Environmental Surveillance and Oversight Program at Savannah River Site – Non-Regulatory Environmental Monitoring around Savannah River Site - 11148

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ABSTRACT

This paper will describe the non-regulatory multi-media environmental monitoring network and activities of the South Carolina Department of Health and Environmental Control's (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) around the Savannah River Site (SRS). With historical legacy wastes, and new missions emerging, the SRS remains one of SCDHEC's largest regulatory customers. SCDHEC initiated the ESOP program as a non-regulatory venue for complementing and supplementing the regulatory monitoring. ESOP's role is to provide data to the interested public, other state agencies, and supplementing information gaps to the public concerning the facility. ESOP collects samples in various environmental media around the SRS perimeter and compares it to environmental data generated by the Department of Energy-Savannah River (DOE-SR) Site Environmental Monitoring Program. This helps to ensure the public that information being disseminated on radionuclides in the environment is comparable between the two programs. An annual data report is generated and distributed to the public in various forums or reports. ESOP public outreach is designed to educate the public on what the state is doing in a non-regulatory oversight capacity at SRS.

ESOP supports and complements SCDHEC's comprehensive regulatory program at the 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 nonregulatory 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 through its public outreach program.

The ESOP environmental monitoring and surveillance network includes determining the quality of air, groundwater, drinking water, surface water, stream water, surface soils and sediments, terrestrial and edible vegetation, dairy milk, fish, and game animals as related to radionuclides on and around the SRS. ESOP has also calculated dose via critical pathways to the public from SRS releases. For information and support purposes, ESOP also provides data internally to other programs associated with oversight of site cleanup activities.

INTRODUCTION

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. 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 and cesium-137. Other radionuclides of interest are strontium-90, cobalt-60, americium-241, and uranium. The five production reactors (R, K, P, L, and C) were the primary sources for these radionuclide releases directly to site streams and the atmosphere. 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 containing water pumped from deep wells into site streams. The fuel fabrication area (M-Area), heavy water reprocessing facility (D-Area), and the administration area (A-Area) also contributed radionuclides to liquid effluent. Onsite streams affected by these releases are Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. All of these SRS streams are tributaries to the Savannah River [1].

The SCDHEC is the state agency charged with protecting public health, coastal resources, and the state's land, air and water quality as authorized under multiple state and federal laws. The agency provides vital healthcare and other direct services, monitors pollution, coordinates disease control, carries out the agency inspection and regulatory responsibilities, responds to environmental emergencies, and protects public health and the environment in numerous other ways. SCDHEC relies upon its own internal laboratories for most radiological and non-radiological analytical support for all of the environmental sampling that takes place across South Carolina. These labs are located in Columbia and in five of the regional environmental offices.

The SRS is one of South Carolina's largest and most complex facilities and it is one of SCDHEC's most important customers. It is composed of a large number of legacy facilities along with a variety of on-going operations. The SRS mission is currently focused on waste management, environmental restoration, and technology development and transfer, but new missions continue to emerge.

The evolving mission of the SRS, the legacy wastes and cleanup, and the potential for new releases of contaminants to the environment underscore the importance of SCDHEC's role at SRS to promote and protect the health of the public and the environment. A strong public involvement program is an essential component of community targeted activities to promote meaningful input from the public regarding our programs and their effectiveness.

The Agreement in Principal program, established in 1989, enables states that host DOE facilities to improve their oversight monitoring and emergency preparedness capabilities at each DOE site. The SCDHEC began participating in this program in 1992 and created the Environmental Surveillance and Oversight Program in 1995 as an independent evaluator of SRS non-regulatory environmental monitoring programs. The activities of the ESOP are designed to provide the public with an independent source of information on the effectiveness of the DOE-SR's

monitoring activities. To accomplish this, ESOP conducts technical reviews of the DOE-SR's monitoring programs and collects data through an independent monitoring network around the site. Through regulatory programs and agreements such as the AIP, SCDHEC works with DOE to assure South Carolina citizens that their health, safety, and environment are being adequately protected.

The SCDHEC ESOP conducts monitoring on and around the SRS to accomplish several objectives: to understand the presence and movement of contaminants from the SRS; to quantify those contaminants; to determine the environmental impacts and dose to the communities surrounding the SRS; to provide a means of evaluating data reported by the DOE-SR, and to provide the public with a source of information independent from the DOE-SR that evaluates radiological and non-radiological contaminants in the environment stemming from present, past and future SRS operations and facilities.

