and used for cooking and drinking at boat landings. Sterilization of water does not remove dose.

The SCDHEC MAX (MEI) non-scenario perimeter total was simply all available dose based on the single highest detections per media at maximum consumption rates for a period of one year (11.447 mrem). The perimeter AEI dose total (the typical available dose) was 2.258 mrem in 2011 and no individual dose potential should exceed the MAX dose total (11.447 mrem) on a non-scenario basis. The exception was the addition of DOE-SR additional dose potential not measured by SCDHEC (mostly from onsite deer) that was included in a combined SCDHEC and DOE-SR MEI estimate, which should capture the upper bound for any nondetected dose. A personal scenario different from those described above can be calculated by the reader (see the 2011 Optional Personal Scenario Basis section). Note the 2.258 mrem AEI perimeter dose was approximately the same dose attributable to a single coast-to-coast airplane flight (2.5 mrem, Section 4.0 Figure 2.0), while the 11.447 mrem perimeter MAX dose is less than the NORM dose from living in a brick house (7 mrem/yr) for two years. This AEI dose is less than the NORM dose exposure for people living in the southeastern region of the United States (300 mrem) (Section 4.0, Figure 2.0). The authors of a recent study concluded that if there are harmful health effects at or below 100 mrem, they are “certainly very small” (Manzoli 2004). The nonNORM totals for the 2011 AEI (2.258 mrem) and MAX (11.447 mrem) dose estimates (mostly wild food sources) in 2011 (Section 4.0 Table 1a) were far less than the 1998 food protective action guideline of 500 mrem committed effective dose equivalent to the whole body or 5000 mrem committed dose equivalent to an individual tissue or organ (USDHHS 1998).

The 2011 Scenario Basis

The basic scenario results for 1999-2011 are given in Section 4.0, Table 2.0, and were based on AEI data for the public (smallest dose potential). The survivalist scenario used all MAX dose based on the single highest radionuclide detections in media (highest potential dose). The alpha-beta dose assumptions are now replaced by observed maximum detections (single highest detections per radionuclide per media) that provide a measured (not assigned) upper bound of potential dose and protective buffer for public dose calculations. See Section 4.0, Table 2.0 for the two SCDHEC scenario results for 2011. Even the AEI totals were very conservative estimates of potential dose and should be greater than any actual or typical dose per individual. The DOE-SR hunter would add onsite dose to the sportsman and survivalist dose, if they killed and ate onsite harvested game animals.

Critical pathway basic scenarios estimate a typical dose potential based on averages for lifestyle activities that resulted in media exposures above background (Section 4.0, Table 2). The MAX Survivalist, defines the upper bound of dose potential for SCDHEC detections in media. The notes below Section 4.0 Table 2.0 explain which data were included in each scenario. The 2011 scenario average results were: 0.228 mrem of potential dose for the general public that uses only public water systems, local milk, and local garden vegetables; and 2.219 mrem for the average survivalist that also eats local wild mushrooms and wild vegetation. The milk dose was higher than usual in 2011 due to an I-131 detection that occurred shortly after the Fukishima Diichi radionuclide releases. One drinking water dose was assigned per scenario, and incidental ingestion of water while swimming was added for the worst case exposure at creek mouths for the survivalist category. The MAX Survivalist Scenario dose (11.447 mrem) was based on the total of all dose detection maximums in the MAX column of Section 4.0 Table 1a except for a limitation to one drinking water source (the highest dose source in that column). The surface water dose at boat landings was highest for the MAX column. The MAX Survivalist dose was equal to the MAX Perimeter dose (11.447 mrem), and was the MEI based on SCDHEC data alone. The reader should not assume that the AEI or MEI dose data applied to them except on an optional individual personal scenario basis (dose adjustment) that is described under the next heading. The scenario statistics given below are due to the inclusion of other media as part of the scenario dose.

The 2011 Optional Individual Personal Scenario

Both AEI and MAX media calculations are categorized into two primary exposure pathways (atmospheric and liquid) that were subdivided into other more specialized exposure routes (inhalation, ingestion, and direct) by media. The statistical results are given under the critical pathway heading and summary statistics section.

The public can estimate their potential dose based on activities that involve exposure to one or more media not covered by the given scenarios, provided their personal scenario dose calculation does not exceed 11.447 mrem for offsite (off SRS) MAX exposure or 2.258 mrem for offsite AEI exposure. If a lifestyle is different from one of the given scenarios, each individual can add one or more MAX column media dose detections (Section 4.0, Table 1a) to the perimeter AEI column dose total and subtract the corresponding media AEI column dose to calculate their own maximum dose potential.

For example, a member of the general public who received deer meat for consumption, but did not hunt, may add the deer MAX (6.330 mrem) to the Perimeter AEI Dose total (2.258 mrem) and then subtract the corresponding media AEI dose average for deer (0.520 mrem) to obtain a dose of 8.068 mrem. Thus, by adding deer meat from the local area to the general diet, the non-scenario dose potential would increase from 2.258 mrem (AEI) to a maximum of 8.068 mrem for the worst-case deer consumption exposure. However, the probability is low that this person would receive all the deer meat (may consume more than one deer) from the MEI hunter (4 deer for 1 hunter in 2011) with the highest deer dose, and consume all of the edible portion. This would be a specific personal dose potential versus the highest MAX overall dose detections of 11.447 mrem (MEI) based on all SCDHEC data.

Likewise, if someone consumed wild edible mushrooms in 2011, a MAX of 1.093 mrems could be added, and then subtract the corresponding AEI dose (0.021 mrem) to obtain their potential maximum dose exposure of 3.330 mrem. This does not apply to domestically raised mushrooms grown in protected environments.

Any dose observed by DOE-SR (onsite deer dose, e.g.) that was not sampled by SCDHEC may also be added to the optional total dose, if applicable to the individual (Section 4.0, Table 3.0). An onsite deer hunter could add 14.7 mrem of potential dose (SRNS 2011, Table 6-4). The grand total for any personal scenario dose calculated from this data cannot exceed the SCDHEC plus DOE-SR upper bound (29.770 mrem) given in Section 4.0 of Table 3.0 (refer to the following 2011 Added Dose Basis section).

The SCDHEC AEI dose determination was the most realistic estimate for a typical exposure versus the atypical MAX dose basis, if the individual was exposed to all media listed in Section 4.0, Table 1a. The scenario basis and the individual optional scenario provided an individual estimate based on scenarios or actual media exposure. Also, the scenario medians were potentially more relevant to typical central tendency exposures over the 1999-2011 period versus averages. The individual seeking to calculate their most accurate personal dose estimate should use the Section 4.0 Data Table 1a data, and add up only the relevant radionuclide AEI and/or MAX dose for specific media they encountered within the year.

The 2011 Added Dose Basis

Section 4.0 Table 3.0 includes data from Table 6-4 of the SRS Environmental Report (SRNS 2012) that can be added to give a total combined SCDHEC plus DOE-SR onsite and offsite dose potential of 29.77 mrem for the Upper Bound MEI estimate. This addition of dose detections other than SCDHEC detections from other environmental programs helped to extend the MEI potential dose limit on a definable basis.

A consumption factor of 3.65 kg/yr was used to calculate dose for edible fungi in 2011 for the avid wild mushroom consumer (Botsch 1999). Therefore, the potential dose above background from consuming wild mushrooms was added for the wild mushroom consumer and the SCDHEC MEI (survivalist). The 2011 edible fungi dose maximum (1.093 mrem) was well below the 1998 food protective action guideline of 500 mrem to the whole body (USDHHS 1998).

DOE-SR and SCDHEC 2011 Comparisons

The 2011 SCDHEC MEI represented a potential exposure based on single highest detections per radionuclide per media, and was a survivalist type of individual that received most of the dose exposure through wild game and edible wild plant and fungi consumer pathways. The DOE-SR All-Pathway MEI dose is limited to the liquid plus airborne pathway annual releases representing the typical low dose exposure potential for the general public downstream of SRS. The SCDHEC MAX dose and DOE-SR Sportsman, Hunter, and Fisherman doses represent atypical dose for minority categories (onsite hunter or poacher, e.g.). All typical and atypical potential dose exposures combined represent an upper bound potential dose limit in the environment for the MEI.

The SCDHEC MAX and AEI estimates were inflated (see Dose Critique heading) and represented a potential dose accumulated over several years in environmental samples. The SCDHEC AEI dose was more relevant to actual potential exposure than the very low probability MAX total (MEI) dose. DOE-SR dose is compared to SCDHEC dose ranges with the more typical low dose (AEI) listed first followed by a highly unlikely upperbound (MAX) dose. The SCDHEC scenarios (public and MAX survivalist doses) also represent limits on a lifestyle basis (0.228 and 11.447 mrem, respectively). These scenarios can be compared to the DOE-SR ranges for typical versus atypical dose; i.e., All-Pathway dose (0.21 mrem) versus the total of onsite and offsite dose (20.19 mrem) in Table 6-4 of the SRNS 2011 report. SCDHEC sampling is limited and the actual dose(s) can exceed the given ranges for typical versus atypical dose, since all dose is not sampled (Section 4.0 Table 1a). The addition of and comparison to DOE-SR dose estimates may be directly relevant (onsite deer also represented accumulated dose), while other detections may be from yearly release estimates or measurements that do not necessarily result in depositions within the 50-mile study area (backgrounds). Also, some DOE-SR radionuclide releases cannot be measured and DOE-SR must use computer modeling to generate a theoretical exposure based on known releases. The DOE-SR dose was potentially inflated due to the treatment of unknown alpha as Pu-239 and unknown beta as Sr-90. The DOE-SR All-Pathway (0.21 mrem) and the SCDHEC Public Scenario basis (0.228 mrem) were the most relevant potential dose estimate range for the general public in 2011. However, potential or available dose does not necessarily imply the individual was exposed to any or all of the dose detections. Estimates represent available dose in the environment, but do not confirm exposure. Releases do not equal exposure; e.g., air releases may remain mostly onsite or travel great distances before ground deposition and wide dispersal by weather factors that greatly reduce any dose exposure. Section 4.0 Tables 6 and 7 indicate relative release and exposure media based on DOE-SR data. Certain media (wild food, e.g.) are not included in the general public dose, but added to the survivalist dose (includes all dose potential) that represents the atypical maximum offsite dose (11.447 mrem SCDHEC) and onsite dose (14.7 mrem DOE-SR). Offsite dose is expected to be less than onsite dose due to dispersion at a distance if from SRS. The overall upperbound potential consists of all dose difference additions from the two programs added together for the individual survivalist who is exposed to all dose maximums (29.77 mrem)(Section 4.0 Table 3). This 2011 combined dose estimate is within the Section 4.0 Table 7 DOE-SR average to median range (37.57 to 23.70 mrem) for the period 1999-2011, and Section 4.0 Figure 8 (from Table 7) indicates the yearly average potential exposure has varied around a low range of 10 to 15 mrems since 2007. Section 4.0 Figures 8 and 9 show the overall trend in dose estimates for comparable exposure media. The SCDHEC MAX offsite and DOE-SR 2009-2011 onsite average tend to agree at approximately 13-14 mrem while the combined trend (offsite plus onsite) averaged around 25 mrem (Section 4.0 Figure 9). The most recent and relevant SCDHEC offsite data trend (2009-2011) that includes wild edible vegetation averaged approximately 2.5 mrem for the SCDHEC AEI (Section 4.0 Figure 9). Compare this to the typical exposure risk from a coast-to-coast airplane flight (2.5 mrem, Section 4.0 Table 2).

DOE-SR yearly radionuclide releases were not directly comparable to field measurements that included accumulated dose from past releases. Most comparisons were based on Table 6-4 of the Savannah River Site Environmental Report for 2011 (SRNS 2012) and Table 1a of this report. This comparison assisted in evaluating the 2011 DOE-SR environmental monitoring program and the SCDHEC ESOP environmental monitoring program. The preceding paragraph indicated similarities in the environmental trends for potential dose exposure despite differences in media and methods. The SCDHEC media dose detections within the study area represented accumulated and decayed dose from all area sources including historical (atomic bomb test fallout, Chernobyl, domestic). No detected dose by SCDHEC was strictly assignable to DOE-SR alone, but was considered of potential DOE-SR origin if within the 50-mile study area and greater than background.

Most of the 2011 MEI exposure estimates for SCDHEC and DOE-SR were due primarily to Cs-137 occurrence in bioconcentrators of dose in the sportsman food pathway and not to correlations between annual releases and detected dose in media (Section 4.0, Table 1a, and DOE-SR 2011 Table 6-4). The following sections look at the typical radiation exposure routes, air and liquid, and the atypical subpathways while comparing DOE-SR and SCDHEC dose data. The differences between DOE-SR and SCDHEC dose estimates primarily represent a potential range of dose dependent on lifestyle scenarios of exposure and consumption rates.

<u>SCDHEC and DOE-SR Atmospheric Pathway Comparison</u>

This section refers only to detections of atmospheric depositions that may result in dose exposure for an individual in 2011. SCDHEC dose data was calculated as an AEI above background and as a MAX potential dose as if the media could somehow be stored and consumed throughout the year. The potential dose to the MEI from the SRS atmospheric releases was highest due North of the site per the SRS Environmental Report for 2011 (SRNS 2012). The highest tritium detections in air and rainwater in SCDHEC samples was slightly northwest (NW) of the SRS, but there was not a clear trend due to the next highest detections being south and east of the SRS. The highest Cs-137 detections in wild vegetation also tended to occur north of the SRS.

The National Emission Standards for Hazardous Air Pollutants (NESHAP) MEI dose for all radionuclide air pollutants (0.0153 mrem plus 0.0089 mrem diffuse and fugitive releases) was 0.02043 mrem in 2011 for the MEI. This was 0.2 % of the 10 mrem/yr DOE Order 5400.5 air pathway standard. The atmospheric pathway contributed accumulated dose to the individual through the inhalation, ingestion, and direct exposure routes. Rainwater contamination from atmospheric releases of tritium (SCDHEC 0.02 mrem) would directly impact water cisterns that used rain for drinking water. Rainwater SCDHEC MAX dose (0.042 mrem in 2011) was higher than the Savannah River public water supply (PWS) MAX drinking water dose (0.015 mrem), but far less than the exposure from using that same river water in cooking food at boat landings near SRS (0.286 mrem MAX) (Section 4.0 Table 1a).

Not all SRS dose releases resulted in depositions within the sample area. This was evidenced by the inhalation pathway detections (0.006 mrem MAX) that were far less than SRS release estimate of 0.035 mrem (Section 4.0 Table 1a) (SRNS 2012). Atmospheric releases, when deposited outside of the study area are greatly diluted with distance from the originator and by weather factors. The cumulative dose depositions that contributed to the SCDHEC dose detections in any given year and potential dose releases by DOE-SR (an annual estimate) were not directly comparable. The detected exposure in millirems was a more meaningful indicator of dose to the public versus percentages that establish rank.

Unknown variables caused fluctuation in the annual deer dose, but weather and related forage availability may have played a role, especially in bioconcentrators of dose (e.g., mushrooms). Deer tracks among bolete fungi that were mostly missing the caps with scattered pieces nearby were observed in 2008 at an Audubon preserve. The highest known bioconcentrators of Cs-137 found in literature references were mostly bolete fungi that fruit primarily in August and September (Botsch 1999, Kalac 2001). Deer and other animals that consumed boletes could potentially receive the highest dose from boletes no later than October (bolete mushrooms generally occur from June through September). The highest observed Cs-137 concentration (8.145 pCi/g) was found in a *Boletus* group near the highway 39 entrance to the SRS.

Four comparable SCDHEC and DOE-SR media pathway dose results (air, liquid, soil, food) were totaled and compared for 2011 data in Section 4.0, Table 5. SCDHEC detected far less air inhalation dose (0.006 mrem MAX) than the estimated potential dose by DOE-SR releases (0.035 mrem MAXDOSE-SR goat milk pathway). All releases were not detected and were not necessarily deposited within the study area. The air pathway data difference between SCDHEC and DOE-SR was due to dose based primarily on field measurements versus actual atmospheric releases and dose modeling, respectively. Few atmospheric releases resulted in measureable dose detections offsite of SRS within the 50-mile study area perimeter. The DOE-SR pathways most affected by contributions from atmospheric releases in 2011 were the vegetation (0.014 mrem), inhalation (0.012 mrem), goat milk (0.0083 mrem), ground (0.0015 mrem), and meat pathways (0.00026 mrem) (Data Table 6-22 MAXDOSE-SR MEI Dose Using Goat Milk Pathway data, SRNS 2011). The SRS 2011 air dose was due mostly to tritium (74.40%), Sr-90 (11.58%), Cs-137 (4.76%), and I-129 (1.80%).

The DOE-SR airborne dose (0.035 mrem) in 2011 is far less than the atypical hunter dose pathway (SRNS 2012 Table 6-4). The higher accumulated dose in atypical pathways is clear evidence of bioaccumulation of dose (e.g., SCDHEC 0.424 mrem AEI dose in wild edible plants versus 0.005 mrem in soil and sediments). The observed annual dose release detections would require several years to achieve the dose found in some wild food sources (deer, hog, fish, mushrooms, vegetation) by SCDHEC (2012) and DOE-SR (SRNS 2012).

SCDHEC MAX atmospheric pathway dose detections in 2011 came mostly from the sportsman food and wild edible mushrooms and plant pathways (95.02% of 11.447 mrem MAX basis), and was 87.33% of the 2.258 mrem AEI basis (Tables 1a,b SCDHEC 2012). See the Food Pathway Comparison section that follows (Table 4 SCDHEC 2012).

SCDHEC only monitors offsite dose, and terrestrial food did not include an onsite (within SRS boundary) hunter dose (14.7 mrem Table 6-4, SRNS 2011)(Section 4.0 Table 1a, SCDHEC). SCDHEC hog samples AEI dose was 0.510 mrem (1.010 mrem MAX) in 2011. SCDHEC monitored edible fungi (0.021 mrem AEI and 1.093 mrem MAX) and DOE-SR did not (Section 4.0, Table 1a). Animals with large body mass and vegetation with large absorptive surface areas (leaf canopy, root system, or fungi mycelia mat) tended to contain the highest dose for particular radionuclides (Cs-137, e.g.) (Section 5.0 Data).

