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Risk-Based Remediation Approach for Cs-137 Contaminated Sediment/Soils at the Savannah River Site (SRS) Lower Three Runs Tail (U) - 13348
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ABSTRACT

Lower Three Runs is a large blackwater stream that runs through the eastern and southern portion of the Savannah River Site. The Lower Three Runs watershed includes two SRS facility areas: P Area (P Reactor) and R Area (R Reactor) that provided effluent discharges to Lower Three Runs. During reactor operations, effluent discharges were well above natural (pre-industrial) or present day stream discharges. The watershed contains a 2,500-acre mainstream impoundment (PAR Pond), several smaller pre-cooler ponds, and a canal system that connects the pre-cooler ponds and discharges surface water to PAR Pond. From the PAR Pond dam, Lower Three Runs flows approximately 36 kilometers braiding through bottomland/floodplain forests before it enters the Savannah River. About eight kilometers downstream from the PAR Pond dam, the SRS boundary narrows (termed the Lower Three Runs tail) providing a limited buffer of DOE property for the Lower Three Runs stream and associated floodplain. Previous screening characterization efforts revealed Cs-137 contamination in the sediment/soils of the floodplain.

As a part of the American Recovery and Reinvestment Act stimulus package, a comprehensive characterization effort was executed on the sediment/soils of the Lower Three Runs tail floodplain providing a comprehensive look at the contaminant signature of the area. As a follow-up to that characterization, a regulatory decision Core Team, comprised of members of the South Carolina Department of Health and Environmental Control, Environmental Protection Agency - Region IV, and DOE, conducted negotiations on a risk-based approach to address the level of contamination found in the tail floodplain as an early action that provided a long-term solution to exposure scenarios.

For evaluation purposes, the adolescent trespasser was selected as the most likely human receptor for the Lower Three Runs tail portion because of the natural attractiveness of the area for recreational activities (i.e., hunting, fishing, hiking etc.) and access from public property. Exposure of the adolescent trespasser to Cs-137 contaminated sediment/soil at concentrations greater than 23.7 pico curies per gram have been calculated to result in an unacceptable cancer risk ($> 1 \times 10^{-4}$). Comparing the characterization sampling results conducted in 2009 with the benchmark concentration of 23.7 pCi/g, identified elevated risk levels along three sampling areas in the Lower Three Runs tail portion.

On January 5, 2012, it was agreed by the core team that a Removal Action in the Lower Three Runs tail was to be conducted for the identified soil/sediment locations in the three identified areas that exceed the 1 x 10^{-4} risk (23.7 pCi/g) for the adolescent trespasser receptor. The addition of Land Use Controls following the Removal Action was appropriate to protect human health and the environment.

A systematic screening matrix was initiated at the identified hot spots (i.e., sampling points with Cs-137 activities greater than 23.7 pCi/g) to identify the limits of the excavation area. Sediment/soil within the defined removal areas would be excavated to the depth necessary to achieve the cleanup goal and disposed of in a CERCLA Off-Site Rule approved disposal facility. It was agreed that this removal action would adequately reduce the volume of available Cs-137 in the Lower Three Runs tail and consequently residual activities of the Cs-137 would decay over time reducing the amount of Cs-137 available in the tail which would curtail risk.

The Land Use Controls consist of installation of an additional seven miles of fencing at major road crossings, utility easements, and at areas that showed a higher probability of access. In addition, signs were placed along the entire SRS perimeter of the Lower Three Runs tail approximately every 200 feet. Sign posts included both a No Trespassing sign and a Contaminant Warning sign.

The project initiated a subcontract for both the removal action and the installation of fencing and signs on May 1, 2012. All field activities were completed by July 26, 2012. The project excavated and disposed of over 2700 cubic yards of contaminated sediment/soil, erected approximately seven miles of fence and placed over 2,000 signs demonstrating DOE's commitment to protect human health and act as a good neighbor to residents in the area.

