Ash Migration Investigation Using Sub-Bottom Profiler Near the Kingston Ash Spill

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PURPOSE

Migration of coal ash downstream was an immediate concern following the Kingston Fossil Plant ash spill on December 22, 2008. Efforts to characterize the extent and depth of submerged ash have been marginally successful due to the logistical constraints in surveying vast areas of waterway. The Tennessee Valley Authority (TVA) purchased a Sub-Bottom Profiling System with Tow Vehicle to overcome these constraints. This system produces reflective images of the sub-surface sediment as a function of density. Reflective images were used to locate regions of ash deposition and later validated by sediment coring. Digitization of reflective imagery produced an interpreted strata profile between the submerged ash and sediments.

OBJECTIVES

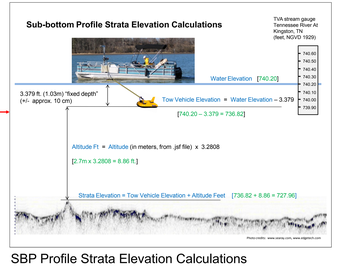
Phase 1: Identification of the areal extent of ash migration from the ash spill.

Phase 2: Characterization of the depth and distribution of ash throughout deposition area. Mapping to depict the extent and depth of ash deposition was performed concurrently during Phases 1 and 2.

SUB-BOTTOM PROFILING SYSTEM WITH TOW VEHICLE (SBP)

The SBP is a wideband frequency modulated (FM) unit that transmits an FM pulse ("chirp pulse") linearly swept over a full spectrum frequency range between 4-24 kHz for data acquisition (DAQ). The P-wave (acoustic pressure wave or primary wave) reflections are measured by the system and displayed as shades of gray on the computer monitor as reflective imagery. Reflective imagery are interpreted and digitized into separate sediment stratums.

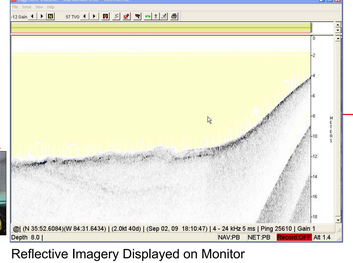
Pontoon Boat



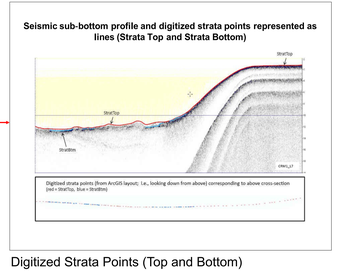
SBP Profile Strata Elevation Calculations

Winch for Tow Vehicle Deployment

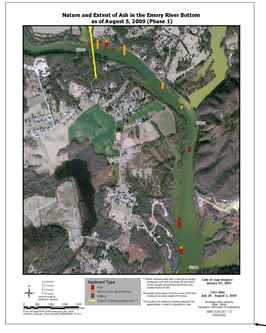
Tow Vehicle



Reflective Imagery Displayed on Monitor



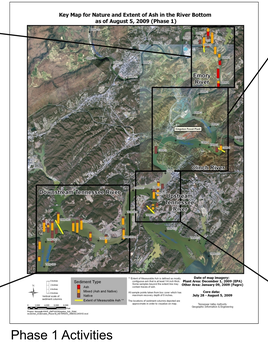
Digitized Strata Points (Top and Bottom)



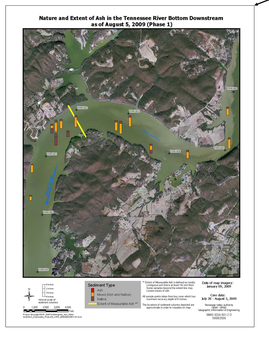
EXPERIMENTAL DESIGN

Phase 1: The areal extent of ash in the river system was quickly determined by collecting box core sediment samples. The presence and depth of ash were measured and recorded. Sediment sampling targeted areas of ash deposition outside the immediate proximity of the spill site. The targeted areas were ascertained by cross sectional profile data acquisition performed using the SBP . The extent of measurable ash was defined as mostly contiguous ash that was at least 1/4 inch thick.