A comparison of atmospheric plus sportsman dose maximums (air, soil, and food pathways) in similar media that were monitored by both DOE-SR and SCDHEC programs gave totals of 5.398 mrem and 10.027 mrem, respectively (Section 4.0, Table 5). The sportsman scenario includes fish (covered under the liquid pathway), but most sportsman dose was related to the atmospheric pathway (Table 1a SCDHEC 2012). The prime difference between the two program estimates was due to backgrounds and offsite deer and hog dose estimates (7.34 mrem above background for SCDHEC versus 2.03 mrem for DOE-SR). SCDHEC offsite deer and hog dose was measured whereas DOE-SR offsite deer and hog dose was a hypothetical calculation based on onsite measurements. The higher SCDHEC offsite animal dose may be due to contamination from onsite territory cross-over feeding. The SCDHEC Bamberg deer background dose was 0.37 mrem in 2011. The previous higher background in the McBee area may be due to natural factors such as: the abundance of mushrooms (bioconcentrators of Cs-137) consumed by deer during the high background years, legacy spot depositions of Cs-137 in the area by fallout from nuclear weapons testing primarily in the 1950-1970 period, or a variation in weather patterns that affect atmospheric depositions at a distance from potential sources. Section 4.0 Figure 8 shows a general decreasing dose trend in deer and hunter dose. This may indicate that maximums in the deer Cs-137 activity concentration were a result of the legacy dose local maximums and their respective decay rates. If no further releases are added to the Cs-137 population, then future years should show a continuing decline toward the offsite deer AEI dose average of 0.324 mrem or less due to further decay (Section 6.0 Table 2).

The Sportsman pathway accumulated exposure was about the same on a percentage basis for DOE-SR and SCDHEC data. Most of the dose estimate from either DOE-SR or SCDHEC was due to atmospheric deposits and bioaccumulation (all but fish and liquid potential dose). Approximately 93.332 % (18.352/19.665 mrem x 100%) of the DOE-SR 2011 atmospheric dose in Table 6-4 came primarily from the sportsman hunter subpathway within the atmospheric pathway (SRNS 2011). Subtracting the fungi dose (not collected by DOE-SR) contribution from the SCDHEC total APW total leaves 8.136 mrem (Section 4.0 Table 1b). The SCDHEC sportsman hunter subpathway within the 2011 atmospheric pathway accumulated MAX dose was 90.216 % (7.340/8.136 mrem x 100%) of the detected dose in the atmospheric pathway excluding fungi (Section 4.0, Tables 1a,b).

The major dose difference occurred in deer. The DOE-SR MEI estimate was 14.7 mrem for the onsite hunter and 3.64 mrem total dose in hypothetical offsite deer, and was 6.330 mrem in SCDHEC offsite deer. Based on SRS onsite deer dose, SCDHEC deer samples close to the SRS exhibited contamination possibly from crossing over into the SRS. DOE-SR offsite hogs (1.29 mrem) versus SCDHEC offsite hog (1.093 mrem) samples had closer MAX dose estimates.

Deer and hogs harvested near the SRS could contain contamination from onsite travel and food consumption within the SRS. The DOE-SR offsite hog dose was hypothetical and each turkey kill was assigned a dose of 1.0 mrem. The SCDHEC AEI dose was lower (hogs 0.510 mrem, deer 0.520 mrem) and represents the typical offsite dose. The averaging in of nondetections versus using only detections in dose calculations accounts for some of the difference. Dose accumulations in offsite fungi (1.093 mrem) were near hog MAX contamination levels (1.010 mrem)(Section 4.0 Table 1a). DOE-SR did not collect fungi on or off the SRS, therefore program comparisons of Cs-137 in fungi were not possible.

The approximate DOE-SR atmospheric dose accumulation (20.015 mrem) was higher than the SCDHEC atmospheric (subtracting fungi) dose accumulation (8.136 mrem). The theoretical estimates made by DOE-SR for offsite deer (0.74 mrem) were less than the field samples calculated by SCDHEC on a MAX basis (6.33 mrem), but close on an AEI basis (0.52 mrem). However, the theoretical estimates for offsite hogs were closer on a MAX basis (1.29 mrem DOE-SR and 1.01 mrem SCDHEC).

All atmospheric releases would not result in media contamination within the study area due to weather dispersion factors, but the offsite dose samples were subject to many years of accumulated dose. Also, historical dose accumulation has many potential sources.
Any close agreement of the MEI calculations between the two monitoring programs was due primarily to Cs-137 occurrence in bioconcentrators of dose in the sportsman food pathway, and to tritium in the Savannah River water supply pathway, and not to a correlation between releases and detected dose in media. Despite bioaccumulation over several years versus annual release estimates, both environmental program MEI estimates added together indicated that the upper bound of the combined MEIs (29.77 mrem) in 2011 was far less than the 100-mrem (not applicable except on an annual release basis) DOE-SR Order 5400.5 dose release standard. Accumulated dose over several years was primarily dependent on the higher energy of radiation and longer half-life radionuclides (Cs-137 and Sr-90) versus tritium (lowest beta energy) (Baum 2009). Comparisons to DOE-SR annual dose release limits are not strictly applicable, but serve to illustrate that accumulated dose in the environment is less than any single years DOE-SR allowed dose release.

The MAX limit of available exposure or upper bound for the SCDHEC 2011 MEI air dose excluding atypical exposure pathways (the sportsman and survivalist dose, e.g.) was based on exposure to the total of the single highest maximums (SCDHEC data) for air inhalation (0.006 mrem), local vegetables (0.012 mrem) and milk production (0.205 mrem) for a total of 0.223 mrem of accumulated dose. Note that the atmospheric accumulated dose is well under the DOE-SR yearly air limit for dose releases to the public of 10 mrem/yr. (Section 4.0, Table 1 and Section 5.0 Data). Atypical annual atmospheric exposures were included by DOE order 5400.5 under the 100-mrem total annual limit. The addition of upper bound (ALL-Sources) dose calculations illustrated that MEI APW including atypical exposures could not be greater than 9.187 mrem based on SCDHEC sampled media MAX detections, and not greater than 1.690 mrem for the AEI APW (Section 4.0 Table 1b). Note that atmospheric pathway field samples contained depositions accumulated over many years mostly in sportsman media and wild edible vegetation and fungi sources.

SCDHEC detected sportsman soil exposure dose (0.031 mrem) based on riverbank and forest soils was far less than the estimated DOE-SR swamp soil dose (2.90 mrem) (Section 4.0, Table 1) (Table 6-4 SRNS 2012). Again, DOE-SR calculations were based on an annual dose potential, whereas SCDHEC data results measured accumulated dose in sampled media (not directly comparable). However, note that SCDHEC accumulated dose estimates were less than the annual release estimates of DOE-SR, which indicated that most of the dose releases either stayed on SRS or were carried far away by weather atmospherics and dispersed.

The SCDHEC order of MAX detected radionuclide dose in the 2011 atmospheric pathway excluding assigned NORM was: Cs-137 in deer (6.330 mrem), Cs-137 in fungi (1.093 mrem), Cs-137 in hogs (1.010 mrem), tritium in vegetation (0.543 mrem), I-131 in milk (0.202 mrem), tritium in air (0.006 mrem), and <0.01mrem for all others (Section 4.0 Table 1a). Iodine-131 was detected by SCDHEC and DOE-SR within three weeks of the Fukishima Daiichi reactor explosions. Differences in observed dose were potentially influenced by weather depositional factors. The major contributors to the atmospheric pathway dose were primarily Cs-137 and H-3 in the food pathway. The SCDHEC MAX dose from the atmospheric pathway (9.187 mrem/yr) was less than that from living in a block house for one year (7 mrem/yr) and taking one coast-to-coast flight (2.5 mrem) (Section 4.0 Figure 2, SCDHEC 2006). The DOE-SR MAX doses included Cs-137 in animal flesh with a maximum hunter dose of 14.7 mrem onsite and 3.64 mrem offsite, fisherman (0.35 mrem), vegetation (0.014 mrem), inhalation (0.012 mrem), goat milk (0.0083 mrem), ground (0.0015 mrem), and domestic meat (0.00026 mrem).

<u>SCDHEC and DOE-SR Liquid Pathway Comparison</u>

A comparison of liquid ingestion media (e.g., river water) categories with DOE-SR gave different maximums. The SCDHEC survivalist that saved Savannah River water to a cistern on the highest tritium release date received the highest liquid potential dose consumption at Steel Creek Boat Landing for tritium (0.286 mrem) in 2011 (Section 4.0, Table 1a). It is possible to collect a tank full of water (observed) at any location and transport it to a personal cistern or well. Calculation of this maximum yearly dose based on the single highest sample, however improbable, served to illustrate that the survivalist (an atypical scenario) should not receive a higher dose due to tritium than 0.286 mrem from untreated Savannah River swamp water in 2011. The SCDHEC comparable PWS processed drinking water maximum detection for the typical public exposure was 0.015 mrem (Savannah River water). The DOE-SR drinking water dose averaged 0.019 mrem for the Savannah, Chelsea, and Purrysburg downriver locations. Both atypical and typical liquid pathway exposures were well below the 4 mrem/yr DOE 5400.5 drinking water pathway annual release standard (SRNS 2011). The SRS plus plant Vogtle contributions (VEGP) was 0.035 mrem tritium. However, the swamp dwelling survivalist was unlikely to pull a tanker to Steel Creek Landing and save that dose to a tank, well, or cistern on that date, and drink only that water for the rest of the year. Even the highest incidental ingestion dose of tritium in water from swimming at Fourmile Creek mouth would add only 0.028 mrem.

The SCDHEC fish dose MAX value was 1.914 mrem and the AEI was 0.497 mrem. The DOE-SR total offsite fisherman dose was 0.35 mrem (Table 6-4 SRNS 2011). SCDHEC determined the fish dose based on the sum of the highest dose per radionuclide in all fish and not per fish species, since the survivalist was assumed to eat all fish. Most of the difference between DOE-

SR and SCDHEC was a consumption factor of 48.2 kg/yr for the SCDHEC survivalist versus 19 kg/yr for the DOE-SR typical fisherman. These different estimates represent a range of dose (0.35 to 1.914 mrem) that applies to the fisherman according to lifestyle scenario choices (typical sportsman versus atypical survivalist). The MAX liquid pathway dose potential (0.286 mrem) was due primarily to H-3 in nonpotable Savannah River water (Section 5.0, Data Tables). The SCDHEC AEI liquid dose (0.569 mrem) applied to the average potential exposure versus the highly improbable MAX exposure based on a single highest (2.259 mrem) detection (Section 4.0, Table 1b). Ingestion or dose uptake after bioconcentration of Cs-137 in fish was the dominant route of exposure to the public via the food pathway that was of liquid pathway origin.

The DOE-SR potential dose contributions via a theoretical irrigation pathway (vegetable, milk, meat – 0.092 mrem) is higher than the typical liquid pathways (fish, water, shoreline, swimming, and boating – 0.084 mrem). The main liquid dose release contributors were Cs-137 (69%), tritium (15%), unknown alpha (5%), U-234 and U-238 (3% each), I-129 (2%), nonvolatile beta, and Sr-90 (1% each), and the rest were all <1% each (Tables 6-12 and 6-16 SRNS 2011). The DOE-SR liquid releases percent of dose potential in 2011 was 72 % for fish consumption, 27 % for water consumption, and <1 % for the shoreline, swimming, and boating. Comparison of the DOE-SR fish dose of 0.061 mrem based on the irrigation pathway and the fish dose range in SCDHEC fish samples (0.497 mrem AEI and 1.914 mrem MAX) indicates that yearly dose releases are building up in fish (mostly due to Cs-137). The higher dose range for SCDHEC dose compared to the 0.068 mrem for DOE-SR was mostly due to a consumption rate of 48.2 kg/yr for the SCDHEC survivalist versus 19 kg/yr for the DOE-SR fisherman.

The 2011 SCDHEC MAX dose in public water supply river water (PWSRW) was tritium (0.015 mrem) (Section 4.0, Table 1a). The DOE-SR measured dose at the downstream water supply locations of Chelsea, Purrysburg, and Savannah I&D averaged 0.019 mrem and rounded off the same at 0.02 mrem (SRNS 2011 Table 6-2). Weather also played a role in that tributary streams floodwater can greatly dilute radionuclide concentrations in the Savannah River at any given time at tributary and downstream locations. The time and locations of sampling for both programs were independent.

The SCDHEC order of MAX detected radionuclide dose in the 2011 liquid pathway excluding assigned NORM was Cs-137 in bass fish (1.663 mrem), tritium in Steel Creek boat landing water (0.286 mrem), and Sr-89/90 in bass (0.248 mrem)(Section 5.0, Data Tables). The bioconcentrated radionuclides, primarily Cs-137 and Sr-89/90 in the food pathway, were the major contributors to the liquid pathway dose. The 2011 MAX dose from the liquid pathway (2.259 mrem/yr) was close to that from a single coast-to-coast airplane flight (2.50 mrem/yr) (Section 4.0 Table 1b and Figure 2, SCDHEC 2006).

<u>All-Pathway SCDHEC and DOE-SR Comparison</u>

DOE-SR and SCDHEC detected comparable dose in the basic air and liquid pathways. The consumption of PWS water at downstream locations was typically <0.02 mrem for DOE-SR and SCDHEC data. The VEGP contributions raise the DOE-SR drinking water estimate to 0.035 mrem (SRNS 2012). The SCDHEC survivalist who used boiled swamp water at Steel Creek Landing for drinking water was typically the AEI dose or 0.039 mrem (Section 4.0 Table1a). Again, both programs agree at the 0.04 mrem significance level. The SCDHEC liquid plus air

MAX (MEI) potential dose in 2011 (0.292 mrem) was less than that received from taking one coast-to-coast flight (2.5 mrem) (Section 4.0 Figure 2, SCDHEC 2006). The DOE-SR MEI All-Pathway including irrigation yearly dose (0.21 mrem) basically represented combining typical exposures from the airborne and liquid pathways for the general public who were not subject to increased exposure from atypical activities. The DOE-SR All-Pathway potential has not exceeded 0.28 mrem in the last thirteen years and has an overall downward trend since 1999 except for the irrigation pathway in 2011 (SCDHEC Section 4.0 Table 7, DOE-SR Data Table 6-12).

The Food Pathway SCDHEC and DOE-SR Comparison

DOE-SR radionuclide annual releases were generally not directly comparable to SCDHEC accumulated dose detections in food media, since some media may contain or bioconcentrate several years of dose releases and food sources were highly variable in tissue mass and age. The food pathway has contributions from the liquid (primarily fish) and the atmospheric pathway (primarily wild game and wild vegetation food sources).

The 2011 DOE-SR food media contributing dose to the food pathway from highest annual release estimates were: onsite deer (14.7 mrem), offsite hog (1.29 mrem), offsite deer (0.74 mrem), fish (0.068 mrem), vegetation (0.014 mrem), goat milk (0.0083 mrem), and domestic meat (0.00026 mrem) pathways for a total of 16.81356 mrem in 2011 (SRNS 2011). Also, the new irrigation pathway adds 0.092 mrem from vegetable (0.052 mrem), milk (0.013 mrem), and meat (0.0047 mrem) to total 16.9045 mrem. The onsite deer dose (14.7 mrem) is included in the comparison since many SCDHEC offsite deer were close to and probably traveled within site boundaries of SRS and some hunters harvested onsite deer.

SCDHEC AEI food ingestion dose potential was 2.188 mrem in 2011, but the true central tendency should be lower (see the critique section). The SCDHEC MAX potential offsite food dose was 11.111 mrem: deer (6.330 mrem), fish (1.914 mrem), edible fungi (1.093 mrem), hog (1.010 mrem), wild edible plants (0.531 mrem), milk (0.205 mrem), riverbank and soil exposure (0.016 mrem), and domestic edible plants 0.012 mrem. The likelihood of wild edible mushroom consumption by animals or humans is a major factor in dose exposure.

DOE-SR and SCDHEC food dose is not directly comparable due to differences in media, location, times sampled, annual estimates in some cases versus field accumulations, and differences in definition of the MEI basis. The 2011 SCDHEC AEI (2.188 mrem) food dose with trace dose from sediments in food represents the average potential dose from all food media sampled and is close to the offsite food dose estimate by DOE-SR (2.1909 mrem) (SCDHEC Section 4.0, Table 1a) and (SRNS 2012 Table 6-4). However, the DOE-SR food total (16.8909 mrem) for maximums was based on onsite deer (14.7 mrem) dose added to the hypothetical offsite totals for MEI deer consumption (0.74 mrem), offsite hog (1.29 mrem), irrigation pathways (0.0929 mrem - vegetable, milk, meat), plus creek mouth fisherman (0.068 mrem). SCDHEC did not sample food media onsite, but the food maximums total was 11.095 mrem for offsite dose to the survivalist (Section 4.0 Table 4). The SCDHEC food dose total was 96.92% of the MEI. These are upper bound estimates of the available food dose (11.095 mrem) and are not actually achievable unless somehow stored by the MEI and used continually throughout the year to achieve the total dose potential. Dose differences were attributable to consumption factor differences, temporal and location factors, the number of deer (and hogs) eaten by the respective MEI hunter and resultant dose, and the inclusion of Sr-89/90 in fish bone for the SCDHEC survivalist.

The food difference between the two agency averages in previous years was primarily dependent upon the highest deer or hog dose, but the hog dose ranking was displaced by mushrooms in SCDHEC 2011 data (Section 4.0, Table 1a). Compare the 2011 SCDHEC MAX dose for milk (0.205 mrem for cow milk) and domestic edible vegetation (0.012 mrem) to the DOE-SR maximums of 0.013 mrem in milk and 0.075 mrem in vegetation MEI dose (Data Table 6-16 Potential Doses from Irrigation Pathways SRNS 2012). Most of this DOE-SR nonNORM dose estimate was due to tritium and technetium-99 (Tc-99). Both DOE-SR (Cs-137, I-129, I-131 in charcoal canisters) and SCDHEC (I-131 in milk) had detections potentially related to the Fukushima Daiichi nuclear plant accidental releases near mid-March 2011 (ANS 2011). Technetium-99 and I-129 will play a more dominate role in long term dose calculations as the present dominate contributors to dose (H-3, Cs-137, Sr-90) undergo decay provided there are no further contributions. The I-131 should disappear rapidly due to it's short half-life (8.023 d)(Baum, et.al. 2009).

The reader should keep in mind that the MAX calculation potential applied only if that MAX dose was somehow stored and delivered to the MEI as the sole source of that media throughout the year (e.g., the MEI who received the single highest dose from cow or goat milk, dried the milk into a powder or processed milk solids into cheese without loss of concentration activity, stored it on that day, and consumed it throughout the year). Thus, the reason for concluding that the SCDHEC MEI based on the single highest dose per radionuclide per media was of extremely low probability and that the SCDHEC AEI represents the most probable dose basis for any scenario. Tritium bioaccumulation potential has far less impact on the SCDHEC AEI or MEI dose than Cs-137 and Sr-89/90.