The implementation of radiological and non-radiological surveillance monitoring by ESOP has resulted in a significant increase in our understanding of the concentrations and movement of radioactive contaminants in the environment on and around the SRS. The knowledge gained aids in tracking releases from Site facilities, identifying pathways for potential exposure and coordinating with emergency responders for more effective emergency planning. ESOP is also actively involved in field oversight projects to verify the validity and effectiveness of monitoring activities at Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites and D & D sites. Additional projects will be considered if needed to provide information for new proposed SRS facilities, fill data gaps, and evaluate other SRS non-regulatory monitoring programs. The on-going improvements in monitoring capabilities underscore the commitment by the SCDHEC to fulfill its mission to protect the public health and the environment, reinforcing the DOE's commitment to improving open communication and cooperation with host states.

ESOP monitors critical pathways for human exposure to radiological contaminants from the SRS. In general, the SCDHEC ESOP results indicate that while there continues to be a measurable impact on the environment from the SRS, the values are, in most cases, below established federally mandated contaminant guidelines, and the results are consistent with those values reported by the DOE-SR.

Radiological Atmospheric Quality

Atmospheric transport has the greatest potential to impact the citizens of South Carolina from releases associated with activities at the SRS. This project provides independent quantitative monitoring of atmospheric radionuclide releases associated with 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.

The SCDHEC ESOP air monitoring capabilities include 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). The glass fiber filters are used to collect total suspended particulates (TSP). Particulates are screened weekly for gross alpha and gross beta-

emitting activity. Precipitation, when present, is sampled and analyzed monthly for tritium. Silica gel distillates of atmospheric moisture are analyzed monthly for tritium. TLDs are collected and analyzed every quarter for ambient beta/gamma levels.

Ambient Groundwater Quality

DOE-SR currently utilizes a regional monitoring network of groundwater monitoring wells. These agencies include DOE-SR, SCDHEC, South Carolina Department of Natural Resources, and the United States Geological Survey. ESOP has identified and considered wells in this network for inclusion in the ESOP Ambient Groundwater Monitoring Network.

The ESOP Ambient Groundwater Quality Monitoring Project evaluates ambient groundwater quality adjacent to SRS. This annual evaluation is conducted to determine possible offsite groundwater impacts due to operations conducted at SRS. 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; 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.

Drinking Water Quality

ESOP evaluates and provides assurance to the public that radiological constituents have not impacted community drinking water systems adjacent and downstream to the SRS. Additionally, ESOP provides analytical data from this project for comparison to published DOE-SR data. The project objectives are to collect monthly composite surface water samples from water treatment plants using the lower portion of the Savannah River, and to collect semi-annual grab samples from selected community drinking water systems within 30 miles of SRS. SCDHEC analyzes 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, 18 groundwater fed and four surface water fed community drinking water systems were selected. Three downstream locations near the coast provide drinking water from the Savannah River. With SRS and Plant Vogtle being upstream of these drinking water systems, ESOP collects samples from these locations to ensure the public that their water consumption is safe. These systems serve approximately 285,000 customers with approximately 109,000 receiving their water from groundwater sources. None of the drinking water samples collected, originated from the SRS drinking water system.

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 [1]. 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. They were primarily released in surface streams in the 1960s, or into the atmosphere in the separation areas [3]. There have been no detections of gamma-emitting radionuclides since ESOP began testing drinking water in 2002. Currently, DOE-SR does not conduct drinking water sampling off-site from groundwater fed wells.

Tritium continues to be the most abundant radionuclide detected in public drinking water supplies impacted by SRS and Plant Vogtle. It was detected in both surface water and ground water. The levels detected however, were low compared to the EPA standard for tritium. Gross alpha, non-volatile beta and gamma emitting radionuclides were also detected, but were below their respective Maximum Contaminant Levels (MCLs) and appear to be from naturally occurring deposits.

Radiological Surface Water Monitoring

The SRS surface water bodies, as well as the Savannah River, are the focus for monitoring and surveillance activities of the ESOP Radiological Monitoring of Surface Water (RSW) project. 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 DOE-SR data. DOE-SR has conducted 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.