INTRODUCTION

Lower Three Runs (LTR) is a large blackwater stream system that runs through the eastern and southern portion of the Savannah River Site (SRS) and is being investigated through the Integrator Operable Unit (IOU) program under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). IOUs are defined as surface water bodies (e.g., streams and lakes) and associated wetlands, including soil, sediment, and related biota. The LTR watershed includes two SRS reactor facility areas: P Area Operable Unit (PAOU) and R Area Operable Unit (RAOU) that provided effluent discharges to LTR. During reactor operations, effluent discharges were well above natural (pre-industrial) or present day stream discharge. The watershed contains a 1012 hectare (2,500-acre) mainstream impoundment (PAR Pond), several smaller pre-cooler ponds, and a canal system that connects the pre-cooler ponds and discharges surface water to PAR Pond. From the PAR Pond dam, LTR flows approximately 36 kilometers (km) (23 miles) braiding through bottomland/floodplain forests before it enters the Savannah River. About five miles downstream from the PAR Pond dam, the SRS boundary narrows (termed the LTR tail) providing a limited buffer of Department of Energy – Savannah River (DOE-SR) property for the LTR stream and associated floodplain (Figure 1). Soil types surrounding the LTR Stream corridor range from seasonally wet, hydric soils to well drained soils. Sediment/soil term refers to floodplain sediment that may periodically be dry, but may also periodically be flooded and/or inundated. Sediment is typically inundated with surface water associated with a stream channel or ponds. Previous screening characterization efforts

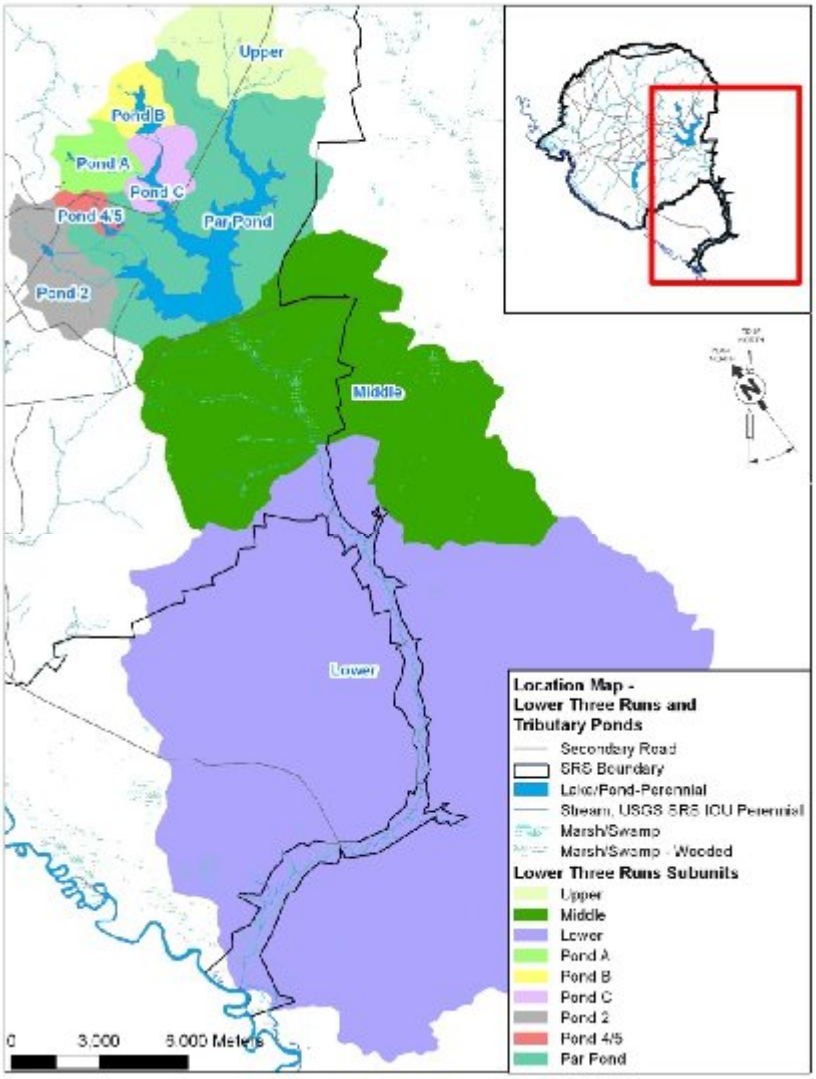

Figure 1. Location of the Lower Three Runs IOU at the Savannah River Site

revealed Cesium-137 (Cs-137) contamination in the sediment/soils of the floodplain (WSRC 2004).