SCDHEC adds the single highest media detected dose (nonscenario basis) as a protective upper bound limit for the potential worst-case minority (survivalist). The survivalist may consume all of the maximally contaminated deer, hog, fish, mushrooms, and farm crops due to activity near SRS (and potential as a poacher and onsite hunter dose), which is most of the MEI dose or 96.925% (Section 4.0, Table 1) (Section 4.0, Table 4). Compare these MAX or MEI percentages to the AEI percentages for the food pathway (96.924%). The food pathway was clearly the dominate dose pathway whether on a MAX or AEI basis.

DOE-SR found that terrestrial food products had the following radionuclide detections: Cs-137 in peanuts, collards, pecans, and milk; Sr-89/90 in beef, collards, and milk, uranium-234 (U-234) in collards and beef; Am-241 in collards; U-238 in collards and beef; Tc-99 in collards, peanuts, and beef; and tritium (H-3) in pecans, milk, cabbage, collards, fruit, and beef (SRNS 2011).

SCDHEC detected tritium in wild plums, wild mustard greens, grapes, pokeberry leaf, prickly pear cactus, yucca flower, bolete fungi, and wild persimmons. AOC Cs-137 MAX detections were found in the following fungi: several *Boletus* species (8.145 pCi/g), *Cantharellus cibarius* (1.831 pCi/g), *Cladonia leporina and rangiferina* (0.215 pCi/g), and *mixed jellies* (0.172 pCi/g). Only tritium and Cs-137 detections were potentially not of natural origin and contributed dose to the MEI. These edible mushrooms contributed a potential dose to the minority wild mushroom consumer, whether animal or human. Although reindeer lichen (*Cladonia rangiferina*) and other lichens are not a particularly desirable food even with proper preparation, lichens tend to store elemental levels contained in ambient air and serve as an effective biomonitor of atmospheric quality and plays a significant role in caribou and in wolf predator Cs-137 contaminant levels (White 1986).

The combined SCDHEC and DOE-SR MEI dose potential (29.77 mrem) confirmed that any scenario or individual was not exposed to a dose greater than the DOE-SR annual dose limit of 100 mrem/yr., especially since this total represented accumulated dose over many years and not just one year. DOE-SR monitored individual hunters on the SRS to ensure that they did not exceed the DOE 100 mrem annual release standard or the 30 mrem per year administrative limit for game animals (SRNS 2012). Both SCDHEC and DOE-SR programs sampled the same dominant dose contributors despite differences in locations, methods, and analyses. Section 4.0, Table 8 statistics derived from DOE-SR release dose estimates revealed that the overall dose to the onsite hunter (14.7 mrem) was greater than the SCDHEC offsite MAX deer and hog dose (7.340 mrem) in 2011 (SRNS 2012). Large offsite game animals may roam onto the SRS and be exposed to onsite dose and vice versa.

The dose detected in comparable media by SCDHEC came from previous years dose accumulations or bioconcentrations of legacy dose, which may or may not have come from DOE-SR annual releases or other sources (commercial, worldwide nuclear tests or accidents).

Critical Pathways 2011 Summary

All SCDHEC dose detections occurred in one of the following pathways: atmospheric and liquid routes of exposure, and subpathways of food ingestion, air and dust inhalation, direct exposure, public water supply ingestion, and the nonpotable drinking water ingestion. Most of the critical pathways were discussed in detail under the section “DOE-SR and SCDHEC Comparisons”. Percentage comparisons of critical pathways in 2011 denote their relative importance to overall dose exposure (Section 4.0 Table 1a and Section 5.0 Data). The 1999-2011 Statistics Summary Section 6.0 covers the overall media trends. The AEI data represented the typical dose levels above background or yearly dose and the MAX data represented the extreme data points or one time dose extreme that occurred sometime during the year. The MAX dose is very conservative since it is based on a single high detection as if it was stored and constantly used throughout the year.

The Atmospheric Pathway 2011 Summary

The SCDHEC 2011 atmospheric pathway contributed dose to the individual through the inhalation of air and resuspended soil, ingestion of food and game, and direct exposure routes. Table 1b Section 4.0 and Figure 3 clearly illustrate the dominance of the APW over the LPW routes of exposure, and the dominance of the food subpathway (mostly due to wild edible vegetation and wild game) over all other subpathways. It is obvious from Section 4.0 Tables 1a, 2, 3, 4, and Section 6.0 Summary Tables 2, 3, and 4 that most dose exposure under any scenario is due to food consumption.

The Section 5.0 Data Tables indicate that most of the dose exposure in 2011 was due to Cs-137 (1.521 mrem total) in wild game, fish, and edible vegetation that included fungi. Strontium-89/90 was the second highest dose exposure in 2011 (0.448 mrem), I-131 third (0.202 mrem), and tritium fourth (0.118 mrem). Tritium occurs in all major pathways (APW and LPW). Iodine-131 displaced tritium in 2011 from third to fourth. A first time occurrence of iodine-131 occurred with a single detection in a SCDHEC cow milk (APW pathway) sample following the Fukushima Diiachi nuclear reactor accidental release of radionuclides in 2011.

The SCDHEC APW All-Sources limit or upper bound (MAX column) for the atmospheric dose accumulated potential in Section 4.0 Table 1b was based on exposure to the single highest media maximums (9.187 mrem APW), and was not directly comparable to the DOE-SR annual atmospheric dose limit.

The Liquid Pathway 2011 Summary

The SCDHEC 2011 liquid pathway contributed AEI dose to the individual through the ingestion of fish (0.497 mrem), groundwater (<MDA), surface water (0.039 mrem), public water supplies (0.013 mrem), swimming ingestion (0.023 mrem), direct exposure routes (0.010 mrem), and inhalation (0.003 mrem) pathways (Section 4.0 Table 1a). Riverbank sediments were an example of a media that can impact both atmospheric (through inhalation of resuspended dry sediments) and liquid pathways (through ingestion and direct contact), dependent on how the exposure occurred. The LPW contributions to dose exposure were second to those contributing to the APW pathway. A review of the Section 5.0 Data and Section 6.0 Table 1 shows the radionuclide rank order (Cs-137 in fish, Sr-89/90 in fish and water, and tritium in surface and drinking water) that occurred in the LPW pathway in 2011.

The Food Pathway

The food pathway was covered under the atmospheric and liquid pathways except for these few additional observations. The 2011 SCDHEC AEI versus 1999-2011 AEI food pathway dose order for averages was deer, hog, fish, edible vegetation, milk, and fungi versus fish, hog, deer, fungi, edible vegetation, and milk, respectively (Section 6.0 Table 4 and Section 5.0 Data). Milk AEI dose is higher than fungi in 2011 only because of a single I-131 detection that occurred shortly after the Japanese reactor explosion in 2011. Single high detections can occur in any of the game, fish, or wild fungi and vegetation samples and cause a reversal of the rank order of media in any year. The 2011 MAX versus 1999-2011 MAX food pathway was deer, fish, fungi, hog, edible vegetation, and milk versus deer, fish, hog, fungi, edible vegetation, and milk, respectively. Most of this dose was due to Cs-137 and strontium (all calculated as Sr-90) detections in fish and wild edible vegetation. The food pathway contained all detected radionuclides (Cs-137, Sr-89/90, tritium, and I-131) contributing to dose exposure. The dominant food categories were game dose higher than nongame, and wild type edible vegetation higher than domestic crops for multi-year averages.

1999-2011 Summary Statistics

Section 6.0 Table 1 summarizes *all potential dose detected* regardless of applicability, and Section 6.0 Table 2 summarizes only media dose relevant (assigned) to the AEI and MAX media calculations. Section 6.0 Tables 3 and 4 break down the primary contributor to dose exposure, the food pathway, into subpathways and media.

The critical pathway basis of comparison for SCDHEC detected dose comes from accumulated releases of radionuclides that were deposited outside of SRS and within 50-miles of the SRS center-point. These tables illustrate the dominance of the atmospheric pathway dose (61.91%) over the liquid pathway (38.09%) and emphasizes the AEI dose basis (Section 6.0 Tables 2,3). The food subpathway (90.10% of dose) was the dominant route of exposure, the nonpotable drinking water supply was second (4.93%), the direct exposure pathway third (2.43%), the public water supply pathway fourth (2.23%), and the inhalation pathway fifth (0.31%).

Section 4.0 Figures 1 and 2 illustrate the various pathways of dose exposure. The total detected critical pathway contributions (AEI basis) are about the same as encountered in one coast-to-coast airplane flight. The food pathway dominance of 91.83% of the dose is evident for the pie sections APW plus LPW; and are only slightly greater than the food pathway pie section. Figures 4,5,6,7 in Section 4.0 illustrate the media exposure trends via line graphs. These figures clearly illustrate that the various media can change rank order in any given year on an AEI and MAX basis. Summary statistics, especially medians, for multi-year periods are more relevant to actual trends and comparison of typical dose exposures from media.

Cesium-137 (69.44% of *all* AEI dose detections) accounted for most accumulated dose detections in all media for the period 1999-2011, and occurred primarily as a result of exposure to wild food sources (Section 6.0 Tables 1 and 2). Total strontium (4.79% of *all* AEI dose) was second, and tritum ingestion (3.16%) third. All other potential non-NORM radionuclides were less than 1% of the dose exposure for the period 1999-2011. The I-131 detection in 2011 was a single occurrence related to the Fukushima Diichi reactor explosion releases, and contributed only 0.63% of dose in the period 1999-2011. The potential NORM radionuclide dose detections came primarily from potassium-40 (highest, but not listed as a radionuclide of concern), radium-226 (Ra-226), actinium-228 (Ac-228), and uranium-238 (U-238).

Section 6.0 Table 2 offsite hunter MAX (averaged 9.635 ± 9.652 mrem, and median 8.000 mrem) and AEI (averaged 0.849 ± 1.426 mrem, and median 0.156 mrem) summary statistics are only for game animal totals, and all other statistics are on a single media basis. The 2011 MEI dose was based on a hunter MAX dose of one hunter consuming the edible portion of 4 deer and another hunter consuming 2 hogs (7.340 mrem). Thus, the SCDHEC hunter who was not the MEI would receive far less dose on average (AEI), and the typical dose that was not based on extremes of consumption should be closer to the AEI offsite hunter median (0.156mrem), because nondetections were not part of the dose estimate calculations (Section 6.0 Table 2). Section 6.0 Table 2 medians, which reduce the influence of the extremes, should provide the most relevant central tendency for environmental media exposure estimates over the period 1999-2011 due to the large amount of data (Gilbert 1987), and the median is still protective since the statistics are based on detections only. The dominant sources of exposure on an AEI median basis were hog (0.740 mrem), fungi (0.518 mrem), fish (0.440 mrem), and deer (0.145 mrem) (Section 6.0 Table 2). The MAX categories change the median order and indicate the dose potential that exists in exposure to extremes. Compare the hunter MAX median dose (8.000 mrem) to the hunter AEI median dose (0.156 mrem). The MAX median order is deer (6.926

mrem), fish (1.768 mrem), hog (1.565 mrem), and edible fungi (1.526 mrem). Notice that deer meat consumption represents the most variable rank (from last place on an AEI basis to first on a MAX basis) in this comparison of AEI to MAX detections.
Refer to Section 6.0 Table 2 for the median statistics of relatively *minor dose that occurred in other media* including the only other food categories; wild type vegetation (0.186 mrem), domestic vegetation (0.010 mrem), and milk (0.003 mrem). The highest dose potential in water media would come from consuming water from the Savannah River at boat landings (SWBL) (median 0.040 mrem). The next highest media minor dose came from Savannah River drinking water (median 0.020 mrem). DNR wellwater (represents private wellwater) was third (0.012 mrem), rainwater fourth (0.010 mrem), and public water system wellwater fifth (0.009 mrem). Milk dose (median 0.003 mrem) is potentially the result of annual inhalation dose by cows or depositions on annual food crops, whereas the air filter dose (median 0.002 mrem) represents mostly inhalaton and relates directly to annual releases. See Section 6.0 Table 2 for the AEI average and standard deviation of each media, which illustrate the potential variation in dose. The remainder of the minor median dose contributions are soil exposure (0.005 mrem), air inhalation (0.002 mrem), and sediment and swimming dose exposure (0.000 mrem). Compare these AEI median ranks to the AEI averages, which are inflated estimates for the reasons listed in the dose critique: surface water consumption at boat landings (0.051 mrem), DNR wellwater (0.028 mrem), public water supplies using Savannah River water (0.026 mrem), PWS groundwater (0.014 mrem), rainwater (0.011 mrem), soil direct exposure (0.008 mrem), air inhalation (0.005 mrem), sediment exposure (0.003 mrem) primarily at boat landings, and swimming ingestion exposures (0.004 mrem). The only median (0.518 mrem) higher than the average (0.476 mrem) occurred in the edible mushrooms or fungi (all Cs-137). At Chernobyl the highest environmental dose rank occurred in individuals who consistently ate wild mushrooms (Botsch 1999).

Section 4.0 Figure 1 illustrates that public and environmental dose exposure can occur through many routes and pathways via atmospheric and liquid releases to various media. Section 4.0 Table 6 illustrates the 1999-2011 DOE-SR Percent of Total Dose potential to the MEI for the atmospheric and liquid pathways based on annual releases. The greatest potential dose exists in the inhalation, vegetation, cow milk, ground, and domestic meat pathways *when atypical dose (e.g. sportsman or survivalist dose) is not included*. SCDHEC Section 4.0 Table 7 illustrates that the dominant dose (mrem) exposure for the overall DOE-SR MEI for 1999-2011 on a median basis is from the sportsman pathways (onsite hunter 14.70 mrem, offsite hunter 8.30 mrem, offsite fisherman 0.52 mrem) versus the All-Pathway typical exposure (0.18 mrem).

SCDHEC data from dose accumulations in all media shows that dose exposure is dominated by the wild food (deer, hog, fish, fungi) pathway for the period 1999-2011 (Section 4.0 Figures 4, 5, 6, 7, 8) (Section 6.0 Table 2). Wild food dominates the dose exposure to the MEI. The SCDHEC recent addition of edible fungi (mushroom MAX dose was 1.903 mrem in 2011) and other edible native plants plus fungi shifts the emphasis of maximum exposure to include the atypical survivalist who takes advantage of all food sources. Figure 5 represents bioconcentrators of dose (highest dose media is wild food, animal or plant), Figure 6 represents exposure in the liquid pathway (minor dose media), and Figure 7 indicates trace air pathway dose contributions. Figure 8 shows the general agreement between DOE-SR and SCDHEC sportsman media, and the overall trend in sportsman media dose (declining). Figure 9 shows recent dose trends since SCDHEC added the wild edible plant and fungi pathways. The DOE-SR offsite dose estimate tends to be twice the SCDHEC AEI dose and the onsite hunter dose tracks near the SCDHEC MAX dose. Also, the upper bound for the combined program dose estimate averages 25 (± 3.7) mrem 2009-2011. DOE-SR did not collect fungi and few wild-type edible vegetation species during 1999-2011. Most of the SCDHEC dose detections in wild-type vegetation came from bolete and chanterelle mushrooms, and woody edible plant sources (not annuals). Annual plants are exposed mostly to seasonally absorbed surface dose. Perennial plants such as shrubs and trees have two or more years of exposure through extensive root and foliage absorptive areas, and long-lived fungi mycelia mats may have even greater absorptive surface for dose accumulations and/or bioconcentrations over many years. This accumulated dose is then passed on to the consumer of those sources. The data seems to indicate that the true MEI is primarily a survivalist who is also a sportsman.

Section 6.0 Table 2 gives individual media statistics for assigned dose to the MEI on an AEI basis without regard to applicability, and the media row total mrem, averages, and/or medians could be totaled for an individual optional scenario dose estimate for the period 1999-2011. The general non-sportsman public, for example, could total the medians for the most applicable media exposures (PWSRW 0.020 mrem, air 0.002 mrem, domestic vegetation 0.010 mrem, and milk 0.003 mrem) to obtain a 13 year public scenario median above background of 0.035 mrem (far less than a single year of TV cathode ray exposure). Also, the total exposure changes based on the public water source or private well used by the individual. The typical public risk is less than that from viewing TV for one year regardless of the water source used (Section 4.0 Table 2).

The hunter doses given in Section 6.0 are not scenarios, but merely game category combinations without additional dose from other media that might be applicable to total dose under a scenario. The unusual occurrence of identical values for the 2011 MAX Survivalist average and the 1999-2011 median may indicate that the central tendency for the SCDHEC MEI is now based on sufficient data (Section 4.0 Table 2).

Dose Critique

The median may be a more applicable reference for deciding the true central tendency in environmental data when media sample numbers are relatively large in size (Gilbert 1987). Random sampling in most SCDHEC media revealed that the environmental data detections are asymmetric and skewed to the left (most detections are low and near the origin) and the median of the population probably tends to be larger than the true mean. Most sampling resulted in <MDA determinations and were not included in the above statistics that used detections only. The use of detections only in statistics was protective, but distorts the true central tendency, which was the primary basis for concluding that the median was probably closer to the actual central tendency.

The DOE-SR study area shows a gradual downward exposure trend due to inactive SRS reactors and radioactive decay and dispersal processes. This trend can change based on new DOE-SR missions or outside influences from global atmospheric sources.
All dose was summarized by average, standard deviation, and median. The median may be a better indicator of the central tendency in environmental media dose compared to average dose

for large sample numbers due to:

1) the decrease in the central tendency without extremes;
2) the added conservancy present in selected dose factors;
3) the addition of dose based on single highest detections such as hog and deer worst-case game animal consumption;
4) the use of "detections only" for statistical analyses when many sample results were less than the detection limit;
5) the assignment of the higher dose to dual radionuclide determinations (e.g., the assignment of dose based on Sr-90 when the detection is for Sr-89/90 or total strontium);
6) the use of 0.00 mrem as background subtraction for <MDA data averages;
7) and the influence or potential of false positives (WSRC 2003a).

The NORM averages and maximums were not included in the dose estimates since this dose was part of the 300-mrem expected NORM for the study area. The yearly dose averages greater than background were based on SCDHEC detections only and are inflated since most sample results were less than the MDA. The justification for using detections only was to allow for undetected radionuclides and media. The justification for selecting higher source consumption levels was due to the consideration of the SCDHEC MEI as a survivalist type who consumed natural media at a greater than typical use rate. The basis for both considerations was to be protective of the public and environment. The inclusion of alpha and beta assumed dose in the past was excessive and not supported by media radionuclide species detections. The inclusion of calculations based on a single highest maximum detection for each radionuclide/media was a more definable basis for establishing an upper bound rather than the dose assumption of unknown alpha as Pu-239 and unknown beta as Sr-90. The SCDHEC 2007 Critical Pathway Dose Report noted that 38.50 % of the dose was assigned and represents a potential dose overestimate that may in fact be NORM detections (alpha and beta). Also, only 44.25% of the detected dose above background was potentially from SRS, if all NORM potentials were excluded. The SCDHEC dose calculations since then were still protective due to the use of detections only in determining dose, the calculation of a maximum dose for the MEI based on a single maximum detection for each radionuclide/media, and the use of very conservative consumption rates.