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. At some locations, samples are collected three days per week. Tritium, gross alpha, gross beta and gamma analyses are dependent on location and frequency. Some locations were chosen because they are considered to be public access locations, are downstream of SRS and provide a potential means for exposure to radionuclides. Monthly samples are collected for tritium analysis from the five creeks 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 flow for this creek is interrupted by the Savannah River Swamp and there is no creek mouth access.

An enhanced surface water monitoring program was 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. Results from the enhanced program are considered to be unofficial results and are used only for notification purposes. 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 along with an additional grab sample. Samples are analyzed for tritium 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 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. The primary focus of this monitoring is the Saltstone facility, F-Area, and H-Area. The Saltstone facility is responsible for stabilizing and disposing of low-activity liquid radioactive waste produced on SRS [3]. Samples are collected on Monday, prepped the same day, and analyzed the next day as part of a quick scan early detection procedure.

The RSW Project will continue to 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.

Non-Radiological Surface Water Monitoring

The streams located on the SRS receive treated wastewater and nonpoint source runoff from on-site facilities. Data from SRS Environmental Reports and ESOP monitoring indicate that SRS surface waters are in accordance with Freshwaters Standard guidelines stated in SCDHEC's Water Classifications and Standards (Regulation 61-68), [4].

The ESOP assesses the surface water quality for nonradiological parameters at SRS by sampling the on-site streams for inorganic and organic contaminants. Sampling locations were strategically chosen to monitor ambient surface water conditions to detect the nonradiological impact from the DOE-SR operations. Water quality on the SRS for nonradiological parameters meets the Freshwaters Standard for South Carolina streams. Streams are tested for these parameters on a monthly interval; pH, temperature, dissolved oxygen, alkalinity, turbidity, biochemical oxygen demand, total suspended solids, fecal coliform, ammonium, nitrite, nitrate, total phosphorous, and Total Kjeldahl Nitrogen. Cadmium, chromium, copper, iron, mercury, manganese, nickel, lead, zinc, and total organic carbon, Volatile organic carbons and pesticides are sampled bi-annually. Data from ESOP surface water locations were compared to DOE-SR data where sample points were colocated [5, 6].

Surface Soils and Sediment Monitoring

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 [7].

The Savannah Rite Site streams receive surface water runoff and water from permitted discharges [8]. Stormwater basins may receive runoff and atmospheric fallout from diffuse and fugitive sources. Cesium-137 (Cs-137) contamination occurs along the entire length of Lower Three Runs (LTR) and Steel Creek on the Savannah River Site (SRS), and the private property of Creek Plantation due to accidental releases of nuclear materials from past operations. 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 [9]. Flooding and dam releases from Par Pond and L-Lake scour creek bottoms that may result in the movement of contaminated sediments. The SRS is within the Savannah River watershed with five major SRS streams feeding into the Savannah River. Dispersal of any contaminants from these SRS streams has the potential to impact the publically accessible Savannah River.

ESOP personnel independently evaluate sediment samples for radionuclide and nonradionuclide contaminant concentrations in SRS streams, SRS stormwater basins, publically accessible creek mouths along the boundary of SRS, the Savannah River, and other publically accessible sites in the SRS vicinity. Background locations are sampled to compare ambient levels of radionuclides from past nuclear fallout events to those sampled on SRS to determine impacts due to SRS operations. Sediment samples on SRS are routinely split with DOE-SR in order to compare results.

All samples are analyzed for gross alpha, gross non-volatile beta, gamma, and metals. The stream sediment samples from SRS are also analyzed for organic and inorganic constituents. 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 the result of accumulation over many years and do not represent yearly depositions. ESOP continued a study that began in 2007 to compare annual in-situ Cs-137 radiation results in the LTR and Steel Creek floodplains using a portable Sodium Iodide (NaI) detector.

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 and the publically accessible Savannah River warrants these monitoring efforts.

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 exposing aquatic systems [10]. Air and water are subject to a much greater mixing than soil; therefore, dilution of metal load does not occur in soil as in other media. 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 [11]. The re-suspension and subsequent airborne contamination of materials, due to cleanup processes and prescribed burns, facilitates the movement of contaminants to areas outside of the Savannah River Site (SRS) boundary.

