Groundwater Model Development and Subaqueous Cap Design for PCB-Contaminated Sediments at the New Bedford Harbor Superfund Site

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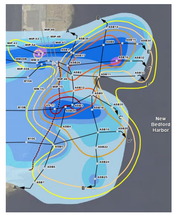
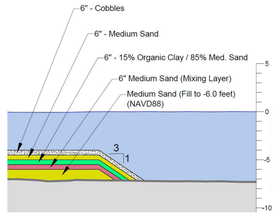
Abstract

Groundwater modeling analyses were conducted to support an interim subaqueous cap design over areas of polychlorinated biphenyl (PCB)-contaminated harbor sediment at the New Bedford Harbor Superfund Site adjacent to the primary upland PCB source area. The analyses determined the proposed cap design, which incorporates organclay, would provide both a physical separation between the contaminated sediment and the harbor, and a chemical migration barrier which would retard the transport of PCBs.

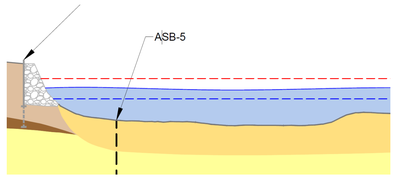




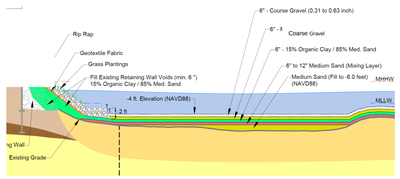
Objectives

Define the extent of the subaqueous cap design and evaluate the effectiveness of the design to prevent PCB migration and discharge into the harbor.

Current Harbor Bathymetry



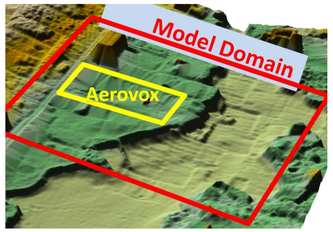
Subaqueous Cap Design

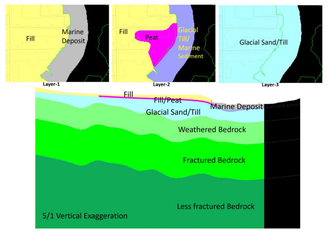


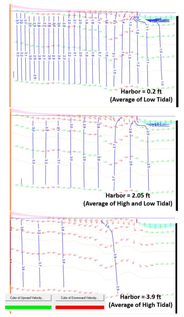
Site-Topo with Harbor Bathymetry

Approach

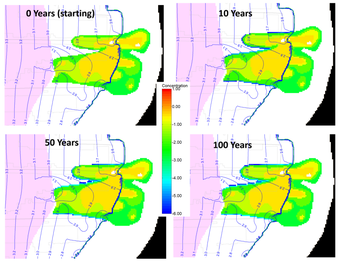
A 3-D model was constructed using detailed land topography, harbor bathymetry, areal and vertical distribution of lithology, physical and hydraulic properties of the substrate, engineering features on the property, groundwater and surface water boundary conditions, groundwater data, and surface water data. Flow and fate-transport analyses were conducted to determine the PCB discharge to the harbor from all defined sources. The groundwater flow model was first used to develop the groundwater flow regime in the area and adjacent harbor under various tidal conditions to aid in the delineation of the extent of the cap. Sensitivity runs were conducted to evaluate the impact of the key parameters and to reduce the uncertainty in predicted groundwater flow. Fate-transport modeling was then conducted to determine the long-term movement of the PCBs in groundwater at the site and to quantify the potential PCB mass discharge into the harbor. Lastly, the proposed cap design was incorporated into the model to evaluate the design performance.

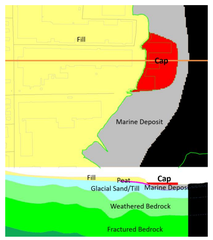






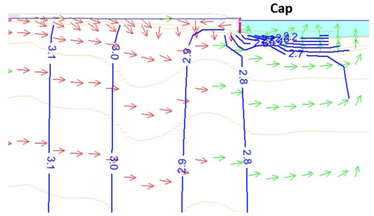
Model Application and Analysis Results





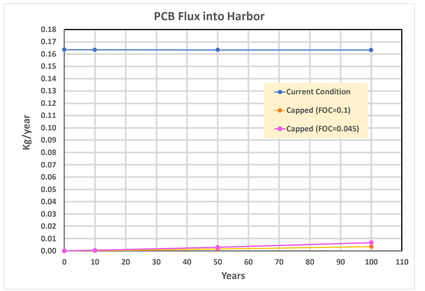
Results

Groundwater flow modeling based on the proposed interim cap suggests that there will be little change to the groundwater-surface water interaction in the area. The cap layers in the model are composed of mostly conductive materials that would have minimal impact on the water flux out of the less conductive marine sediments. Fate-transport modeling of PCBs through the cap suggests a significant reduction of PCB mass flux into the harbor through groundwater discharge. Pre-cap flux estimates under average conditions are approximately 0.164 kg/yr. Post-cap flux estimates are between 0.001 and 0.007 kg/yr depending on the organic carbon fraction applied to the cap layers. Breakthrough of PCB mass through the cap is not predicted until year 50. The proposed cap design achieves both a physical separation between the contaminated sediment and the harbor water, and a chemical migration barrier by including the organoclay/sand mixing layer in the cap to retard the movement of PCBs.



Predicted Groundwater Flow Under Capped Condition

PCB Flux Reduction by Cap Construction



Acknowledgements

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