The AEI was given prominence as protective for general dose considerations, and the reader should be aware that the AEI dose estimate was conservative or biased high due to the use of 'detections only' in calculations and the use of very conservative consumption rates for the SCDHEC AEI. For example, the omission of <MDA assignments from calculations would raise any calculated number to a higher value. Alternatively, <MDA actually represents an undetermined low number that may be zero or any number up to the given MDA value for that analysis. All detected dose above background was assigned either to the AEI, MAX (the MEI), or NORM dose dependent on assignable cause that was based on knowledge of environmental sources, media, and locations (Section 4.0, Tables 1a,b and Section 5 Data). For example, the potential NORM dose for resuspended soils was not assignable as farmer inhalation, if not detected by air samplers (see atmospheric pathway section). The SCDHEC MEI was primarily a sportsman scenario because most potential dose was found in game animals and fish. However, the wild edible mushroom and plant consumer potential dose would add significant additional dose to the survivalist. The wild edible vegetation AEI dose exposure (0.424 mrem) was higher compared to domestic (0.009 mrem) edible vegetation (Section 6.0 Table 4). The MEI by

definition would consume the single highest maximum activity/isotope/media and defined a limit of potential dose based on detections only. This was done since SCDHEC sampling was limited and did not necessarily include the true yearly MEI exposure (due to undetected dose and/or dose accumulations) for the exceptional individual who may receive the MEI dose resident in the 50-mile perimeter study area. Thus, the dose limiting factors were biased high to be protective of the public and the environment, but realistic or limiting in that only measured radionuclides were used in calculations.

Specific radionuclide (speciated) doses were used in the estimated dose for 2011 except for the dose assignments of total strontium as Sr-90. The use of detections only, the calculation of dose based on a single maximum for each radionuclide/media, and high consumption levels, provide an elevated dose basis that is protective without the inclusion of screening value assumptions for alpha and beta. SCDHEC field detection dose accumulations over many years and DOE-SR yearly releases were not directly comparable and yet the potential MEIs calculated from both programs were close primarily due to the dominance of Cs-137 in the wild food pathway.

This project used dose instead of risk so that direct comparisons of dose magnitude can be made with similar media data published in the SRS Environmental Reports. Both the United States Environmental Protection Agency (USEPA) and SCDHEC use risk calculations when determining clean-up levels at Comprehensive Environmental Resource Compensation and Liability Act (CERCLA) and Resource Conservation Recovery Act (RCRA) sites. DOE-SR modeled radionuclide releases for a particular year were not directly comparable to SCDHEC yearly-detected dose in some media due to accumulation or biomagnification factors that may occur over many years.

3.0 CONCLUSIONS AND RECOMMENDATIONS

A very conservative estimate by SCDHEC of the average DOE-SR perimeter dose potential above background was only 2.258 mrem in 2011 (Section 4.0, Table 1). The dose to the general public that does not consume wild food is 0.288 mrem in 2011 and averages 0.079 (±0.067 mrem) with a median of 0.068 mrem over the last thirteen years. The 2011 public dose is higher than usual due to an I-131 detection in milk shortly after the Japan Fukushima Daiichi nuclear reactor explosions in 2011.

The survivalist MEI scenario should include all potential dose as a worst-case scenario. The SCDHEC MEI detected worst-case dose potential that excluded the South Carolina background and probable NORM was 11.447 mrem for the offsite dose in 2011. The SCDHEC MEI total potential dose was based on the single highest maximum detections/radionuclide/media in 2011 that included edible fungi, and was less than the dose typically received by living in a block house for two years (7 mrem/yr) (Section 4.0, Figure 2). Additional dose added primarily from DOE-SR onsite estimates for sportsmen increased the combined onsite and offsite dose potential to 29.77 mrem for the combined MEI. The SCDHEC MAX dose estimate represents an upper bound of all detected dose potential and is not potentially achievable unless all dose maximums could somehow be stored and maintained as a constant exposure throughout the year. This improbable combined MEI potential accumulated dose was less than the DOE-SR 100-mrem annual dose release standard to the public in 2011 despite contributions from other years dose and bioaccumulations (Section 4.0, Table 3). Most of the dose in the DOE-SR and SCDHEC estimates were due primarily to the Cs-137 occurrence in bioconcentrators of dose in the sportsman and wild food pathways.

The SCDHEC 2011 All-Pathway MAX dose estimates relative to the All-Pathway DOE standard atmospheric (0.006 mrem from air inhalation) and liquid (0.286 mrem from surface water ingestion at boat landings) pathways excluding the atypical dose pathways, were less than the respective 10 mrem and 4 mrem DOE Order 5400.5 limits (Section 4.0, Table 1) despite dose additions from other years inherent in field collected media. The DOE limits apply only to yearly DOE releases and not to dose accumulated in the environment and are not applicable to SCDHEC field detections. However, it is important to note that even the environmental accumulations over several years have not reached the DOE annual limits even when on a single highest detection basis instead of a yearly average. The All-Pathway DOE atmospheric and liquid estimates exclude atypical dose (game e.g.), which was captured under the total MEI estimate for comparison to the DOE defined dose limit for all annual dose releases to the public (100 mrem/yr). The SCDHEC estimates included atypical dose, which was primarily due to Cs-137 from ingested game animals. Inhalation was 0.114 % of the AEI dose to the critical pathway, ingestion was 99.681 %, and direct exposure was 0.206 % in 2011 (Section 4.0, Table 1a). The primary critical pathways for dose exposure were via atmospheric and liquid dose that was eventually ingested directly or indirectly from wild food sources, and the primary dose contributor was Cs-137 with minor contributions from strontium species, tritium, and I-131.

Two dose scenario estimates were updated based on SCDHEC data from 1999 through 2011 as an AEI dose above background. The medians were viewed as the best representation of the central tendency over the period 1999-2011, and were still protective estimates (see Dose Critique Section). The survivalist, who was a wild plant and mushroom consumer (new in 2008), received an average dose of 2.258 mrem in 2011 and averaged 1.746 (±0.885) mrem with a median of 1.874 mrem. The general public who ate domestic vegetation, but was not a sportsman or wild vegetation or mushroom consumer, and was not exposed to swamp soils, received less than 0.228 mrem of dose in 2011 and averaged 0.079 (±0.067) mrem with a median of 0.068 mrem (Section 4.0, Table 2). The general public dose was the exposure potential that the local population may have received within the study area and was a conservative and protective estimate (Section 2.0 Dose Critique).

Most of the 1999-2011 AEI dose was the result of atmospheric pathway deposits (61.91% or 13.929 mrem total) and the balance was from the liquid pathway route (38.09% or 8.571 mrem total) (Section 6.0, Table 3). The food ingestion subpathway contained mostly Cs-137 from wild food sources and contributed 90.10% or 20.272 mrem of dose from 1999 through 2011 primarily through the fish, hog, deer, fungi, wild vegetation, and milk ingested dose (Section 6.0 Table 4). The second highest dose subpathway was due to the nonpotable drinking water subpathway consumption (4.93 % or 1.110 mrem), primarily from tritium in ingested Savannah River water by sportsmen at boat landings near SRS. Direct exposure primarily from Cs-137 in Savannah River bank soil at public boat landings was the third major pathway (2.43% of dose or 0.547 mrem) due to tritium, public water supply sources were fourth (2.23% of dose or 0.502 mrem), and inhalation was fifth (0.31% or 0.069 mrem) primarily from tritium.

The dose rank comparison for all MEI assigned dose detections greater than 1% from 1999 through 2011 (Section 6.0 Table 1) were: Cs-137 (69.44%), total strontium (4.79%), and tritium (3.16%). These three radionuclides were the main contributors of dose primarily through the wild food pathway (atypical dose pathways). Tritium was the primary contributor of dose through the typical atmospheric and liquid pathways.

ESOP has increased sampling near the perimeter of SRS and in closer proximity to SRS tank farms, basins and seepage areas to ensure an early warning for any contaminant making its way to the SRS streams. New media sampling will be added in the future if needed. Edible fungi sampling was started in 2008 to address the concern for Cs-137 bioconcentration in edible mushrooms, and a wider variety of wild edible vegetation sources were added in 2011.

Potential atmospheric and liquid release concerns that may play a relatively larger role in the dose to the surrounding public in the future may include the following:

1) releases of americium-241 (Am-241), plutonium and uranium radionuclides from the Mixed Oxide Fuel Fabrication Facility (MFFF) through the air and surface water environmental mediums (Compagnie Generale des Martieres Nucleaires or COGEMA, Duke, Stone, & Webster 1998);
2) a high concentration of tritium predicted by computer models migrating from the Old Radioactive Waste Burial Ground (ORWBG) to Upper Three Runs (WSRC 2001) and/or the Savannah River;
3) and radionuclides such as carbon-14 (C-14), I-129, neptunium-237 (Np-237) and Tc-99 may be an ORWBG contaminant to monitor in the future because of their long half-lives.

These findings indicated that monitoring of the potential accumulations and bioconcentrations of dose should continue, especially within the sportsman food and wild edible food source subpathways, in addition to the primary inhalation, ingestion, and direct exposure routes from the typical atmospheric and liquid pathways. The down-gradient wells, surface water, sediments, plants, and animals should be carefully monitored for any signs of the contaminants that are present at tank farms, basins, and seepage areas. Early detection is paramount to protecting the public and the environment if a release to offsite streams or groundwater occurs. SCDHEC will continue to monitor the SRS and adjacent area for the primary radionuclide contributors to dose potentially associated with DOE-SR operations.

4.0 Tables and Figures
2011 Critical Pathway Dose Report

Table 1a. 2011 SCDHEC Non-Scenario Dose (mrem/yr) Estimates for Pathways, Exposure Routes, and Media

Pathways	Routes	Media	AEI[1]	MAX[2]	MAX minus AEI[3]
APW[4]	Inhalation	Air	*0.003*	*0.006*	0.004
APW	Inhalation	Resuspended Soil	*0.000*	*0.000*	*0.000*
LPW[4]	Inhalation	Resuspended Riverbank Sediment	*0.000*	*0.000*	*0.000*
AEI **%**	0.114	**Air Inhalation Totals**	**0.003**	**0.006**	0.004
LPW	Ingestion	Fish[5]	*0.497*	*1.914*	1.418
APW	Ingestion	Deer	*0.520*	*6.330*	5.810
APW	Ingestion	Hog	*0.510*	*1.010*	0.500
APW	Ingestion	Domestic Vegetable/Fruit	*0.009*	*0.012*	0.003
APW	Ingestion	Wild Vegetable/Fruit	*0.424*	*0.531*	0.107
APW	Ingestion	Milk	*0.203*	*0.205*	0.003
APW	Ingestion	Soil	*0.000*	*0.000*	*<MDA*
LPW	Ingestion	Riverbank Sediments	*0.005*	*0.016*	0.011
APW	Ingestion	Edible Fungi	*0.021*	*1.093*	1.072
AEI **%**	96.924	**Food Ingestion Dose Totals**	**2.188**	**11.111**	8.923
LPW	Ingestion	PWS River Water	0.013	0.015	0.002
LPW	Ingestion	PWS Wells	*0.000*	*0.000*	*0.000*
LPW	Ingestion	DNR GW Wells	*0.000*	*0.000*	*0.000*
LPW	Ingestion	SR Water at Boat Landings	*0.039*	*0.286*	0.247
APW	Ingestion	Rainwater	*0.017*	*0.042*	0.025
LPW	Ingestion	Swimming Ingestion	*0.023*	*0.028*	0.005
AEI **%**	underlined (2.757)%	**All DW Ingestion Dose Totals**	**0.093**	**0.371**	0.278
APW	Direct	Submersion (Cloud)	NS	NS	NS
APW	Direct	Absorption (Skin)	NS	NS	NS
LPW	Direct	Immersion (Swimming)	*0.000*	*0.000*	*0.000*
LPW	Direct	Sediment Wading (Skin)	*0.000*	*0.000*	*0.000*
APW	Direct	Ground Direct Exposure (Shine)	*0.000*	*0.000*	*0.000*
LPW	Direct	Boating	*0.000*	*0.000*	*0.000*
LPW	Direct	Riverbank (Shine)	*0.005*	*0.015*	0.010
LPW	Direct	Swamp Dweller Surface Water Shine	*0.000*	*0.000*	*0.000*
AEI **%**	0.206	**All Direct Exposure Dose Totals**	**0.005**	**0.015**	0.011
All-Sources[6] Dose (Upper Bound of Detections) Totals			2.289	11.504	9.216
Perimeter[7] Dose (Applicable Media Only Totals Underlined[8]) Totals			***2.258***	***11.447***	9.189
See Table 1b for critical pathway summary and notes. <MDA results are assigned as 0.000 mrem.					

Tables and Figures
2011 Critical Pathway Dose Report

Table 1b. 2011 SCDHEC Non-Scenario Dose (mrem/yr) Estimates for Pathways, Exposure Routes, and Media

Examples of maximum dose substitutions for an AEI media average result.				
Examples of adding	Replace Avg Deer with Max Deer	**8.068**	2.258 plus difference 5.810	
maximums to avg dose	Replace Avg Fish with Max Fish	**3.675**	2.258 plus difference 1.417	
Perimeter[8] Dose Detections Applicable to MEI				
Critical Pathway Summary of MEI Perimeter8 Dose (mrem)		**AEI[1]**	**MAX[2]**	**MAX minus AEI[3]**
The Atmospheric Pathway Perimeter Totals (**APW**)		1.69	9.187	7.497
The Liquid Pathway Perimeter Totals (**LPW**)		0.569	2.259	1.69
Perimeter[8] Critical Pathways Percent Contributions (%)		**AEI**	**MAX**	**MAX minus AEI[3]**
Atmospheric (**APW**) Pathway		**APW%**	**APW%**	
Percentage Totals for Perimeter Dose		74.812	80.264	5.452
Liquid (**LPW**) Pathway		**LPW%**	**LPW%**	
Percentage Totals for Perimeter Dose		25.188	19.736	-5.452
All-Sources[6] Dose (Upper Bound of Detections) Detections				
Critical Pathway Summary (mrem)		**AEI1**	**MAX2**	**MAX minus AEI[3]**
The Atmospheric Pathway Totals (**APW**) From All-Sources[6]		1.707	9.229	7.522
The Liquid Pathway Totals (**LPW**) From All-Sources[6]		0.582	2.274	1.692
ALL-Sources Critical Pathways Percent Contributions (%)		**AEI**	**MAX**	**MAX minus AEI[3]**
Atmospheric (**APW**) Pathway		**APW%**	**APW%**	
Percentage Totals for Perimeter Dose From All-Sources		74.574	80.231	5.657
Liquid (**LPW**) Pathway		**LPW%**	**LPW%**	
Percentage Totals for Perimeter Dose From All-Sources		25.426	19.769	-5.657

Table 1 Notes:
1 - AEI is the average radionuclide activity concentrations (dose) above background excluding NORM.
2 - MAX is the single highest (maximum) radionuclide activity concentration (dose) above background excluding NORM.
3 - Difference of values in AEI and MAX (highest single dose) columns.
4 - APW is the atmospheric pathway media and LPW is the liquid pathway media.
5 - Fish dose totals are based on the highest dose detection/radionuclide instead of fish species.
6 - All-sources refers to all detected dose except NORM without qualification as to its' applicability.
7 - Perimeter refers to the study area which is outside of DOE-SR boundaries and within 50-miles of an SRS center-point.
8 - The underlined DW ingestion total and AEI % comes from the total of the doses that are underlined. The maximum consumption rate can only be used with one drinking water (DW) source (highest underlined).
9 - Nonspecific screening level detections of alpha, beta, and beta-gamma were replaced by the MAX estimate.

Table 2. Dose Scenario Estimates

Scenarios in Millirem of Exposure	**2011**	**1999-2011**		
	Avg.	**Avg.**	**SD**	**Median**
Public[1]	0.228	0.079	0.067	0.068
MAX Survivalist[2]	**11.447**	10.164	4.874	**11.447**

Notes: Includes data corrections and the Japan release of I-131 affected all scenarios via milk dose.
1 – The public who is exposed only to the milk, air, domestic vegetation, and the highest public water supply AEI dose.
2 - The MAX survivalist adds all remaining maximums in place of the AEI dose (started in 2008). The exception is that only one drinking water maximum can be used. Equals the perimeter MAX dose total.
3 - Scenario results are not directly comparable to non-scenario results due to specified media/scenario, but the MAX Survivalist receives all of the perimeter nonscenario dose, which is the SCDHEC MEI.
4 - Data and scenario corrections through 2007 include updates for dividing edible vegetation into wild and domestic vegetation dose, and dividing surface soil and river bank sediments into direct and resuspened inhalation dose.
5 - **Bolded** data here notes the 2011 dose average similarity to the median value for thirteen years of sampled dose. This population central tendency is based on single highest dose assumptions that represent an outer bound estimate.

Tables and Figures
2011 Critical Pathway Dose Report

Table 3. 2011 MEI All-Pathway and Survivalist Potential Dose Comparisons to DOE-SR (mrem)

Pathway	Media Comparison Additional Dose	DOE-SR[1]	SCDHEC[2]	Add to SCDHEC[3]
All-Pathway	Liquid (PWS plus Air Table 1) plus Airborne[4]	0.21	0.02	0.189
Sportsman	Onsite Hunter	14.70	**NS**	14.700
	Creek Mouth Fish	0.07	1.91	0.000
	Offsite Hog	1.29	1.01	0.280
	Offsite Deer	0.74	6.33	0.000
	Hunter Soil Exposure[5]	2.90	0.00	2.900
	Fisherman Soil Exposure[6]	0.28	0.03	0.249
	Other Pathway[7] (Irrigation)	0.09	1.05	0.000
Mushroom Consumer	Edible Fungi[8]	**NS**	1.09	0.000
Totals	**SCDHEC MEI**	NA	**11.45**	NA
	Total Difference to be added for MEI	NA	**18.32**	**18.318**
	SCDHEC plus DOE-SR MEI Additions[9]	NA	**29.77**	NA

Notes:
1 - DOE-SR data primarily from Table 6-4 (SRNS 2011).
2 - SCDHEC Maximums or single highest detection basis for all media per route of exposure (Table 1).
3 - MEI all-source 2010 dose additions. Some DOE-SR offsite dose is based on computer modeling.
4 - Air inhalation plus LPW water source ingestion (PWS).
5 - APW soil sources were from Creek Plantation (DOE-SR) and other soil and sediment (SCDHEC).
6 - LPW soil and sediment sources (location differences).
7 - Highest Irrigation food pathways - milk, vegetable, meat, and recreational swimming ingestion sources
8 - Edible fungi dose from Cs-137 bioconcentration was highest in *Cantharellus* and *Boletus* spp.
9 - Biased high primarily due to single maximums (SCDHEC), assigned dose (DOE-SR), and released dose basis. Not all released dose is absorbed, and explains why field measurements do not detect all dose released.