ESOP personnel independently evaluated surface soils for gross alpha and gross non-volatile beta and select gamma-emitting radionuclides as well as a United States Environmental Protection Agency (USEPA) specified Target Analyte List (TAL) for metals. These soil samples were collected to determine if SRS activities might have impacted areas outside of the site boundary. Radionuclide detections in soil may be the result of accumulation over many years and may not represent yearly depositions.

Terrestrial Vegetation on and Adjacent to SRS

Terrestrial vegetation, fungi, lichens, mosses, etc., 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. As with all ionizing radiation, exposure to tritium and cesium-137 (Cs-137) can increase the risk of developing cancer. The DOE-SR contracts for the collection and analysis of terrestrial vegetation, primarily Bermuda grass, to determine concentrations of radionuclides [3].

ESOP conducts independent vegetation monitoring at 17 locations around the perimeter of the SRS; three former SRS monitoring locations 25 miles from the center of SRS; and 24 locations selected at random (12 near SRS and 12 background sites around South Carolina). Sampling was performed quarterly in February, May, August, and November.

ESOP data supports the DOE-SR conclusion that elevated tritium levels in vegetation at and near 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. It appears that sampling of broadleaf vegetation may be a better indicator of radionuclide occurrence around the SRS perimeter.

Precedence for the monitoring of fungi was established at the Savannah River Site when mushroom samples were found to contain 2 to 540 picocuries per gram (pCi/g) of Cs-137 in 1983, and 19 to 640 pCi/g in 1984 at locations within SRS (DuPont 1984). The abundance of mushrooms may be related to weather factors and could explain some Cs-137 concentration variations in deer and hogs. The Cs-137 contribution to food dose in humans was over one hundred times greater for fungi than the next largest food source (berries) at Chernobyl [12]. DOE-SR mushroom samples collected in the 1980s were obtained from eleven DOE-SR locations that were administratively controlled to prevent public access.

Radiological Monitoring of Edible Vegetation

Radionuclide deposition on crops and other plants may result in entry into the food chain in several ways. One pathway is by direct absorption into the plant through the foliage; another is by ingestion of the contaminated plant by animals or man. Radionuclides deposited on plants may also be washed off and enter the ground where they can be taken up by plants or may enter aquatic systems [13]. 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 [14]. “Sampling and analyzing native vegetation can provide information about the presence and movement of radionuclides in the environment” [15].

ESOP monitors edible food products from perimeter and background locations around the SRS. ESOP addresses public concerns pertaining to SRS operations through independent monitoring of radionuclide activities in edible vegetation grown around the perimeter of SRS. Edible vegetation was collected based solely on availability, and was directly dependent upon the growing season. To gain access to samples, relationships are established on an ongoing basis with farmers, gardeners, and/or businesses surrounding the perimeter of SRS. Vegetation samples, such as wild plums and pears, were collected as available.

The DOE-SR annually collects and analyzes terrestrial food products to determine the presence of gamma-emitting radionuclides, tritium, total strontium (Sr-89/90), uranium-234 (U-234), uranium-235 (U-235), uranium-238 (U-238), plutonium-238 (Pu-238), plutonium-239 (Pu-239), americium-241 (Am-241), cobalt-60 (Co-60), curium-244 (Cm-244), gross alpha, and gross beta. In comparison, the ESOP analyzes food products collected to determine the presence of gamma-emitting radionuclides (cesium-137 (Cs-137), Co-60, iodine-131 (I-131), radium-226 (Ra-226), uranium/thorium-238 (U/Th238, Am-241), tritium, Sr-89/90. Alphas (or betas) are not directly comparable due to the unknown nature (species) of the contributing alphas (or betas) in any two compared samples. As resources become available and situations warrant, samples are shipped to a contract laboratory for U-234, U-235, U-238, P-238, P-239 testing. The DOE-SR collects collards and watermelons annually from one location within each of four quadrants. Secondary crops are also included on an annual rotating schedule (pecans, peanuts, soybeans, corn, cabbage, and wheat). ESOP continues to strive to improve comparisons between the two programs.

