Modeling of Mercury Distribution in Soil and Groundwater in Support of the Oak Ridge Mercury Remediation Strategies

FIU's Applied Research Center (ARC) is assisting the U.S. Department of Energy's (DOE) Oak Ridge Reservation (ORR) in developing solutions to mercury (Hg) contamination in soil, sediment and water, including the incorporation of emerging technologies for the efficient management of mercury-contaminated materials.

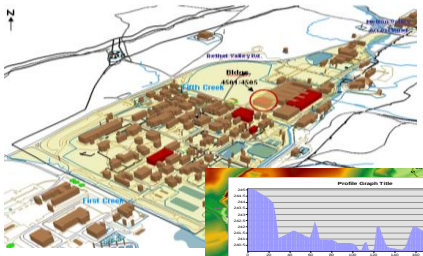
An integrated surface/subsurface model has been developed to aid in prediction of Hg fate and transport under varying environmental conditions within the White Oak Creek (WOC) and Lower East Fork Poplar Creek (LEFPC) watersheds. The purpose is to provide a better understanding of the mercury fate and transport in relation to the hydrological and transport patterns of the contaminated areas. The simulations are used to evaluate the risks associated with mercury mobilization and transport under different hydrologic scenarios, including seasonal fluctuation of precipitation and extreme stormwater events, and during decontamination and decommissioning (D&D) activities. Primary emphasis has been on the effects of seasonal rainfall; surface and groundwater (GW) flow rates; and contaminant adsorption/desorption and retardation mechanisms and rates.

Project Objectives

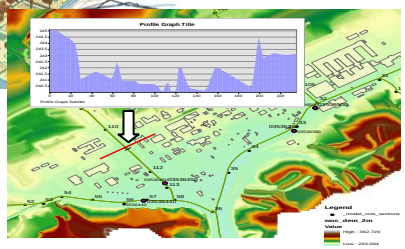
- Develop an integrated surface and GW model to study the multiphase transport of Hg species in the saturated and unsaturated zones of the WOC and LEFPC watersheds, including physical, biological and chemical transformations under site-specific environmental conditions.
- Utilize MIKE SHE/11 hydrological modeling software by DHI Water & Environment Inc. with integrated geographic information systems (GIS) data input to analyze the entire hydrological cycle (river flow, overland flow and GW flow in the saturated and unsaturated zone) and predict mercury fate and transport in the WOC and LEFPC watersheds.
- Conduct laboratory tests to determine mercury methylation/demethylation and the transport and adsorption/desorption (Kd) parameters in ORR soil to support model development via the use of experimentally determined input values.
- Provide stakeholders with a tool for "what if" analyses and for accomplishing lower uncertainty and considerably better spatial and temporal forecasting of the mercury contamination.

Project Benefits

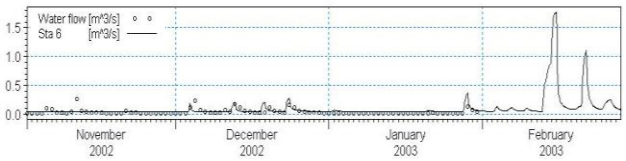
- Forecast the Hg fate and transport in soil and groundwater under varying environmental conditions.
- Use of actual mercury contaminated material from ORR, thus providing site-specific input values which enhance the model's accuracy and applicability.
- Evaluate the mercury speciation, transport parameters and distribution in different phases.
- Evaluate the risks associated with D&D operations and potential mobilization of mercury.
- Reduce the cleanup costs and accelerate cleanup schedule.
- Provide better understanding of the environmental conditions governing the process of mercury methylation/demethylation.



Identified mercury contamination sources at ORNL complex



Typical cross section profile from a tributary of White Oak Creek



Model calibration output of computed discharge at a USGS gauging station in White Oak Creek

Project Accomplishments

Simulated the hydrology and mercury transport of the watersheds for the period 1951 to present and provided the DOE site with topical reports analyzing the risks associated with mercury contamination within the ORR complex under natural environmental conditions and under D&D activities.

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