Table 4. Sportsman versus Nonsportsman Food Comparison

2011		**1999-2011 mrem[6]**			
2011 AEI Food Categories	**Total mrem**	**Media**	**Avg.**	**SD**	**Median**
Game[4]	1.527	Fish,Deer,Hog	1.316	1.378	1.079
Nongame	0.636	All Veg and Milk	0.082	0.172	0.017
Fungi	0.021	Fungi	0.476	0.383	0.518
AEI All-Food Total[1]	**2.184**	**AEI All-Food Total[1]**	**1.874**	**NA**	**1.614**
MAX All-Food Total[1]	**11.095**	**MAX Game Total[1]**	**11.000**	**9.619**	**9.255**
Substitute MAX Deer/Hog for AEI Deer/Hog[2]	9.568	**2011 Food Type[5]**		**MAX**	**% of MEI[3]**
Substitute MAX Fish for AEI Fish[2]	3.676	Fungi Only		1.093	9.548
Substitute MAX Fungi for AEI Fungi[2]	3.330	Sportsman (fish, deer, hog)		9.254	80.842
Substitute MAX Domestic Veg for AEI Veg[2]	2.261	Public (vegetables and milk)		0.217	1.896
Substitute MAX Wild Veg for AEI Veg[2]	2.365	Survivalist (wild vegetation, fungi)		1.624	14.187
All Food MAX Totals[1]				**11.095**	**96.925**

Notes:
1 - The AEI All-Food totals and statistics are based on the AEI values from Section 4.0, Table 1.
2 - Examples of adding a single highest maximum in place of the AEI value.
3 - Food type % of MEI is on a MAX basis percent of the MAX Perimeter dose (11.447 mrem).
4 - Game animal (deer,fish,hog) consumption in 2011 had greatest effect on food dose followed by fungi, wild vegetation, milk, and domestic vegetation least.
5 - Food dose was 96.925% of the total MEI dose with sportsman media containing the most potential dose (80.842%), survivalist type food second (14.187%) with fungi (9.548%) being the main contributor, and only 1.896% from domestic food sources.
6 - Collection years vary for some media. See Summary Statistics Table 2.

Tables and Figures
2011 Critical Pathway Dose Report

Table 5. Variability in SCDHEC and DOE-SR Media Dose Pathway Maximums, 2011

Environmental Monitors	SCDHEC				DOE-SR[1]			
Pathways - - - - - - -	Air	Liquid	Soil	Food	Air	Liquid	Soil	Food
Media and mrem Dose[2]	Single Highest Dose				DOE-SR MEI			
Water		0.286				0.180		
Inhalation	0.006				0.032			
Combined Soil[3]			0.031				3.180	
Swimming		0.028				0.000		
Boating		0.000				0.000		
Milk (cow or goat)				0.205				0.013
Edible Vegetation				0.531				0.075
Creek Mouth Fish				1.914				0.068
Offsite Deer				6.330				0.740
Offsite Hog				1.010				1.290
Totals	0.006	0.314	0.031	9.990	0.032	0.180	3.180	2.186
Avg	0.006	0.105	0.031	1.998	0.032	0.060	3.180	0.437
SD	NA	0.158	NA	2.506	NA	0.104	NA	0.563
Median	0.006	0.028	0.031	1.223	0.032	0.000	3.180	0.072
2010 MEI Comparison	Media				Summary Statistics			
Program Standards (mrem)	Air (10)	Liquid(4)	Soil	Food	Totals(100)	Avg[4]	SD[5]	Median
SCDHEC	0.006	***0.314***	0.031	***9.990***	10.341	**2.585**	4.938	0.173
DOE-SR	***0.032***	0.180	***3.180***	2.186	5.578	**1.395**	1.543	1.183
Combined average	0.019	0.247	1.606	6.088	7.960	1.990	NA	0.678
and standard deviation	0.018	0.095	2.227	5.518	3.368	0.842	NA	NA
% of standard[6]	**0.320**	**7.850**	***Highest media across programs Total (Italics)***				***13.516***	is <100 mrem

Notes:

1. Used highest DOE-SR MEI estimates from air, liquid, goat, irrigation, and sportsman pathways of the Savannah River Site Environmental Report for 2011, SRNS-STI-2012-00200. The sum of highest dose potential across programs in these media (13.516 mrem) is > the SCDHEC MEI of 11.447 mrem.
2. Most media are not directly comparable due to annual release estimates versus field accumulations over several years.
3. The combined soil reflects dose from surface and riverbank soil (SCDHEC), swamp and Steel Creek soils (DOE-SR).
4. Avg is average.
5. SD is standard deviation.
6. Percent (%) of DOE annual air (10 mrem) and liquid (4 mrem) releases using highest program dose. The highest dose detections (include accumulations) from either program is < these standards. The 13.516 mrem total is far less than the outer bound based on SCDHEC maximum potential of 29.77 mrem. The combined average with standard deviation may approximate an expected range of media maximum dose.
7. The SCDHEC single highest dose is based on one MAX detection exposure assumed constant throughout the year.

Tables and Figures
2011 Critical Pathway Dose Report

Table 6. 1999-2011 DOE-SR Percent of Total Dose to the MEI for Atmospheric and Liquid Releases

MEI from Atmospheric Releases (MAXIGASP-SR Code) Percent of Total Dose													
DOE-SR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Plume	0.1	0.4	0.5	0.2	0.4	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0
Ground	1.0	1.7	0.7	2.1	1.7	1.6	2.3	6.4	3.8	0.30	3.2	2.7	4.5
Inhalation	48.3	45.7	42.6	41.0	33.5	43.4	42.7	41.6	41.1	43.20	41.1	47.0	36.3
Vegetation	44.4	41.9	44.1	44.5	51.9	39.4	40.7	46.3	39.6	39.32	38.7	32.2	42.4
Cow Milk	4.6	7.3	9.0	9.1	9.6	11.3	10.3	1.5	10.9	12.34	12.2	17.4	16.1
Meat	1.7	2.9	3.2	3.2	2.9	4.4	4.0	4.3	4.6	4.84	4.7	0.7	0.8

Cow Milk Pathway % Dose			
1999-2011	Avg	SD	Median
Plume	0.1	0.2	0.0
Ground	2.5	1.7	2.1
Inhalation	42.1	4.0	42.6
Vegetation	42.0	4.7	41.9
Cow Milk	10.1	4.2	10.3
Meat	3.3	1.4	3.2

MEI from Liquid Releases Percent of Total Dose													
DOE-SR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Fish	61.0	45.8	40.2	42.5	55.4	47.0	59.0	59.0	51.0	43.0	64.0	61.0	72.0
Water	38.5	53.9	59.5	57.2	44.2	53.0	41.0	41.0	49.0	57.0	36.0	39.0	27.0
Shoreline	0.4	0.3	0.3	0.3	0.4	<1	<1	<1	<1	<1	<1	<1	<1
Swimming	0.0	0.0	0.0	0.0	0.0	<1	<1	<1	<1	<1	<1	<1	<1
Boating	0.0	0.0	0.0	0.0	0.0	<1	<1	<1	<1	<1	<1	<1	<1

Potential MEI % Dose Liquid Releases			
1999-2011	Avg	SD	Median
Fish	53.9	9.8	55.4
Water	45.9	9.9	44.2
Shoreline	0.3	0.1	0.3
Swimming	0.0	0.0	0.0
Boating	0.0	0.0	0.0

Notes:
1 - See the list of acronyms for abbreviation definitions.
2 - Data accumulated from the DOE-SR SRS Environmental Reports for the listed years.
3 - The off-site hunter inclludes deer ad hog (when available) for his total.
4 - The DOE-SR All-Pathway dose is for the liquid and airorne pathways excluding the sportsman dose.

Table 7. 1999-2011 DOE-SR Committed Dose (mrem) for MEI and Sportsman Pathways (DOE-SR)

Path / Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All Pathway	0.28	0.18	0.18	0.18	0.19	0.15	0.13	0.20	0.10	0.12	0.12	0.11	0.21
Onsite Hunter	77.00	63.00	14.00	39.50	15.60	70.80	8.80	22.00	9.00	13.00	8.4	12.37	14.7
Offsite Hunter	9.10	10.10	4.93	16.60	5.60	21.70	8.30	9.60	4.80	8.60	4.44	3.27	3.64
Offsite Fisherman	0.61	1.18	0.64	0.62	0.66	0.71	0.52	0.52	0.50	0.37	0.38	0.40	0.35

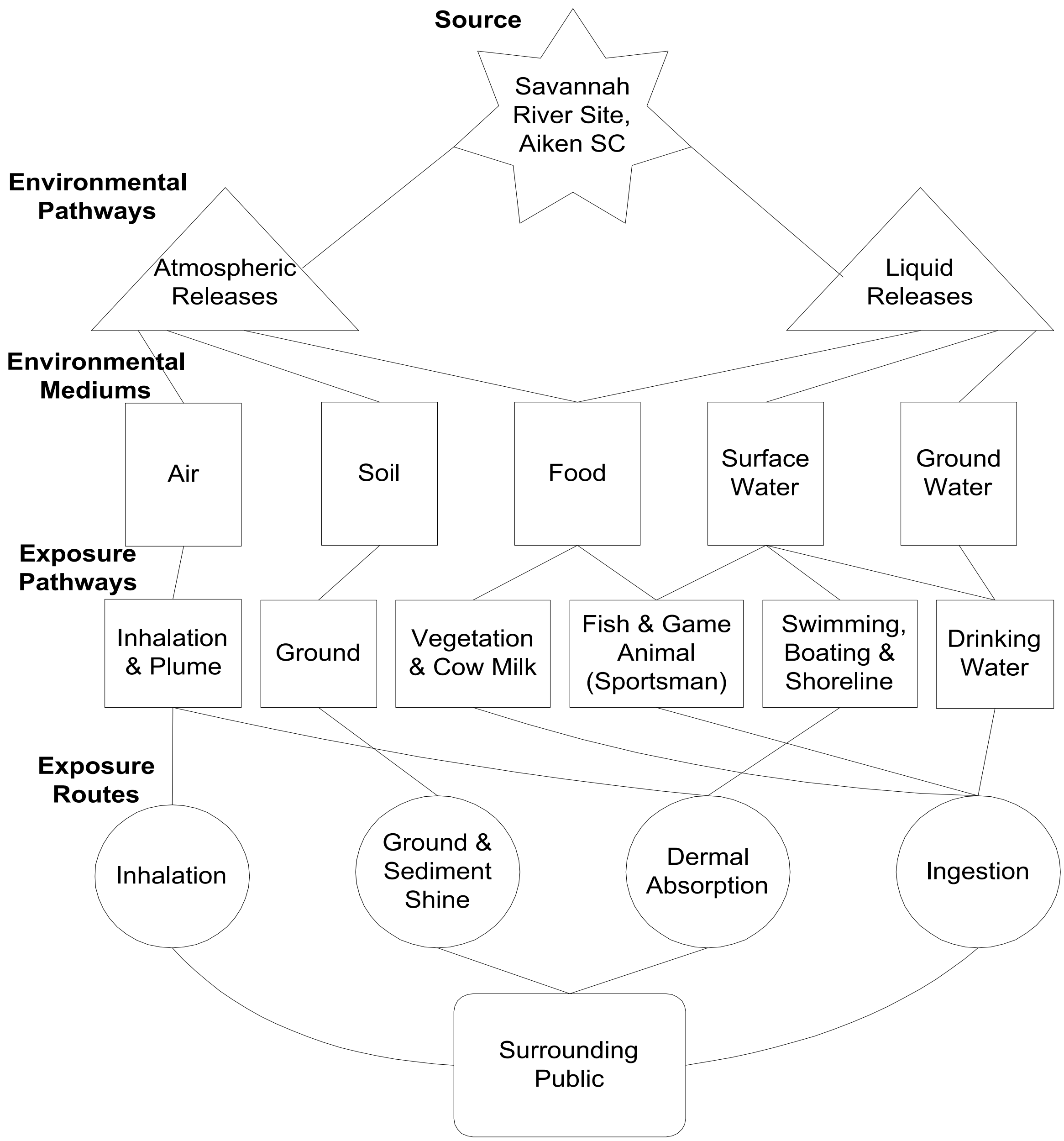
	Statistics			
1999-2011	Avg	SD	Median	
All Pathway	**0.17**	0.05	**0.18**	
Onsite Hunter	**28.32**	25.39	**14.70**	
Offsite Hunter	**8.51**	5.37	**8.30**	
Offsite Fisherman	**0.57**	0.22	**0.52**	
Total Potential Dose	**37.57**	**NA**	**23.70**	Median represents bulk of data central tendency estimate.

Notes:
1 - See the list of acronyms for abbreviation definitions.
2 - Data accumulated from the DOE-SR SRS Environmental Reports for the listed years.
3. The offsite hunter includes deer and hog (when available) for this total.
4. The DOE-SR All-Pathway dose is for the liquid and airborne pathways excluding the sportsman dose.

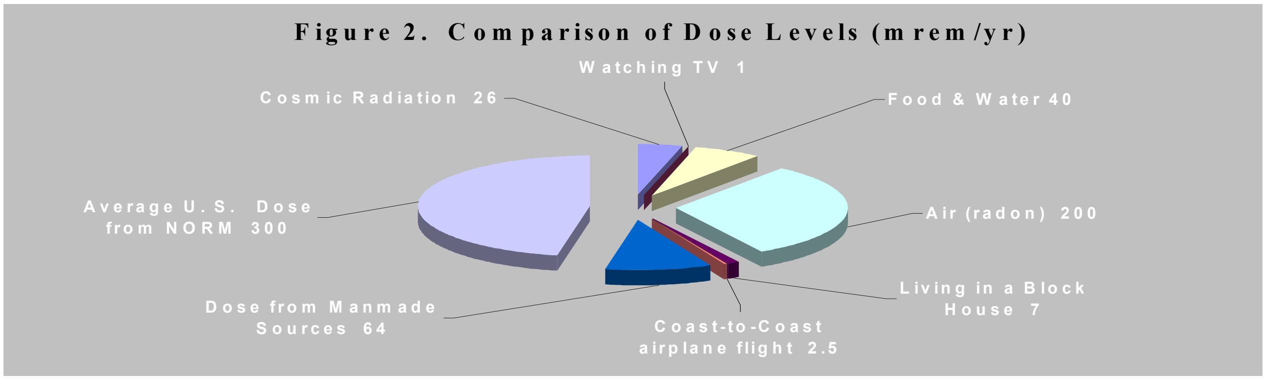
Tables and Figures
2011 Critical Pathway Dose Report

Figure 1. DOE-SR Critical Pathways and Dose Media

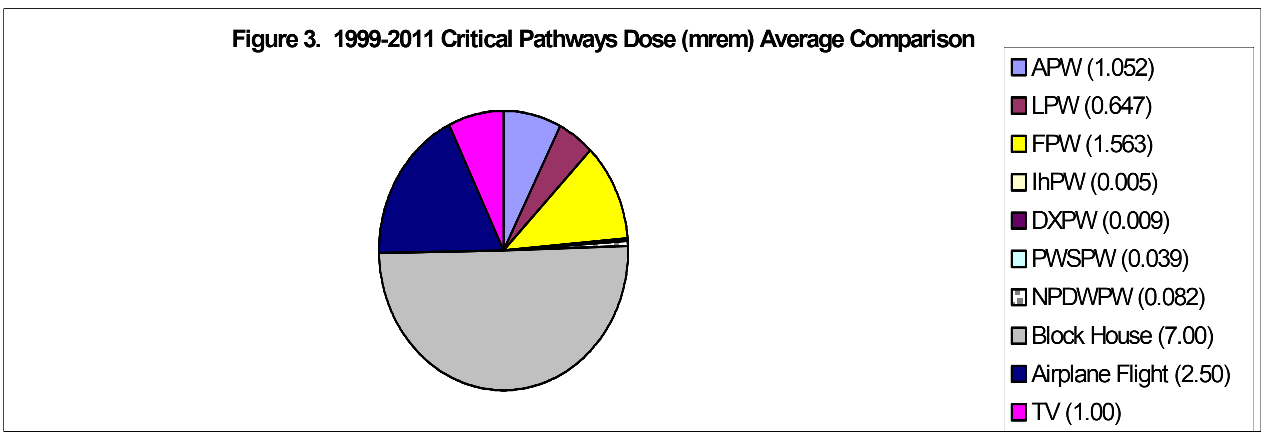
SRS Exposure Pathway



Tables and Figures
2011 Critical Pathway Dose Report



Notes:
1 – The average naturally occurring radioactive material (NORM) is 300 mrem/yr.
2 – Pie sections are relative to each other and not to percent of total.

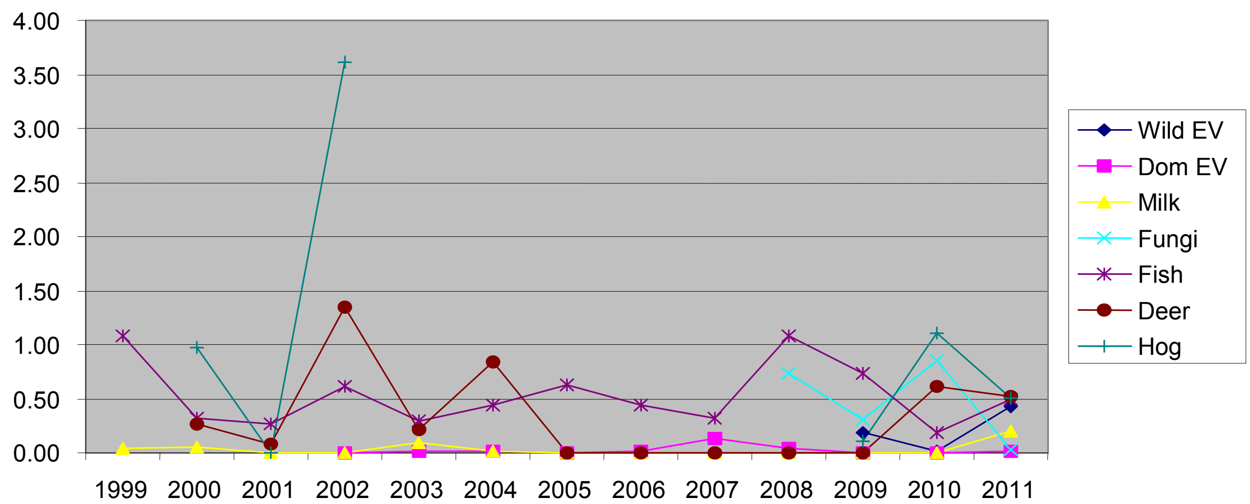


Notes: These pie sections are relative to each other.

