High-Resolution Site Characterization of a Chlorinated Solvent Groundwater Plume Beneath a Phytoremediation Site

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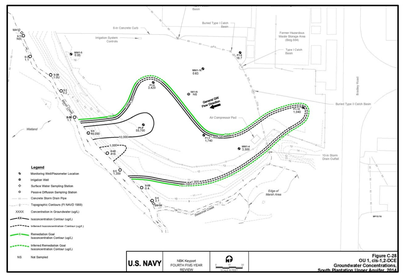
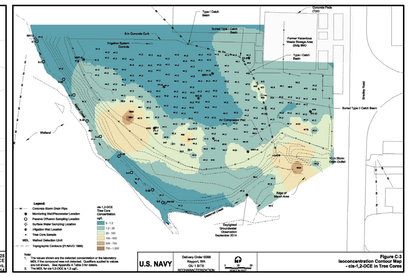
BACKGROUND AND OBJECTIVES

Naval Base Kitsap Keyport occupies 340 acres (including tidelands) on a small peninsula in the central portion of western Puget Sound in Kitsap County, Washington. The former landfill at the base comprises approximately 9 acres on the west side of the installation and was formerly part of a wetland that now borders the landfill to the west and south.

Wastes from the plating, paint and stripper shops were disposed of in the southwest area of the unlined landfill from the 1930s until landfill closure in 1973. The primary contaminants of concern (COCs) at the site are trichloroethene, trichloroethane, and their daughter products. Phytoremediation in concert with natural attenuation was the selected remedy for two primary source areas. After more than 15 years of monitoring, the southern phytoremediation plantation was determined to have not met remedial expectations. Re-characterization was performed with the objective of delineating contaminant hot spots beneath the south plantation in anticipation of future treatment.



Apparent cis-1,2-DCE plume based on data from shallow monitoring wells, 2014

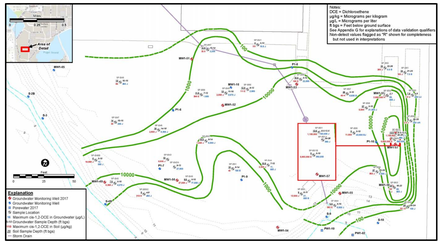


Apparent cis-1,2-DCE plume based on data from phytoremediation tree cores, 2015

TECHNICAL APPROACH

Re-characterization progressed iteratively over three field seasons, from high-density screening-level data collection to progressively more focused definitive data collection. Isoconcentration contours were initially developed using 267 tree core samples. Apparent hotspots were then investigated in 2016 using 61 membrane interface probe (MIP) direct-push borings. Depth-specific isoconcentration contour maps generated based on the MIP data were used to select locations and depths for collection of grab soil and groundwater samples for laboratory analysis, collected in 2017 using direct-push continuous coring at 31 locations. The laboratory results of soil and groundwater samples were used to select locations for permanent groundwater monitoring wells. During auger drilling of permanent monitoring wells, relatively undisturbed soil samples were collected for analysis of soil characteristics. Groundwater samples from the newly installed wells were analyzed for the target chlorinated volatile organic hydrocarbons (cVOCs) as well as conventional chemistry parameters, PFAS, 1,4-dioxane, and microbial populations to allow screening of remedial technologies that could be used to target hot spots and reduce the restoration timeframe.

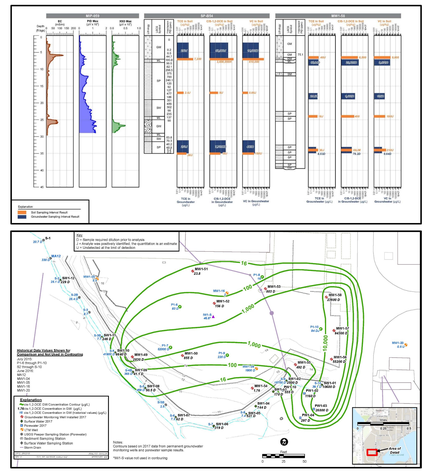
Apparent contaminant distribution based on MIP data, 2016



Apparent cis-1,2-DCE plume based on grab groundwater data, 2017

RESULTS

The iterative investigation approach succeeded in focusing definitive data collection activities on high-value, data-rich locations. The MIP investigation revealed a much more complex vertical distribution of cVOCs than was surmised from the tree core data and the original conceptual site model. Field photoionization detector readings during direct-push continuous coring matched well with the MIP response. However, where the MIP and field PID data implied low cVOC concentrations, soil and groundwater samples revealed exceedances of the remediation goals. Isoconcentration contours based on each method of investigation imply different plume shapes and lateral extent. The combined data set provided a high level of confidence for selecting optimal locations for permanent groundwater monitoring wells and collection of soil characteristics data representative of each hot spot.



Apparent cis-1,2-DCE plume based on optimized monitoring well data and pore water samples, 2017

Installing new permanent monitoring wells based on the results of high resolution site characterization.