Comprehensive characterization efforts were executed on the sediment/soils of the LTR IOU floodplain as part of the American Recovery and Reinvestment Act of 2009. These characterization events provided a comprehensive look at the contaminant signature of the area. After characterization, the Core Team negotiated a risk based approach to address the level of contamination found in the tail portion of the floodplain. The Core Team is comprised of members from South Carolina Department of Health and Environmental Control (SCDHEC), United States Environmental Protection Agency – Region IV (EPA-4), and DOE-SR that work together to reach key regulatory agreements on remedial decisions. This risk based approach led to a remedial decision for an early action that provided a long-term solution to contaminant exposure scenarios.

LAND USE OF LTR

Current land use in the LTR watershed is mixed. Industrial areas cover less than 10% of the LTR watershed in the PAOU and RAOU. The remainder of the watershed primarily consists of managed forests, wetlands/floodplain habitats, and surface water impoundments. It is no longer used for industrial purposes. The upper and middle portion of the LTR (including ponds and canals) are well within and surrounded by SRS property. The tail portion of LTR however, is bounded on both sides by private property, some of which includes residential parcels. The DOE-SR owned LTR tail consists of an approximate 1/8 – 1/4 mile wide buffer on each side of the main stream channel. There are four public road crossings, two power line crossings, and a railroad crossing along the tail portion of LTR providing potential access to the Cs-137 contaminated floodplain.

PREVIOUS ACTIONS AT LTR

From the initial evaluations of the LTR IOU (WSRC 2004 and WSRC 2007), the underlying concern has always been the protection of the public and the environment. To that end, in September 2004, the DOE, with agreement from the Core Team members, prepared an Early Action Fact Sheet to document actions taken along the tail section of LTR IOU. An Early Action Fact Sheet detailed the action to protect SRS workers and unintentional trespassers from exposure to contaminated floodplain sediment using warning signs and fences. A Fact Sheet was made available for public review and comment and the action began in December 2004. In 2007 the SCDHEC issued a Government Performance and Results Action (GPRA) Human Exposure Environmental Indicator (EI) letter (SCDHEC 2007) indicating that human exposure was not under control unless additional actions were taken along the LTR tail section. In response, the DOE executed an early action plan that included posting additional signs and documenting inspections along the entire reach of the tail section, and initiated a reconnaissance to survey for evidence of trespassing within DOE property. Additionally, letters were sent to landowners with property adjacent to the LTR tail portion of the DOE-SR property notifying them about trespassing within DOE-SR property. The correspondence to the property owners reiterated that Cs-137 contamination is present in the stream and floodplain sediments and informed property owners of increased patrols in the area searching for evidence of trespassing.

CHARACTERIZATION EFFORTS IN THE LTR WATERSHED

Past characterization efforts of the LTR IOU had shown that Cs-137 was the major contaminant in the watershed. Under the IOU program, characterization efforts had focused primarily on determining the nature of contamination and identify areas where early actions were required. In 2009 and 2010, an extensive sampling effort was conducted in the IOU as part of the American Recovery and Reinvestment Act (ARRA). This sampling was performed as outlined in an approved Sampling and Analysis Plan (SRNS 2010) and included sampling within three types of systems (canals, pre-cooler ponds and stream channel/floodplain). Within each system, the sampling design involved an even spacing of transects to collect an unbiased population of data. Data consisted of field collected gamma readings (using Lanthanum Bromide Scintillation Detectors [LaBr Detectors]) along transects and was supplemented with the collection of sediment, sediment/soil, and surface water samples collected for laboratory analyses. Additional sampling included collection of filtered and unfiltered surface water, composite and two depth

intervals for sediments/soil, and biological data (primarily fish) from LTR subunits as well as several background locations for all media.