1 - TV is the typical yearly dose exposure to watching cathode ray source TV (1 mrem).
2 - Airplante flight, coast-to-coast, results in a dose exposure of approximately 2.5 mrem.
3 - Block house is the typical exposure for living in a block house for one year (7 mrem).
4 - There are two major pathways (PW) for radiation exposure, APW (atmospheric pathway) and LPW (liquid pathway). The APW and LPW combined average exposure is less than that from a coast-to-coast airplane flight and only slightly greater than the FPW (food pathway) exposure. The FPW portion of the APW and LPW is 1.563/1.699 or 91.995 % of the period 1999-2011.
5 - The two major routes of exposure (APW and LPW) can be subdivided into five subpathways for the observed data. The observed potential dose exposure in SCDHEC samples occurred in the following subpathways: FPW (food), IhPW (inhalation), DXPW (direct exposure or shine), PWSPW (public water system pathways), and NPDWPW (nonpotable drinking water pathways). Wild game and wild vegetation consumption is the dominant exposure route for the SCDHEC MEI.
6 - Compare these relative dose levels with the higher NORM exposure levels in Figure 2. The average exposure during the years 1999-2011 was approximately 1.69 mrem above the NORM (300 mrem) background. The highly improbable SCDHEC MEI (maximum survivalist stored dose basis) that was exposed to all of the maximum detections in the environment for an entire year averaged 10.16 mrem or 3.39% of the NORM background (1999-2011).

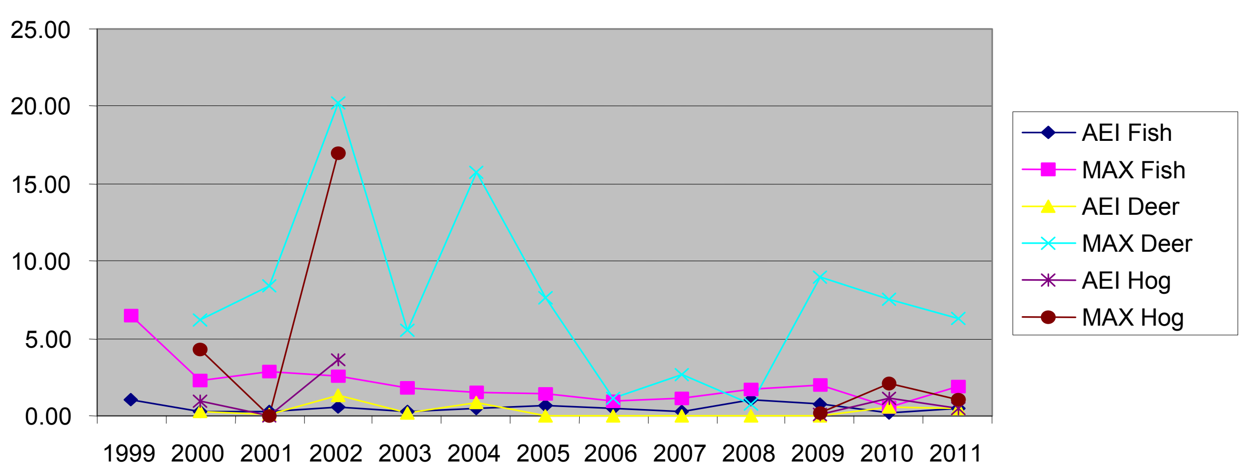
Tables and Figures
2011 Critical Pathway Dose Report

Figure 4. 1999-2011 AEI Food Media Trends (mrem)



Notes:
1 - The AEI food dose is typically less than 1.5 mrem.

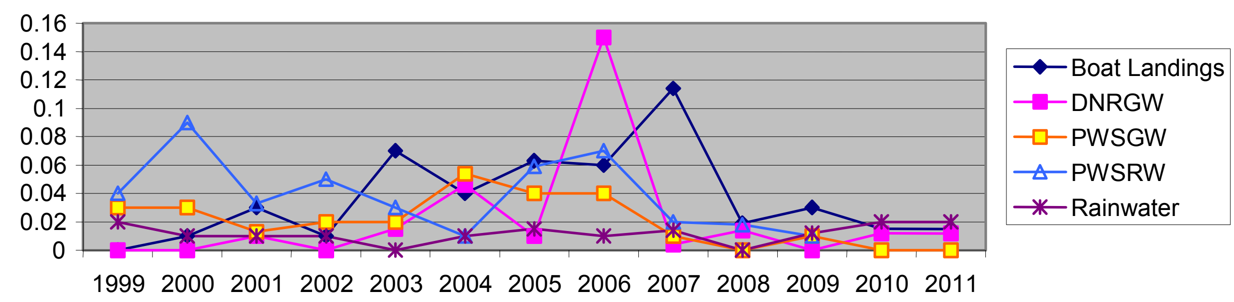
Figure 5. 1999-2011 AEI Versus MAX Dose (mrem) Trends in Sportsman Food Media



Notes:
1 - AEI is the average detected dose above a South Carolina background.
2 - MAX is the single highest maximum detected dose as if it occurred throughout the year.

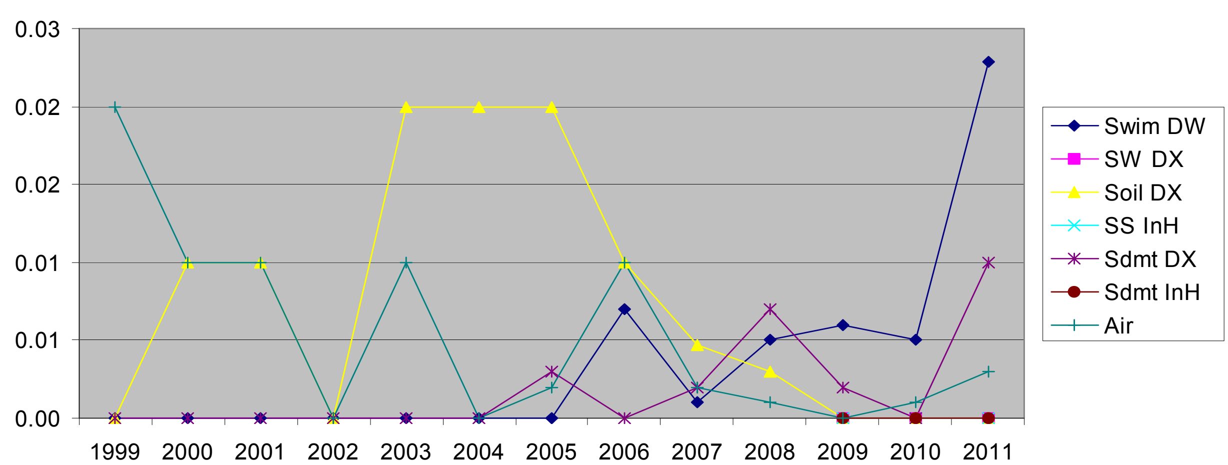
Tables and Figures
2011 Critical Pathway Dose Report

Figure 6. 1999-2011 AEI Dose Trends in Water Sources (mrem)



Notes:
1 - SWBL is surface water at boat landings
2 - DNRGW is Department of Natural Resources wellwater, and is comparable to private wells
3 - PWSGW is public water system system groundwater
4 - PWSRW is public water system river water sources
5 - RW is rainwater

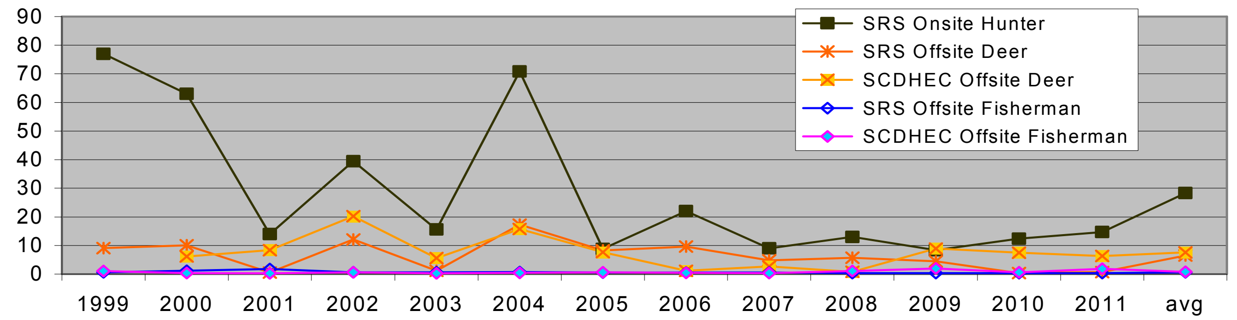
Figure 7. 1999-2011 AEI Trends in Minor Dose Media (mrem)



Notes:
1 - Swim DW means incidental drinking water while swimming.
2 - SW DX is direct exposure from surface water.
3 - Soil DX is direct exposure from soil.
4 - SS InH is the inhalation of resuspended surface soil.
5 - Sdmt DX is direct exposure from riverbank sediments.
6 - Sdmt InH is the inhalation of resuspended riverbank soil.

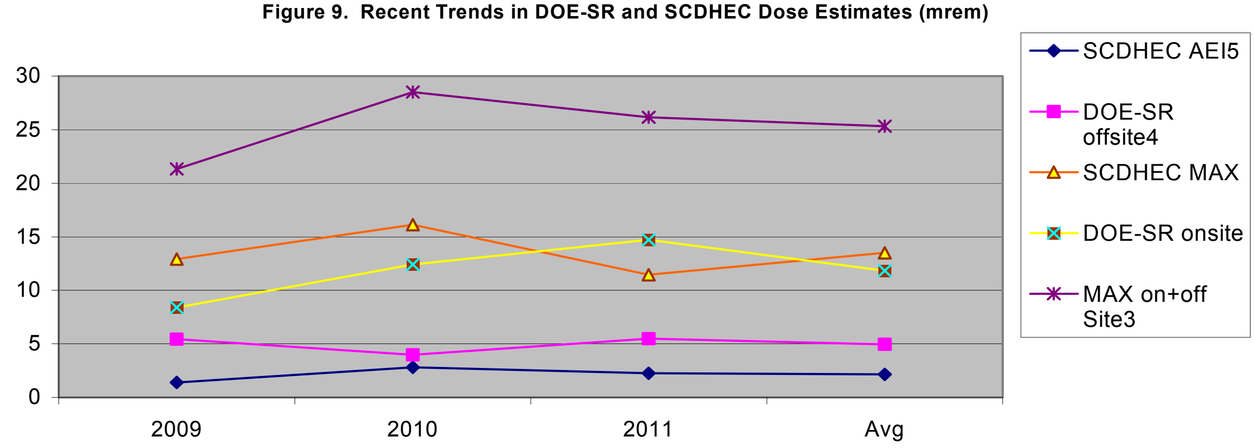
Tables and Figures
2011 Critical Pathway Dose Report

Figure 8. SCDHEC and DOE-SR Sportsman Maximum Dose Trend (mrem)



Notes:
1 - The average offsite deer dose (1999-2011) of SCDHEC and DOE-SR estimates are close (6.49 vs. 7.59 mrem).
2 - The average offsite fish dose (1999-2011) of SCDHEC and DOE-SR estimates are close (0.58 vs. 0.52 mrem).

Figure 9. Recent Trends in DOE-SR and SCDHEC Dose Estimates (mrem)



Notes: Comparison updated since the addition of wild edible vegetation and fungi.
1 - DOE-SR Table 6-4 (DOE-SR offsite and onsite) reference doses (SRNS 2012) of annual estimates.
2 - SCDHEC Table 1a (SCDHEC AEI and MAX) offsite reference doses (SCDHEC 2012) of 2009-2011.
3 - The upper bound of highest offsite and onsite (Both) dose potentials, 25.33 plus or minus 3.67 mrem (SD).
4 - DOE-SR offsite dose estimate tracks between the SCDHEC AEI and MAX dose estimates.
5 - SCDHEC detected offsite AEI dose accumulations are less than the annual DOE-SR estimates..
6 - Compare this DOE-SR onsite plus SCDHEC offsite combined estimate to Table 7 (all DOE-SR).
7 - Average over last three years dropped and median increased compared to the thirteen year statistics.

5.0 Data
2011 Critical Pathway Dose Report

2011 AVERAGE DOSE DETECTIONS IN FOOD MEDIA 37

2011 SINGLE HIGHEST DOSE DETECTIONS IN FOOD MEDIA 38

2011 AVERAGE DOSE DETECTIONS IN WATER MEDIA 39

2011 SINGLE HIGHEST DOSE DETECTIONS IN WATER MEDIA..... 40

2011 AVERAGE DOSE DETECTIONS IN SOIL AND AIR MEDIA 41

2011 SINGLE HIGHEST DOSE DETECTIONS IN SOIL AND AIR MEDIA 42

Notes:

1 – The following "Average Dose" data tables subtract an average background activity from the average activity of the listed radionuclide found in a media.

2 – The "Single Highest Dose" data tables subtract the same average background from the single highest maximum for a particular radionuclide found in a media.

3 – The resultant net activity is multiplied by a consumption rate and dose factors from USEPA FGR sources to obtain the dose result for a particular radionuclide and media source. The 2006 Dose Report and 2007 Critical Pathway Dose plan explain how these calculations result in a dose estimate in millirems per year.

4 – The last column/page gives the resultant dose that was assigned to the maximum exposed individual.

5 – Alpha, beta, and beta-gamma dose is no longer included since these are screening values with assigned dose for calculating an upper bound. The maximum dose from the single highest detected dose per radionuclide per media replaces this upper bound calculation with an actual detected radionuclide factor instead of an assigned substitute factor.

6 – See the list of acronyms, radionuclides, and units for abbreviation definitions.

7 - Section 4.0, Table 1 places the dose from media sources into applicable critical pathway categories. There are many crossover pathways; for example liquid dose can result in both direct exposure to the swimmer and water ingestion. Specific knowledge of the science, radionuclides, media, locations, and supporting media are required to properly assign dose as NORM or nonNORM. Only nonNORM dose is included in these tables.

8 – Calculations by SCDHEC are to three decimal places in millirem determinations and rounded as needed for appropriate comparisons to DOE-SR data.

9 – NORM activity is not included since total (Ttl) yearly NORM detections are far less than the 300 mrem average background.

10 – Edibility of wild plants is based on Porcher (1863, 2001) and fungi on Lincoff (1981).

11 – Data Table abbreviations are defined in the acronym section.

12 – All <MDA results are assigned as 0.000 mrem.

2011 Average Dose Detections in Food Media

Project	Isotope	AOC	SCBkg	Net	MCR	Dose	Summaries		MEI
Media		Activity	Activity	Activity		mrem	Species		Dose
Potential Dose from Fish Ingestion							Average	Totals	NonNORM
Fish		pCi/g	pCi/g	pCi/g	kg/yr	mrem	per Isotope		Basis
Bass	H-3	0.516	0.000	0.516	48.2	0.002	H-3	H-3	0.004
	Cs-137	0.232	0.050	0.182	48.2	0.439	0.002	0.008	
	Sr-89/90	0.100	0.060	0.040	48.2	0.023			
	Bass nonNORM dose average					0.154	Cs-137	Cs-137	0.470
Catfish	H-3	0.694	0.000	0.694	48.2	0.002	0.454	0.909	
	Cs-137	0.195	0.000	0.195	48.2	0.470			
	Sr-89/90	0.056	0.020	0.036	48.2	0.020	Sr-89/90	Sr-89/90	0.023
	Catfish nonNORM dose average					0.164	0.022	0.044	
Red Drum	H-3	0.228	0.000	0.228	48.2	0.001	per Fish		
	Mullet nonNORM dose average					0.001	Bass	0.463	
Mullet	H-3	1.191	0.000	1.191	48.2	0.004	Catfish	0.493	
	Red Drum nonNORM dose average					0.004	Red Drum	0.001	
							Mulllet	0.004	
	Average Dose for All Fish					*0.240*	*All Fish total*	*0.961*	
Potential Dose from Milk Ingestion									0.203
Cow		pCi/L	pCi/L	pCi/L	kg/yr	mrem	nonNORM in Cow Milk		
	H-3	0.000	0.000	0.000	230.0	0.000			
	Sr-89/90	1.035	0.849	0.186	230.0	0.001			
	I-131	16.490	0.000	16.490	230.0	0.202		Cow Milk Total	
	Cow milk nonNORM dose avg					0.068		0.203	
Avg Potential Dose From Game									1.030
Game Animal		Study Area Avg		Bkg Average		Annual	Avg Basis	Game Total	
Ingestion	Isotope	mrem		mrem		mrem	0.515	1.030	
Avg Deer	Cs-137	0.890		0.370		0.520			
Avg Hog	Cs-137	0.510		0.000		0.510			
	Game Animal nonNORM dose average					0.515			
Potential Dose from NonNorm in Edible Vegetation									
Edible Vegetation	Isotope	pCi/g	pCi/g	pCi/g	kg/yr	mrem	Leafy nonNORM Basis		0.077
All Leafy	H-3	0.547	0.000	0.547	73.0	0.003	Total	0.077	
All Leafy	Sr-89/90	0.112	0.027	0.085	73.0	0.074			
domestic only	Sr-89/90	0.028	0.027	0.001	73.0	0.001			
wild veg only	Sr-89/90	0.111	0.027	0.084	73.0	0.073			
Leafy Vegetables nonNORM Average						0.038	Fruit nonNORM Basis		0.356
All Fruit	H-3	0.331	0.000	0.331	276.0	0.006	Totals	0.356	
All Fruit	Sr-89/90	0.133	0.027	0.106	276.0	0.350			
wild fruit only	Sr-89/90	0.133	0.027	0.106	276.0	0.350			
Vegetable fruits nonNORM Average						0.178	Fungi nonNORM Basis		
Fungi	H-3	0.272	0.000	0.272	3.65	0.000	Totals	0.021	0.021
Fungi	Cs-137	2.270	2.157	0.113	3.65	0.021			
Fungi nonNORM Average						0.010			
All EV - average by type		0.076	All EV - totals by type			0.453	Total nonNORM		2.183

Table notes:

1 - Underlined data is the highest detection per isotope by media contributing to the stated MEI value.

2 - Fish total MEI dose is based on adding the highest values per each radionuclide regardless of fish species.

3 - These edible fungi were not identified to species level. Most boletes are edible and other edible fungi potential dose was added only as a special case representing a minority consumer of wild mushrooms.

4 - <LLD and <MDA are entered as a zero average detection.