Box Corer

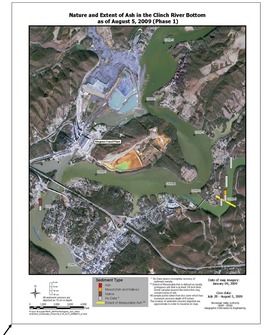


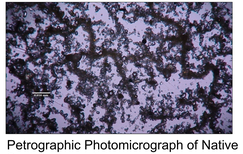
Phase 1 Activities



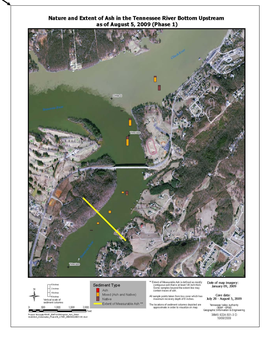
RESULTS

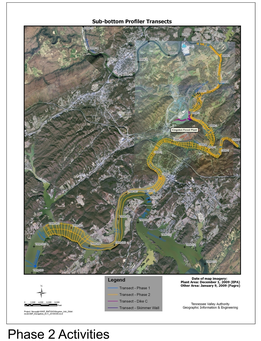
Phase 1: The extent of measurable ash has been identified at approximately Emory River Mile (RM) 6.0 (upstream of ash spill), Clinch RM 5.0, Tennessee RM 562.0 (downstream), and Tennessee RM 568.7 (upstream). Areas beyond the defined extent may contain trace amounts of coal ash. Sediment sampling from Phases 1 revealed that the ash has either mixed with or been covered by native sediments.



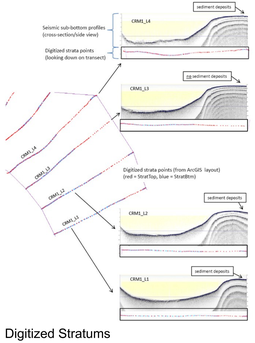


Petrographic Photomicrograph of Native Sediment and Ash

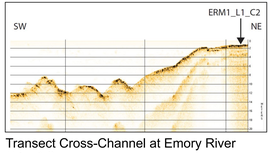




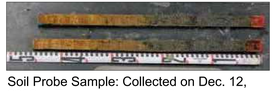
Phase 2 Activities



Digitized Stratums



Transect Cross-Channel at Emory River Mile. 1.9



Soil Probe Sample: Collected on Dec. 12, 2009 at Emory River Mile 1.9 on a submerged river terrace. Ash mixed with native sediments and organic detritus was recovered from 3-12cm of the sediment core, which overlain native alluvial material.

EXPERIMENTAL DESIGN

Phase 2: Sub-bottom profiler data were collected in transects running parallel and perpendicular to the river channel between the spill site and the extent defined in Phase 1. The reflective imagery were interpreted and digitized into stratums. Subsequently several coring devices were utilized to determine ash depth and correlate reflective imagery.

RESULTS

Phase 2: Sediment sampling from Phases 1 and 2 revealed that the ash has either mixed with or been covered by native sediments. These results have caused difficulties in differentiating the two using the Sub-bottom profiling reflective imagery. However, ash deposits predating the 2008 ash spill were discovered my microscopy at 1.2 meters below the sediment surface near Clinch RM 1.0.

SIGNIFICANCE AND BENEFIT OF RESULTS TO KINGSTON ASH RECOVERY PROGRAM

Using SBP technology, TVA was able to survey vast areas of waterway in a time efficient manner and target sediment coring locations. Sediment core data were used to create maps depicting the depth and extent of ash migration.

CONTINUED OR FUTURE STUDIES

Differentiating between ash and native sediment is a difficult problem that has not currently been solved using the SBP P-wave reflection technology. Sediment cores have not matched the reflective imagery profile interpretations for the Emory, Clinch, or Tennessee Rivers. Data acquisition parameters need to be optimized based on sub-surface properties to obtain data that matches in-situ sediment core samples. Depending on the results of parameter optimization and future high-flow events, portions of this investigation may be repeated.

ACKNOWLEDGEMENTS

The authors would like to thank the following agencies and individuals for their assistance with collecting, processing, analyzing data and mapping for this study: Tennessee Valley Authority Organizations: Geographic Information and Engineering[1], Environmental Engineering[2], Surveying and Project Services[3], Kingston Ash Recovery Project Staff. Thacker Seramur and Associates LLC[4], Appalachian State University - Environmental Science Program[5], Jacobs Engineering[6], Restoration Services Inc.[7], and Chesapeake Technology Inc.[8], Roy Teal[1], PJ Nabors[1], Charlie Smart[1], Dave Hankins[1], Richard Schulz[1], Monica Anderson[1], Justin Hunteman[1], Deborah Smith[1], Will Jagels[1], Spencer Whittier[2], Tommy Thomas[2], Tim Stephens[2], John Roberts[3], Keith Seramur[4], Jay Thacker[4], Roy Sidell[5], Paul Clay[6], Jeff Bale[7], Adam Johnson[7], Eddie Arnold[7], Ramona Josefczyk[7], Dave Mathis[7], and Bobby Beasley[7].