During the 2009 and 2010 characterization efforts there were a total of 1,437 samples gathered throughout the watershed, including background areas, and over 57,800 analyses were conducted on those samples (SRNS 2012). Based on data collected during 2009 and 2010, three areas within the middle and lower tail subunits contain soils contaminated with Cs-137 at levels that exceed risk based limits. This data was used in conjunction with the previous data in determining a risk based remediation approach.

RISK BASED EVALUATION

For risk evaluation purposes screening is conducted to determine contaminant threats to potential human and ecological receptors. Established screening levels, or benchmarks, are based on particular exposure scenarios which estimate the risk associated with exposure to contaminants within the IOU (SRNS 2012). These ecological and human health scenarios evaluated are intended to estimate the potential risk of a human or an ecological receptor in contact with the contaminated media. The human receptors considered for the LTR IOU were: the on-site worker (an SRS employee expected to conduct research or collect samples in the IOU); an adolescent trespasser (an unintentional trespasser who uses the area for various recreational activities); a potential resident (someone who lives for 30 years within the IOU); and a subsistence fisherman (someone who maintains a subsistence level of fish consumption from the area).

All of these receptor scenarios were evaluated using unique exposure criteria to determine the estimated risk of that scenario. Based on the protective actions that had previously been performed, the Core Team agreed that the most probable and appropriate scenario for the risk evaluation was the adolescent trespasser. This was selected as the most likely human receptor, especially for the LTR tail portion, because of the natural attractiveness of the area for recreational activities (i.e., hunting, fishing, hiking etc.), the possibility of access from adjoining public property, and the evidence of trespassing observed during reconnaissance expeditions. The Core Team recognized that the on-site worker was a knowledgeable participant in the area and was required to abide by current worker protection procedures thereby limiting worker exposure. The potential resident was ruled as an unlikely option since the IOU is a wetland/floodplain habitat, and the subsistence fisherman, although considered, did not approach the exposure to sediment represented by the adolescent trespasser scenario.

The adolescent trespasser exposure scenario utilizes a ten year exposure duration spending 90 days a year, 18 hours a day exposed to the contaminated media. For the LTR IOU, exposure of the adolescent trespasser to Cs-137 contaminated sediment/soil at concentrations greater than 23.7 pico curies per gram (pCi/g) was calculated to result in an unacceptable cancer risk ($> 1 \times 10^{-4}$). Comparing the characterization sampling results conducted in 2009 and 2010 with the soil-based benchmark concentration of 23.7 pCi/g identified elevated risk levels at three discernible areas in the LTR middle and tail portions of the IOU.

On January 5, 2012, it was agreed by the core team that a remedial action in the LTR tail was to be conducted for the identified soil/sediment locations in the three identified areas that exceed the 1×10^{-4} risk (23.7 pCi/g) threshold for the adolescent trespasser receptor. The addition of

Land Use Controls (LUCs) following the completion of the remedial action was deemed appropriate to further protect human health and the environment (Figure 2).