5 - Statistics are based only on detections resultant dose and are biased high as a result.

2011 Single Highest Dose (MAX) Detections in Food Media

Project	Isotope	AOC	SCBkg	Net	MCR	Dose	Summaries		MEI
Media		Activity	Activity	Activity		mrem	Species		Dose
Potential Dose from Fish Ingestion							Average	Totals	NonNORM
Fish		pCi/g	pCi/g	pCi/g	kg/yr	mrem	per Isotope		Basis
Bass	H-3	1.162	0.000	1.162	48.2	0.004	H-3	H-3	0.004
	Cs-137	0.740	0.050	0.690	48.2	1.663	0.003	0.011	
	Sr-89/90	0.470	0.040	0.430	48.2	0.248			
	Bass non-NORM dose average					0.638	Cs-137	Cs-137	1.663
Catfish	H-3	0.967	0.000	0.967	48.2	0.003	1.193	2.386	
	Cs-137	0.300	0.000	0.300	48.2	0.723			
	Sr-89/90	0.070	0.036	0.034	48.2	0.020	Sr-89/90	Sr-89/90	0.248
	Catfish non-NORM dose average					0.249	0.134	0.268	
Red Drum	H-3	0.228	0.000	0.228	48.2	0.001	per Fish		
	Red Drum non-NORM dose average					0.001	Bass	1.914	
Mullet	H-3	1.191	0.000	1.191	48.2	0.004	Catfish	0.746	
	Mullet non-NORM dose average					0.004	Red Drum	0.001	
							Mullet	0.004	
	Average Dose for All Fish					*0.666*	*All Fish tota*	*2.664*	
Potential Dose from Milk Ingestion									0.205
Cow		pCi/L	pCi/L	pCi/L	kg/yr	mrem	H-3	I-131	
	H-3	0.000	0.000	0.000	230.0	<MDA	<MDA	0.202	
	Sr-89/90	1.964	0.849	1.115	230.0	0.003	Sr-89/90	Cow Total	
	I-131	16.490	0.000	16.490	230.0	0.202	0.003	0.205	
	Cow milk nonNORM dose avg					0.103			
Potential Dose From Game									7.340
Game Animal		Study Area Average		Bkg Average			Hunter Game MEI Total		
Ingestion		mrem		mrem		mrem	7.340		
MAX Deer	Cs-137	6.700		0.370		6.330	Based on 4 deer/1 hunter		
MAX Hog	Cs-137	1.010		0.000		1.010	Based on 2 hogs/1 hunter		
Hunter MEI	Cs-137	Deer & Hog				7.340	Based on deer+ hog		
Deer & Hog	Game Animal nonNORM dose average					3.670			
Potential Dose from NonNorm in Edible Vegetation									
Edible Vegeta	Isotope	pCi/g	pCi/g	pCi/g	kg/yr	mrem	Leafy nonNORM Basis		0.185
All Leafy	H-3	0.991	0.000	0.991	73.0	0.005	Totals	0.185	
All Leafy	Sr-89/90	0.233	0.027	0.206	73.0	0.180			
domestic only	Sr-89/90	0.028	0.027	0.001	73.0	0.001			
wild veg only	Sr-89/90	0.233	0.027	0.206	73.0	0.180			
Leafy Vegetables nonNORM Average						0.092	Fruit nonNORM Basis		0.357
All Fruit	H-3	0.418	0.000	0.418	276.0	0.007	Totals	0.357	
All Fruit	Sr-89/90	0.133	0.027	0.106	276.0	0.350			
wild fruit only	Sr-89/90	0.133	0.027	0.106	276.0	0.350			
Vegetable/Fruits nonNORM Average						0.179	Fungi nonNORM Basis		1.093
Fungi	H-3	0.272	0.000	0.272	3.7	0.000	Totals	1.093	
Fungi	Cs-137	8.145	2.157	5.988	3.7	1.093			
Fungi nonNORM avg						0.546			
All EV - average by type	0.272	All EV - totals by type				1.635	Total nonNORM		11.095

Table notes:

1 - Underlined data is the highest detection per isotope by media contributing to the stated MEI value.

2 - Fish total MEI dose is based on adding the highest values per each radionuclide regardless of fish species.

3 - These edible fungi were not identified to species level. Most boletes are edible and other edible fungi potential dose was added only as a special case representing a minority consumer of wild mushrooms.

4 - <LLD and <MDA are entered as a zero average detection.

5 - Statistics are based only on detections resultant dose and are biased high as a result.

2011 Average Dose Detections in Water Media

Project	Isotope	AOC	SCBkg	Net	MCR	Dose	Exposure Group	MEI
Water		Activity	Activity	Activity		mrem		Dose
Sources	Radionuclide Ingestion From Surface Water (SW) and Wells						Totals	(mrem)
PWSRW(DW)		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM in ……**	**0.013**
SW	**H-3**	**536**	250	**286**	730	**0.013**	**PWSRW(DW)**	
Savannah River Public Water Supplies (PWS) Drinking Water (DW) from the Savannah River (SR)								
Downstream river water near Savannah would be < surface water (SW) values below due to tributary dilutions.								
PWSGW(DW) Ingestion		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM in ……**	**0.000**
GW	**H-3**	0.000	**568**	**0.000**	730	0.000	**PWSGW(DW) Ingestion**	
Public Water Supplies with Groundwater (GW) Sources used for drinking water (DW)								
DNRGW		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM in ……**	**0.000**
GW	**H-3**	0.000	767	0.000	730	0.000	**DNRGW**	
DNR Monitoring Wells (comparable to local untreated private wells)								
Nonpotable DW		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM in ……**	**0.039**
SW	**H-3**	**1091**	250	**841**	730	**0.039**	SW	
Survivalist Ingestion of river water for drinking or cooking at Savannah River Boat Landings								
Rainwater	**H-3**	**373**	0	**373**	730	**0.017**	**NonNORM in ……**	**0.017**
Nonpotable Average Dose Potential from all sources.						0.028	Rainwater	
Streams and Savannah River Surface Water Samples Excluding PWSRW(DW)								
Surface Water Swimming		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM in ……**	**0.023**
Ingestion	**H-3**	**39523**	250	**39273**	91	**0.023**	**SW Swimming**	
Incidental ingestion of water while swimming at Savannah River Site Creek Mouths								
Surface Water Immersion		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM in ……**	**0.000**
Immersion	**H-3**	**39523**	250	**39273**	91	0.000	**SW Immersion**	
Direct exposure to the skin while swimming at SRS Creek Mouths.								
Surface Water Shine		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM in ……**	**0.000**
Boating	**H-3**	**39523**	250	**39273**	192	0.000	**Surface Water Shine**	
Direct exposure to skin from SRS Creek Mouth Water while Boating or Fishing.								
Surface Water Shine		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM in ……**	**0.000**
Resident	**H-3**	**39523**	250	**39273**	4380	0.000	**Surface Water Shine**	
Direct exposure to skin from surface water while living in a boat or swamp house.								
Sediment at Creek Mouths								
Skin Dose - Wading exposure from 1 cm sediment depth.							**NonNORM in ……**	**0.000**
Sediment Dose		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**Sediment Dose**	
Creek Mouths	**Cs-137**	**0.700**	0.060	**0.640**	91	0.000	Foot depression to	
Boat Landings	**Cs-137**	**0.200**	0.060	**0.140**	91	0.000	1 cm depth.	
Avg dose to skin from wading in sediments at creek mouths and landings is <0.000.							**Total nonNORM**	**0.093**

2011 Single Highest Dose (MAX) Detections in Water Media

Project	Isotope	AOC	SCBkg	Net	MCR	Dose	Exposure Group		MEI
Water		Activity	Activity	Activity		mrem			Dose
Sources	Ingestion							Totals	(mrem)
PWSRW(DW)		pCi/L	pCi/L	pCi/L	L/yr	mrem	NonNORM in......		0.015
SW	**H-3**	**576**	250	**326**	730	**0.015**	**PWSRW(DW)**		
Savannah River Public Water Supplies (PWS) Drinking Water (DW)									
Includes RW from Chelsea, Beaufort Jasper, and City of Savannah minus Jackson boat landing background.									
PWSGW(DW) Ingestion		pCi/L	pCi/L	pCi/L	L/yr	mrem	NonNORM in......		NA
GW	**H-3**	0.000	**568**	0.000	730	NA	**PWSGW(DW) Ingestion**		
Public Water Supplies with Groundwater (GW) Sources used for drinking water (DW)									
PWSGW(DW) Public Water Supplies from Wells.									
DNRGW		pCi/L	pCi/L	pCi/L	L/yr	mrem	NonNORM in......		<MDA
GW	**H-3**	0.000	**767**	**NA**	730	<MDA	**DNRGW**		
DNR Monitoring Wells (comparable to local untreated private wells)									
Nonpotable DW		pCi/L	pCi/L	pCi/L	L/yr	mrem	NonNORM in......		0.286
SW	**H-3**	**6365**	250	6115	730	**0.286**	**SW**		
Survivalist ingestionof river water for drinking or cooking at Savannah River Boat Landings									
Rainwater	**H-3**	**899**	0.000	**899**	730	**0.042**	NonNORM in......		0.042
Nonpotable Average Dose Potential from Rainwater and Boat Landings.						0.164	Rainwater		
Streams and Savannah River Surface Water Samples Excluding PWSRW(DW)									
Surface Water Swimming		pCi/L	pCi/L	pCi/L	hrs/yr	mrem	NonNORM in......		0.028
Ingestion	**H-3**	**47992**	250	**47742**	91	**0.028**	**SW Swimming**		
Incidental ingestion of water while swimming at Savannah River Creek Mouths									
Surface Water Immersion		pCi/L	pCi/L	pCi/L	hrs/yr	mrem	NonNORM in......		0.000
Immersion	**H-3**	**47992**	250	**47742**	91	0.000	**SW Immersion**		
Direct exposure to the skin while swimming at SRS Creek Mouths									
Average Dose from Skin Exposure to Creek Water						0.000			
Surface Water Shine		pCi/L	pCi/L	pCi/L	hrs/yr	mrem	NonNORM in......		0.000
Boating	**H-3**	**47992**	250	**6115**	192	0.000	**Surface Water Shine**		
Direct exposure to skin from SRS Creek Mouth Water while Boating or Fishing									
Surface Water Shine		pCi/L	pCi/L	pCi/L	hrs/yr	mrem	NonNORM in......		0.000
Resident	**H-3**	**47992**	250	**47742**	4380	0.000	**Surface Water Shine**		
Direct exposure to skin from surface water while living in a boat or swamp house.									
Sediment Random plus Nonrandom at Streams and Creek Mouths									
Skin Dose - Wading exposure from 1 cm sediment depth.							NonNORM in......		0.000
Sediment Dose		pCi/g	pCi/g	pCi/g	hrs/yr	mrem	Sediment Dose		
Creek Mouths	**Cs-137**	**1.300**	0.060	**1.240**	91	0.000	Foot depression of sediment		
Boat Landings	**Cs-137**	**0.310**	0.060	**0.250**	91	0.000	to 1 cm depth.		
Avg dose to skin from wading in sediments at creek mouths and landings is <0.000.							**Total nonNORM (mrem)**		**0.371**

2011 Average Dose Detections in Soil and Air Media

Project	Isotopes	AOC	SCBkg	Net	MCR	Dose	Exposure Group		MEI
Surface		Activity	Activity	Activity		mrem	nonNORM		Dose
Soil									Total
Surface Soil & Riverbank Soil Sample Detections									
Soil Ingestion									
Surface Soil (SS)		pCi/g	pCi/g	pCi/g	mg/day	mrem	NonNORM......		**0.000**
Ingestion	**Cs-137**	**0.110**	0.100	**0.010**	100	0.000	Surface Soil (SS)		
Represents potential dose from ingesting farm soil with plants.							**Avg**	**Totals**	
Surface Soil Ingestion Statistics - All nonNORM dose.							0.000	0.000	
Riverbank Soil (RS)		pCi/g	pCi/g	pCi/g	mg/day	mrem	NonNORM......		**0.005**
Ingestion	**Cs-137**	**2.680**	0.100	**2.580**	100	**0.005**	Riverbank Soil (RS)		
Riverbank Soil Ingestion Dose at Boat Landings.							**Avg**	**Totals**	
Riverbank Soil Ingestion Statistics - All nonNORM dose.							0.005	0.005	
Soil Shine Direct Exposure									
Surface Soil		pCi/g	pCi/g	pCi/g	hrs/yr	mrem	NonNORM......		**0.000**
Shine	**Cs-137**	**0.110**	0.100	**0.010**	4380	0.000	Surface Soil		
Radionuclide shine or direct exposure from farm soil.							**Avg**	**Totals**	
Surface Soil Direct Exposure Dose Statistics - All nonNORM dose.							0.000	0.000	
Riverbank Soil		pCi/g	pCi/g	pCi/g	hrs/yr	mrem	NonNORM......		**0.005**
Shine	**Cs-137**	**2.680**	0.100	**2.580**	4380	**0.005**			
Radionuclide shine or direct exposure from riverbanks.							**Avg**	**Totals**	
Riverbank Soil Direct Exposure Dose Statistics - All nonNORM dose.							0.005	0.005	
Atmospheric Inhalation									
Soil Resuspension and Air Inhalation Dose									
Surface Soil Resuspension		pCi/g	pCi/g	pCi/g	m3/yr	mrem	NonNORM......		**0.000**
	Cs-137	**0.110**	0.100	**0.000**	8000	**0.000**	**Avg**	**Totals**	
Surface Soil Resuspension All Inhalation Avg Dose							0.000	0.000	
Riverbank Soil Resuspension		pCi/g	pCi/g	pCi/g	m3/yr	mrem	NonNORM......		**0.000**
	Cs-137	**2.680**	0.100	**2.580**	8000	**0.000**	**Avg**	**Totals**	
Riverbank Soil Resuspension All Inhalation Avg Dose							0.000	0.000	
All Soil Resuspension (Surface Soil plus Riverbank)							**0.000**	0.000	
Air Inhalation		pCi/m3	pCi/m3	pCi/m3	m3/yr	mrem	NonNORM......		**0.003**
Inhalation	**H-3**	**4.894**	0.000	**4.894**	8000	**0.003**	**Avg**	**Totals**	
							0.003	0.003	
Atmospheric inhalation avg		**0.001**	**Atmospheric inhalation total**			**0.003**	**nonNORM total**		**0.012**

2011 Maximum Dose Detections in Soil and Air Media

Project	Isotopes	AOC	SCBkg	Net	MCR	Dose	Exposure Group		MEI
Surface		Activity	Activity	Activity		mrem	nonNORM		Dose
Soil									Total
Surface Soil & Riverbank Soil Random plus Nonrandom Sample Detections									
Soil Ingestion									
Surface Soil (SS)		pCi/g	pCi/g	pCi/g	mg/day	mrem	NonNORM……		0.000
Ingestion	Cs-137	0.170	0.100	0.070	100	0.000	Surface Soil (SS)		
Represents potential dose from ingesting farm soil with plants.							Avg	Totals	
Surface Soil Ingestion Statistics - All nonNORM dose.							0.000	0.000	
Riverbank Soil (RS)		pCi/g	pCi/g	pCi/g	mg/day	mrem	NonNORM……		0.016
Ingestion	Cs-137	8.630	0.100	8.530	100	0.016	Riverbank Soil (RS)		
Riverbank Soil Ingestion Dose at Boat Landings.							Avg	Totals	
Riverbank Soil Ingestion Statistics - All nonNORM dose.							0.016	0.016	
Soil Shine									
Surface Soil		pCi/g	pCi/g	pCi/g	hrs/yr	mrem	NonNORM……		0.000
Shine	Cs-137	0.170	0.100	0.070	4380	0.000	Surface Soil		
Radionuclide shine or direct exposure from farm soil.							Avg	Totals	
Surface Soil Direct Exposure Dose Statistics - All nonNORM dose.							0.000	0.000	
Riverbank Soil		pCi/g	pCi/g	pCi/g	hrs/yr	mrem	NonNORM……		0.015
Shine	Cs-137	8.630	0.100	8.530	4380	0.015	Riverbank Soil		
Radionuclide shine or direct exposure from riverbanks.							Avg	Totals	
Riverbank Soil Direct Exposure Dose Statistics - All nonNORM dose.							0.015	0.015	
Atmospheric Inhalation									
Soil Resuspension and Air Inhalation Dose									
Surface Soil Resuspension		pCi/g	pCi/g	pCi/g	m3/yr	mrem	NonNORM……		0.000
	Cs-137	0.170	0.100	0.000	8000	0.000	Avg	Totals	
Surface Soil Resuspension All Inhalation Avg Dose							0.000	0.000	
Riverbank Soil Resuspension		pCi/g	pCi/g	pCi/g	m3/yr	mrem	NonNORM……		0.000
	Cs-137	8.630	0.100	8.530	8000	0.000	Avg	Totals	
Riverbank Soil Resuspension All Inhalation Avg Dose							0.000	0.000	
All Soil Resuspension (Surface Soil plus Riverbank)							0.000	0.000	
Air Inhalation		pCi/m3	pCi/m3	pCi/m3	m3/yr	mrem	NonNORM……		0.006
Inhalation	H-3	12.100	0.000	12.100	8000	0.006	Avg	Totals	
							0.006	0.006	
Atmospheric inhalation avg		0.002	Atmospheric inhalation total			0.006	nonNORM total		0.037

6.0 Summary Statistics
2011 Critical Pathway Dose Report

Table 1. Radionuclides of Concern (Millirems and Percentages) 44
Table 2. The 1999-2011 AEI Media Statistics And MAX Special categories of Dose Potential (mrem/yr) 45
Table 3. 1999-2011 AEI Critical Pathways, Subpathways, and Potential Exposure Summary 45
Table 4. Food Media, AEI, and MAX Food Basis 46

Notes: Refer to the acronym section for definitions.

Summary Statistics
2011 Critical Pathway Dose Report

Summary Statistics Table 1. Radionuclides of Concern (Millirems and Percentages).