Radiological Monitoring of Dairy Milk

Operations at the SRS have resulted in the potential for radiological constituents to be released to the surrounding environment. Milk from dairies around the SRS is routinely analyzed for levels of radioactivity that could impact human health. This project provides radiological dairy milk monitoring of selected cow dairies within a 50-mile radius of the SRS in South Carolina (SC). This project also provides analytical data for comparison to published DOE-SR data.

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 muscle 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. Most of the Cobalt-60 (Co-60) contamination came from the period 1968 to 1984 when Co-60 was used as a heat source for a thermoelectric generator [2]. 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, and therefore targets the whole body**.**

Radiological Fish Monitoring

The 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 SRS, ESOP 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 [16]. 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.

ESOP conducts fish monitoring for radionuclide activity in an effort to determine the magnitude, extent, and trends of radionuclide levels. Largemouth bass and catfish are collected from ten sample locations (9 Savannah River locations and one background location from the Edisto River). Studies have shown that these species bioaccumulate measurable amounts of radionuclides [17, 18].

Independent monitoring of radionuclide levels 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.

Game Animal Monitoring

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 of 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. 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. Of all of the mammalian species investigated, white-tailed deer and feral hogs have shown the highest potential for a human exposure pathway for Cs-137 [19].

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 monitor 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 SCDHEC study area and off-site hunter doses are based on DOE-SR models. Therefore, no direct comparisons could be made between ESOP and DOE-SR data.

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, consequently, 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. Cs-137 is of concern because of its relatively long physical half-life of 30 years, and its availability to game animals and associated health risk to humans.

Cesium-137 is readily incorporated into the human body because of its similarity to potassium-40 (K-40) in physiological processes [20]. Cs-137 concentrates in animal skeletal muscles, which are selectively consumed by hunters [21]. Cs-137 is an important radionuclide because of its relatively long physical half-life of 30 years and its associated health risks [19]. Cs-137 emits both beta and gamma radiation, contributing to both internal and external radiation exposure, which may be associated with gastrointestinal, genetic, hemopoietic, and central nervous system damage [22]. Because of these concerns, Cs-137 will be the only isotope discussed in this report.

ESOP 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 2008 for Cs-137 from 51 deer collected from area hunters via hunting clubs, plantations, and Crackerneck Wildlife Management Area within a five-mile study area adjacent to the SRS. Additionally, 10 tissue samples were collected and analyzed from a background location 120 miles northeast of the SRS in the McBee, South Carolina area. Cesium-137 data ranged from less than the minimum detectable activity (MDA) to 4.60 picocuries per gram (pCi/g) for deer within the five-mile study area adjacent to the SRS. Cesium-137 data ranged from 1.91 to 10.59 pCi/g for deer at the 120-mile background location. Sample size, location, and collection dates were dependent on the participating hunters.

White tailed deer were evaluated for the presence of radiological contamination. Cesium-137 was detected in some deer in all of the zones where deer were harvested. Certain zones showed deer with higher levels than others, which may indicate an impact in those areas over and above levels that would be expected from historical atmospheric testing fallout.

FFA Oversight Monitoring

The Site Evaluation (SE) program evaluates areas with potential contamination of hazardous substances. ESOP personnel provides Quality Assurance / Quality Control (QA/QC) of DOE-SR contractor activities associated with SE investigations by splitting soil samples, observing sampling activities, laboratory methodologies, and observing adherence to established Savannah River Nuclear Solutions (SRNS) protocols and procedures (i.e., sampling, equipment decontamination, etc.). The information gathered through these activities provides information to the FFA and the public about the adequacy of the data being provided.

Critical Pathway Study

SCDHEC ESOP implemented Critical Pathway Dose Project to identify the primary pathways of exposure to the public relevant to Savannah River Site operations, to ensure the design of the ESOP monitoring program was appropriate, and 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 (1999-2009), the Risk Assessment Corporation report [1] and the Centers for Disease Control study [23] helped to establish the SCDHEC (1999-2009) Critical Pathway Dose report basis. Radionuclide dose or potential exposure to the public was calculated from radionuclide concentration activities found in various media that may impact the public. A comparison of similar SCDHEC and DOE-SR media resulted in an evaluation of both programs based on averages and standard deviations.