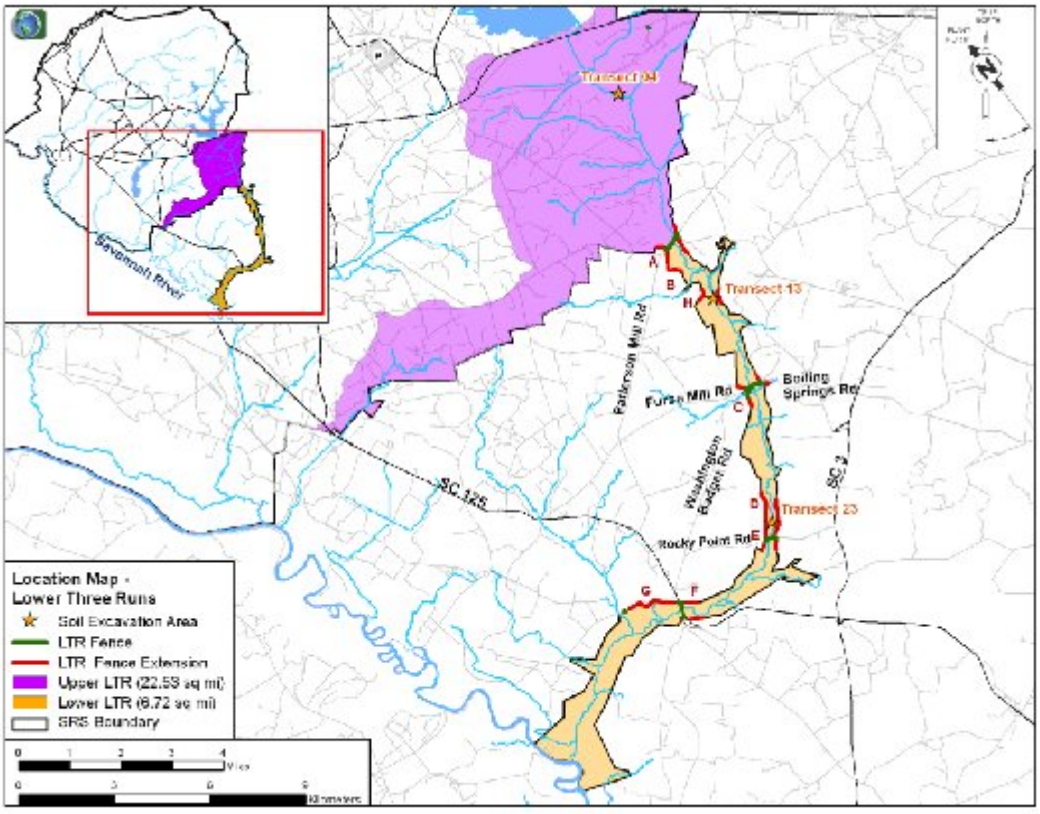

Figure 2. LTR Tail showing Soil Excavation Areas (Transect 04, 13 and 23) and Land Use Control Fencing Extensions

A systematic screening decision matrix was initiated at the identified hot spots (i.e., sampling points with Cs-137 activities greater than 23.7 pCi/g) to identify the limits of the excavation area. Sediment/soil within the defined removal areas would be excavated (Figure 3) to the depth necessary to achieve the cleanup goal (12 pCi/g representing a risk level $<1 \times 10^{-5}$) and disposed of in a CERCLA Off-Site Rule approved disposal facility. It was a Core Team agreement that this removal action would satisfactorily reduce the available Cs-137 in the LTR tail. This removal, in combination with the natural decay of Cs-137, would significantly and immediately reduce the amount of risk associated with Cs-137 in the area.

The LUCs consist of the installation of an additional seven miles of fencing at major access points (Figures 2 and 4). In addition, signs were placed along the entire SRS perimeter of the LTR tail approximately every 200 feet. Signage included both a No Trespassing sign (enforceable by law) and a contaminant present Warning sign (Figure 4).

Figure 3. Removal Action of sediment/soil at Lower Three Runs

The project initiated one subcontract for both the removal action and the installation of fencing and signs on May 1, 2012. Mobilization to the field occurred on May 9, 2012. All field activities were completed by July 26, 2012. The project excavated and disposed of over 2700 cubic yards of contaminated sediment/soil, erected approximately seven miles of fence and placed over 2,000 trespassing and contaminant warning signs. This remedial action demonstrated the utility of the Core Team process while bolstering DOE's commitment to protect human health and the environment, as well as act as a good neighbor to residents in the area.

CONCLUSIONS

The actions completed over the last year successfully implemented a risk based remediation action for the SRS. Working through the Core Team process a strategy was successfully implemented that reduced the risk to an adolescent trespasser to acceptable limits within the Lower Three Runs corridor. The strategy included the removal of over 2700 cubic yards of contaminated sediment/soils in the LTR IOU floodplain, posting over 2,000 No Trespassing and Contaminant Present Warning signs and constructing over seven miles of additional fencing in areas that trespassing might occur.

Figure 4. Land Use Control Signage and Fencing

REFERENCES

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