1999-2011	Sum	%	Avg	SD	Median	Max	D#
Totals	**32.014**	**99.64**	**1.941**	**2.050**	**1.246**	**8.349**	**197**
Cs-137	**22.311**	**69.44**	**0.496**	**0.785**	**0.280**	**4.770**	**45**
Ra-226	5.084	15.82	0.462	0.517	0.189	1.390	11
H-3	**1.014**	**3.16**	**0.012**	**0.013**	**0.008**	**0.057**	**83**
Sr-89/90	**0.870**	**2.71**	**0.062**	**0.084**	**0.016**	**0.231**	**14**
Ac-228	0.714	2.22	0.102	0.053	0.109	0.183	7
Sr-90	**0.460**	**1.43**	**0.092**	**0.186**	**0.009**	**0.424**	**5**
U-238	0.443	1.38	0.055	0.128	0.008	0.372	8
Sr-89	**0.209**	**0.65**	**0.052**	**0.078**	**0.019**	**0.169**	**4**
I-131	**0.202**	**0.63**	**0.202**	NA	**0.202**	**0.202**	**1**
Ra-228	0.185	0.58	0.093	0.018	0.093	0.105	2
U-234	0.177	0.55	0.089	0.084	0.089	0.148	2
Eu-155	0.119	0.37	0.060	0.074	0.060	0.112	2
Zn-65	0.073	0.23	0.073	NA	0.073	0.073	1
Th-234	0.057	0.18	0.029	0.023	0.029	0.045	2
U-235	0.047	0.15	0.016	0.005	0.017	0.020	3
Am-241	0.040	0.12	0.040	NA	0.040	0.040	1
Am-243	0.003	0.01	0.003	NA	0.003	0.003	1
Pu-239/240	0.002	0.01	0.001	0.000	0.001	0.001	2
Zr-95	0.002	0.01	0.002	NA	0.002	0.002	1
Pu-238	0.001	0.00	0.001	NA	0.001	0.001	1
Tc-99	0.001	0.00	0.001	NA	0.001	0.001	1
2011	**Sum**	**%**	**Avg**	**SD**	**Median**	**Max**	**D#**
Totals	**2.289**	**100.00**	**0.742**	**NA**	**0.724**	**1.185**	**19**
Cs-137	**1.521**	**66.45**	**0.380**	**0.240**	**0.490**	**0.520**	**4**
Sr-90	**0.448**	**19.57**	**0.149**	**0.238**	**0.023**	**0.424**	**3**
I-131	**0.202**	**8.82**	**0.202**	NA	**0.202**	**0.202**	**1**
H-3	**0.118**	**5.16**	**0.011**	**0.012**	**0.009**	**0.039**	**11**
Primary Contributors to Dose Exposure Greater Than Background							
1999-2011	**Sum**	**%**		**2011**	**Sum**	**%**	
Totals	25.066	100.00		Totals	2.289	100.00	
Cs-137	22.311	89.01		**Cs-137**	1.521	66.45	
H-3	1.014	4.05		**Sr-90**	0.448	19.57	
Sr-89/90	0.870	3.47		**I-131**	0.202	8.82	
Sr-90	0.460	1.84		**H-3**	0.118	5.16	
Sr-89	0.209	0.83					
I-131	0.202	0.81					

Notes: All data is AEI basis.
1 - Radionuclides shown in bold are the major contributors to nonNORM dose.
2 - This table is not directly comparable to other tables for this summary is based on all media detections and is reduced to radionuclides related to DOE-SR atmospheric, liquid, diffuse, and fugitive releases.
3 - NORM radionuclide detections not of concern (e.g. K-40) are not included in this chart.
4 - D# refers to number of detections and is not the total N# or number of samples.
5 - This table and others include updates of past errors (minor).

Summary Statistics
2011 Critical Pathway Dose Report

Summary Statistics Table 2. The 1999-2011 AEI Media Statistics and MAX Special Categories of Dose Potential (mrem/yr)

Media	Totals	AEI % Basis	Avg.	SD	Median	N#yrs
AEI BASIS (Based on Average Detection per Year Above South Carolina Background)						
SWBL	0.663	2.948	0.051	0.028	0.040	13
DNRGW (2003-2011)	0.251	1.116	0.028	0.048	0.012	9
PWSGW	0.186	0.827	0.014	0.019	0.009	13
PWSRW	0.316	1.406	0.026	0.020	0.020	13
Rainwater	0.148	0.660	0.011	0.006	0.010	13
Swimming Ingestion	0.047	0.208	0.004	0.006	0.000	13
Swimming Direct Exposure	0.000	0.000	0.000	0.000	0.000	3
Soil Direct Exposure	0.353	1.569	0.008	0.008	0.005	13
Soil Resuspension Inhalation	0.000	0.000	0.000	0.000	0.000	3
Sediment Direct Exposure	0.194	0.862	0.001	0.002	0.000	13
Sediment Riverbank Resuspension	0.000	0.000	0.002	0.003	0.000	3
Air	0.069	0.307	0.005	0.006	0.002	13
Wild Type Edible Vegetation	0.619	2.751	0.206	0.208	0.186	3
Domestic Garden Vegetation	0.227	1.009	0.023	0.041	0.010	10
Milk	0.416	1.849	0.032	0.059	0.003	13
Edible Fungi (2008-2011)	1.905	8.465	0.476	0.383	0.518	4
Fish[2] (1999-2011)	6.914	30.728	0.532	0.289	0.440	13
Deer[2] (2000-2011)	3.887	17.276	0.324	0.431	0.145	12
Hog[2] (2000-2002,2009-2011)	6.305	28.022	1.051	1.335	0.740	6
Totals	**22.500**	**100.00**	2.794	NA	2.140	NA
MAX BASIS (Single Highest Detection Assumed Effective for One Year) = Potential Upper Bound						
MAX Deer[2]	91.095	NA	7.591	5.634	6.926	12
MAX Hog[2]	24.530	NA	4.088	6.496	1.565	6
MAX Fish[2]	27.380	NA	2.106	1.467	1.768	13
MAX Fungi	9.748	NA	2.437	2.130	1.526	4
Offsite Hunter MAX	115.625	**NA**	9.635	9.652	8.000	12
Offsite Hunter AEI	10.192	**NA**	0.849	1.426	0.156	12

Note:
1 - This table is not directly comparable to Table 1.
2 - Offsite Hunter MAX and Hunter AEI are relative to the MAX Sportsman and AEI Sportsman, respectively.

Summary Statistics Table 3. 1999-2011 AEI Critical Pathways, Subpathways, and Potential Exposure Summary

Critical Pathways Dose Totals 1999-2011		Millirems	% of Total
Atmospheric Pathway (APW)[1]		13.929	61.91
Liquid Pathway (LPW)[2]		8.571	38.09
Subpathways	Food or Ingestion (FPW)[3]	20.272	90.10
	Inhalation (IhPW)[4]	0.069	0.31
	Direct Exposure (DXPW)[5]	0.547	2.43
	Public Water Supply (PWSPW)[6]	0.502	2.23
	Nonpotable Drinking Water (NPDWPW)[7]	1.110	4.93

Notes:
1 – APW is the atmospheric pathway inhalation plus deposition dose.
2 – LPW is the liquid pathway or water dose.
3 – FPWis the food subpathway.
4 – IhPW is the inhalation subpathway.
5 – DXPW is the direct exposure subpathway.
6 – PWSPW is the public water systems drinking water subpathway.
7 – NPDWPW is the nonpotable or untreated drinking water subpathway.
8 - Does not include alpha, beta, or beta-gamma since they are nonspecific screening values.

Summary Statistics
2011 Critical Pathway Dose Report

Summary Statistics Table 4. Food Media, AEI, and MAX Food Basis

AEI Food Basis Dose Statistics								
Route	Pathway	Media	2011	All Yrs MREM and %		Avg.	SD	Median
APW	FPW	Wild EV 2009-11	0.424	0.619	73.17	0.206	0.208	0.186
APW	FPW	Domestic EV	0.009	0.227	26.83	0.023	0.041	0.010
EV Pathway		Totals	0.433	0.846	100.00	NA		
APW	FPW	All EV 2002-11	0.433	0.846	4.17	0.085	0.138	0.012
APW	FPW	Milk	0.203	0.416	2.05	0.032	0.059	0.003
APW	FPW	Fungi	0.021	1.905	9.40	0.476	0.383	0.518
LPW	FPW	Fish	0.497	6.914	34.10	0.532	0.289	0.440
APW	FPW	Deer	0.520	3.887	19.17	0.324	0.431	0.145
APW	FPW	Hog	0.510	6.305	31.10	1.051	1.335	0.740
Food Pathways		Totals	2.183	20.272	100.00	NA		
MAX Food Basis Dose Statistics								
Route	subPW	Media	2011	All Yrs MREM and %		Avg.	SD	Median
APW	FPW	MAX Deer	6.330	91.095	63.701	7.591	5.634	6.926
APW	FPW	MAX Hog	1.010	24.530	17.153	4.088	6.496	1.565
APW	FPW	MAX Fish	1.915	27.380	19.146	2.106	1.467	1.768
Sportsman Pathway		Totals	9.255	143.005	100.00	NA		
APW	FPW	MAX Fungi	1.093	9.748	92.014	2.437	2.130	1.526
APW	FPW	MAX EV	0.433	0.846	7.986	0.197	0.203	0.132
Vegetation Pathway		Totals	1.526	10.594	100.00	NA		
AEI Food Category Dose Statistics Comparison								
Food Category			2011	Sum of All Yrs				
AEI nonGame (EV,Milk,Fungi) Food			0.656	3.166				
AEI All Game Food (Fish,Deer,Hog)			1.527	17.106				
MAX Sportsman Food (Fish,Deer,Hog)			9.255	143.005				
Hunter MEI (Game-Deer plus Hog)			7.340	115.625				

Notes:

1 - Summary Percentages are relative to food category totals only (e.g., wild and domestic edible vegetation or EV).

2 - APW (atmospheric depositions or inhalation), LPW (liquid pathway consumption), FPW (Food Pathway)

3 - AEI (average exposed individual basis), MAX (single highest exposure basis), MEI is total of MAX.

LIST OF ACRONYMS

AEI	Average Exposed Individual
AOC	Area of Concern
APW	Atmospheric Pathway
AVG	Average
CERCLA	Comprehensive Environmental Resource Compensation and Liability Act
COGEMA	Compagnie Generale des Martieres Nucleaires
D#	Detection number
DNRGW	Department of Natural Resources Groundwater Wells
DOE-SR	Department of Energy - Savannah River
DW	Drinking Water
DXPW	Direct Exposure Pathway
EV	Edible Vegetation
ESOP	Environmental Surveillance and Oversight Program
FPW	Food Pathway
GW	Groundwater
InH	Inhalation
IhPW	Inhalation Pathway
LLD	Lower Limit of Detection
LPW	Liquid Pathway
MAX	Single highest maximum detection
MCR	Maximum consumption rate
MDA	Minimum Detectable Activity
MEI	Maximum Exposed Individual
MFFF	Mixed Oxide Fuel Fabrication Facility
NA	Not Applicable
N#	Number of Samples
NORM	Naturally Occurring Radioactive Material
NPDWPW	Nonpotable Drinking Water Pathway
ORWBG	Old Radioactive Waste Burial Ground
PWSGW	Public Water System Groundwater Wells
PWSPW	Public Water System Pathway
PWSRW	Public Water System River Water
RCRA	Resource Conservation Recovery Act
RW	River Water
SCBKG	South Carolina Background
SCDHEC	South Carolina Department of Health and Environmental Control
SD	Standard Deviation
SRS	Savannah River Site
SRNS	Savannah River Nuclear Solutions
SSRS	Surface Soil Resuspension
SW	Surface Water
SWBL	Surface Water at Boat Landings
TLD	Thermoluminescent Dosimeter
TV	Television cathode ray tube

USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency

UNITS OF MEASURE

hrs/yr	hours per year
kg/yr	kilograms per year
L/yr	liters per year
m^3/yr	cubic meters per year
mrem	millirem or milliroentgen equivalent man
mg/day	milligrams per day
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m^3	picocuries per cubic meter
%	percent
person-rem/y	Person-roentgen equivalent man per year
±	plus or minus one standard deviation unless stated otherwise
<	less than

REFERENCES

ANS. 2011. Fukushima Daiichi: ANS Committee Report. American Nuclear Society Timeline, http://fukushima.and.org/appendices.

Baum, et. al. 2009. Seventeenth Edition Nuclides and Isotopes. Chart of the Nuclides. Copyright © 2010, Bechtel Marine Propulsion Corporation. Revised by Knolls Atomic Power Laboratory 2009. Baum E, Ernesti M., Knox H, Miller T, Watson A.

Botsch. 1999. Investigation of the Radiation Exposure of Inhabitants of Contaminated Areas in Northern Ukraine. Center for Radiation Protection and Radioecology, University of Hanover, Germany and the State Agroecological Academie of Ukraine, Ukraine.

CDC. 2004. "Draft for Public Comment" of Phase III Savannah River Site (SRS) Dose Reconstruction Project for the SRS Health Effects Subcommittee (SRSHES). Radiation Studies Branch, National Center for Environmental Health, Centers for Disease Control and Prevention of the U. S. Department of Health and Human Services.

Duke, Cogema, Stone & Webster, 1998. Mixed Oxide Fuel Fabrication Facility Environmental Report. Charlotte, North Carolina. Docket number 070-03098.

Gilbert. 1987. Statistical Methods For Environmental Pollution Monitoring, Richard O. Gilbert. Pacific Northwest Laboratory. John Wiley & Sons, Inc. 1987, ISBN 0-471-28878-0.

Kalac. 2001. A Review of Edible Mushroom Activity**.** Food Chemistry 75 (2001) 29-35. **www.elsevier.com/locate/foodchem.**

Lincoff. 1981. National Audubon Society Field Guide to North American Mushrooms**.** National Audubon Society Field Guides. By Gary Lincoff. Knopf publisher 1981.

Manzoli, 2004. Current Epidemiological Evidence Regarding the Health Effects of Low-Dose Ionizing Radiation. Manzoli L, Romano F, Schioppa F, D'Ovidio C, Lodi V, and Pirone GM. Sanita Pubbl. 2004, Jan-Apr, 60 (1-2): 81-102.

Porcher, 2001. A Guide to the Wildflowers of South Carolina. By Richard Dwight Porcher and Douglas Alan Rayner. University of South Carolina Press ISBN 1-57003-438-9.

Porcher, 1863. Resources of the Southern Fields and Forests, Medical, Economical, and Agricultural. Being Also a Medical Botany of the Confederate States; with Practical Information on the Useful Properties of the Trees, Plants, and Shrubs: by Porcher, Francis Peyre, Surgeon P. A. C. S. Charleston, Steam-Power Press of Evans & Cogswell, No. 3 Broad Street. 1863. 2000 Electronic First Edition: ©This work is the property of the University of North Carolina at Chapel Hill. It may be used freely by individuals for research, teaching, and personal use as long as this statement of availability is included in the text. Academic Affairs Library, Call number 3041 Conf. (Rare Book Collection, University of North Carolina at Chapel Hill). The electronic edition is a part of the UNC-CH digitization project, Documenting the American South.

SCDHEC. 1999. Standard Operating Procedures for the Environmental Surveillance and Oversight Program, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina .

SCDHEC. 1999-2011. South Carolina Department of Health and Environmental Control Environmental Data Reports, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina .

SCDHEC. 2001. Environmental Surveillance and Oversight Program Field Monitoring Procedures, Bureau of Environmental Services Environmental Surveillance and Oversight Program, Aiken, South Carolina .

SCDHEC. 2006. South Carolina Department of Health and Environmental Control Internet site. http://www.scdhec.net/environment/water/radium.html.

SCDHEC. 2011. 2011 Critical Pathway Dose Project Plan, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SRNS. 2009. **Savannah River Nuclear Solutions, LLC (SRNS).** Savannah River Site Environmental Report for 2008. Savannah River Site. Aiken, SC. SRNS-STI-20102-00175.

SRNS. 2010. Savannah River Site Environmental Report for 2009. Savannah River Site, Savannah River Site. Aiken, SC. SRNS-STI-2009-00100.

SRNS. 2011. Savannah River Site Environmental Report for 2010. Savannah River Site, Aiken, SC. SRNS-STI-2011-00059.

SRNS. 2012. Savannah River Site Environmental Report for 2011. Savannah River Site, Aiken, SC. SRNS-STI-2012-00200.

Till, J.E., et al. 2001. Savannah River Site Environmental Dose Reconstruction Project, Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval, Evaluation of Materials Released From the Savannah River Site. RAC Report No. 1-CDC-SRS-1999-Final. Risk Assessment Corporation (RAC).

United States Department of Health and Human Services (USDHHS) 1998. Accidental Radioactive Contamination of Human Food and Animal Feeds: Recommendations for State and Local Agencies. Radiation Programs Branch, Food and Drug Administration, Center for Devices and Radiological Health, Rockville, Maryland.

White, Robert G., Holleman, Dan F., and Allaye-Chan, Ann C. 1986. Radiocesium Concentrations in the Lichen-Reindeer/Caribou Food Chain: Before and After Chernobyl, Institute of Arctic Biology, University of Alaska, Fairbanks, Alaska. Rangifera, 1986, No. 1 Appendix.

WSRC. 1999. Savannah River Site Environmental Report for 1998. Environmental Monitoring Section, Environmental Protection Department, Westinghouse Savannah River Company Aiken, South Carolina. WSRC-TR-99-00299.

WSRC. 2000. Savannah River Site Environmental Data for 1999, Environmental Monitoring Section, Environmental Protection Department, Westinghouse Savannah River Company Aiken, South Carolina. WSRC-TR-99-00301.

WSRC. 2000. Savannah River Site Environmental Report for 1999. Environmental Monitoring Section, Environmental Protection Department, Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-TR-99-00299.

WSRC. 2001. Savannah River Site Environmental Report for 2000. Savannah River Site. Westinghouse Savannah River Company, Aiken, SC. WSRC-TR-2000-00328.

WSRC. 2002. Savannah River Site Environmental Report for 2001. Environmental Monitoring Section, Environmental Protection Department. Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-TR-2001-00474.

WSRC. 2003. Savannah River Site Environmental Report for 2002. Environmental Monitoring & Analysis, Environmental Services Section, Westinghouse Savannah River Company, Aiken, SC. WSRC-TR-2003-00026

WSRC. 2003a. Radiological False Positives in Environmental Soil and Groundwater Data From Commercial Laboratories. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-MS-2003-00565.

WSRC. 2004. Savannah River Site Environmental Report for 2003. Environmental Monitoring & Analysis, Environmental Services Section, Westinghouse Savannah River Company, Aiken, SC. WSRC-TR-2004-00015.

WSRC. 2005. Savannah River Site Environmental Report for 2004. Environmental Monitoring & Analysis, Environmental Services Section, Westinghouse Savannah River Company, Aiken, SC. WSRC-TR-2005-00005.

WSRC. 2006. Savannah River Site Environmental Report for 2005. Washington Savannah River Company, Savannah River Site, Aiken, SC. WSRC-TR-2006-00007

WSRC. 2007. Savannah River Site Environmental Report for 2006. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC. WSRC-TR-2007-00008.

WSRC. 2008. Savannah River Site Environmental Report for 2007. Washington Savannah River Company, Savannah River Site, Aiken, SC. WSRC-STI-2008-00057.