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Data Summary for the Near-Shore Sediment Characterization Task of the Clinch River Environmental Restoration Program

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Executive Summary

The purpose of the Near-Shore Sediment Characterization Task of the Clinch River Environmental Restoration Program (CR-ERP) was to quantify potential human health risks associated with Department of Energy (DOE)-related contamination of surface sediments in Watts Bar Reservoir (WBR). An estimated 700 Ci of ^{137}Cs and 325 Ci of ^{60}Co were released from White Oak Lake into the Clinch River between 1949 and 1992 (DOE, 1988). A number of previous studies have documented sediment contamination in the deep-water sediments but no study specifically targeted the near-shore environment, which has the most potential for exposure to humans.

Between 1991 and 1994, a total of 926 surface sediment grab samples were collected and analyzed for gamma-emitting radionuclide (^{137}Cs and ^{60}Co) concentrations. Nearly 500 samples were collected along the shoreline of lower WBR; over 300 samples were collected along the shoreline and in deposition zones in the Clinch River arm of WBR; and the remaining samples were collected in the Tennessee and Emory River arms of WBR, Poplar Creek, Melton Hill Reservoir, and Norris Reservoir. Human health risks associated with ^{137}Cs and ^{60}Co in surface sediment were estimated. A rigorous field and laboratory quality control program was implemented to ensure data quality and to enable quantification of uncertainties associated with the data.

Two methods of human health risk calculations were used. First, a screening method was developed that determined the concentrations of both ^{137}Cs and ^{60}Co that would result in a greater than 1×10^{-4} risk of cancer through the external exposure pathway. With this method, a concentration of 15 pCi/g of either ^{137}Cs or ^{60}Co would result in an unacceptable risk. The human health baseline risk method used by the CR-ERP was also employed by back calculating concentrations of ^{137}Cs and ^{60}Co that would result in a risk greater than 1×10^{-4} for six different pathways: direct exposure, ingestion, inhalation, eating vegetables grown on dredged sediments, and consuming the meat or milk from animals that have grazed in dredged sediment areas. The direct exposure pathway posed the most risk to human health. Concentrations of ^{137}Cs and ^{60}Co that would yield a risk of greater than 1×10^{-4} were 11.5 and 7.3 pCi/g respectively.

Concentrations of ^{137}Cs and ^{60}Co are highest near the source, White Oak Creek, with a fairly constant average concentration within the Clinch River arm of WBR. Concentrations are dramatically lower downstream of the confluence of the Tennessee and Clinch River arms. Concentrations of ^{137}Cs and ^{60}Co in the Emory and Tennessee rivers near their confluences with the Clinch River suggest some contamination due to reverse flows in the system.

While ^{137}Cs and ^{60}Co contamination in WBR is present, the concentrations are low and are less than concentrations that result in greater than 1×10^{-4} human health risk. Concentrations of ^{137}Cs and ^{60}Co rarely exceeded critical values. Samples from lower WBR, between winter and summer lake pool, never exceeded critical values. Samples in these areas never exceeded 2 pCi/g ^{137}Cs. A few locations in lower WBR, in deep water greater than 20 ft, did approach 10 pCi/g ^{137}Cs. Samples from shallow areas throughout the WBR never exceeded the concentrations that would yield a risk greater than 1×10^{-4}. Several 1-mile reaches in the Clinch River arm of WBR had individual samples that exceeded the 11.5-pCi/g value for ^{137}Cs. The average ^{137}Cs concentrations in the 1-mile reach around these samples did not exceed the risk-based criteria. Cobalt-60 concentrations in WBR are well below values that would exceed a 1×10^{-4} human health risk. However, the Braden Branch area of Melton Hill Reservoir did have ^{60}Co concentrations that were higher than the rest of the study area but still below the risk-based criteria. This area, contaminated by an old medical supply company that is a State of Tennessee Superfund Site, is not related to DOE activities.

The results of the field and laboratory quality control program suggest that the data collected during this task are of high quality. The number of samples distributed throughout the system is high, the field and laboratory methods proved precise and accurate, and the risk methodology is generally conservative. The uncertainty of the calculated risk is low, and thus, the conclusion that the risk to human health associated with direct exposure to ^{137}Cs and ^{60}Co concentrations in the surface sediments of WBR is low is well founded.