Throughout its operational history there have been documented instances of radiological materials being released to the environment from the SRS. The primary contaminants released and the exposure pathways were identified. A critical pathway assessment of the SRS was performed by the ESOP with emphasis placed on radiological detections since 1999. The ingestion and inhalation routes are the major mechanisms for public exposure to radionuclides from SRS. Consumption of, game animals, fish, vegetation, and surface water were the major contributors to the ingestion exposure route. The greatest source of exposure to the public occurred through the sportsman on-site and off-site hunter-fisherman exposure pathway via the ingestion of Cs-137. Specific radiological contributions to dose released into the atmosphere by the SRS in 2003 were tritium, iodine-129, cesium-137, and plutonium-239. Radionuclides that make up key contaminants in liquid releases from the SRS include tritium, strontium-90, iodine-129, and cesium–137.

PUBLIC OUTREACH

The SCDHEC ESOP staff strives to incorporate the agency's mission, vision and values in all of their work in and around SRS as they carry out the program's objectives. From presenting the program to groups, talking to members of the public about collecting samples or participating in larger community events, ESOP provides outreach and education to the public regarding ESOP's activities and role as a non-regulatory monitoring entity at the SRS. These outreach efforts are used as a venue to solicit public input, establish a dialogue with the opportunity to provide feedback for improvements to the program, and verify the effectiveness of the DOE-SR programs to the public.

ESOP has had a positive impact on the regulated and technical community. The Environmental Protection Agency (EPA), Centers of Disease Control (CDC), other governmental agencies, SRS CAB, environmental groups, members of the general public, and our own agency requests and uses the program data. Staff have routine interactions with groups interested in SRS such as the SRS Citizens Advisory Board and local Environmental Justice groups. The mission of the program is strictly defined by the Department of Energy, and SCDHEC routinely seeks ways to improve the determination of the types and movement of contaminants around the SRS. ESOP has a web page on the SCDHEC web site explaining the program. ESOP staff also participate in many events to explain who we are, what we do and about the agency.

Each year, ESOP staff, as SCDHEC representatives, attend a number of meetings related to SRS issues to share information or exchange data between agencies. The SRS Citizens Advisory Board (CAB), composed of 25 individuals from South Carolina and Georgia, provides advice and recommendations to the U.S. DOE on environmental remediation, waste management and related issues. Each month during the year, there are a number of opportunities where staff attends CAB subcommittee meetings to stay abreast of specific issues, upcoming issues, and milestones. Staff also attends quarterly CAB meetings to keep up-to-date with the activities of the committee. ESOP routinely presents data results to the Citizens Advisory Board, the public, other interested environmental groups, and other governmental agencies. Staff members also attended DOE-SR sponsored meetings (the North Augusta Energy Park, and the Disposition of Mercury) to gain insight into these issues.

ESOP participates each year in the semi-annual Central Savannah River Area Radiological Environmental Monitoring Program (CSRA REMP) meetings. These meetings provide a scientific forum for local radiological monitoring programs to meet, and compare data and discuss program activities. Attendees include DOE, SRNS, Georgia Department of Natural Resources, Beaufort Jasper Water Authority, City of Savannah Water Authority, Southern Company and Plant Vogtle, and SCDHEC. Discussions at these meetings, in addition to public comments at CAB meetings and other CAB subcommittees meetings are considered in the development and prioritization of ESOP activities.

ESOP staff gave a program presentation to a group of teachers and professionals at USC-Aiken along with DOE-SR and EPA. Three groups of college students, a total of 30, visited the local SCDHEC office to gain a perspective of environmental careers. ESOP presented the program to each group along with a demonstration of the equipment used in field sampling. For the seventh consecutive year, ESOP collaborated with the North Augusta Recreation Department and SRS to sponsor the Kids Earth Day in North Augusta. This annual effort afforded ESOP the opportunity to outreach to over 1500+ children and parents with hands-on activities to teach them more about their environment. Four ESOP staff also participated in the annual Science, Education and Enrichment Day (SEED) at USC-Aiken. Staff was available to answer environmental monitoring questions and outreached to over 2000+ students and parents through hands-on activities.
ESOP will continue to participate in local educational events and other forums as requested, publish an annual comprehensive data report summarizing all data for the sampling year, attend SRS Citizen’s Advisory Board and REMP meetings, present program information at public forums, and publish quarterly reports and an annual report.

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