Success in Optimized Accelerated Anaerobic Bioremediation Using High-Resolution Site Characterization at Source Area WP21, Dover Air Force Base, Delaware

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Background/Objectives. Site WP21, two former waste lagoons and oil/water separators, is a major source of chlorinated solvents, primarily tetrachloroethene, trichloroethene, and 1,1,1-trichloroethane that feeds the mile-long Area 6 groundwater plume at Dover Air Force Base in Dover, Delaware. As part of the overall Area 6 remediation strategy, accelerated anaerobic bioremediation (AAB) was implemented using direct-push injections in 2006 to remediate the dissolved phase contaminants in the shallow aquifer at WP21. A second AAB injection event was conducted in 2010 to boost total organic carbon (TOC) levels. As a result, concentrations of daughter products (cis-1,2-dichloroethene [cis-1,2-DCE], vinyl chloride, 1,1-dichloroethane, chloroethane, and ethene/ethane) are one to two orders of magnitude greater than concentrations of parent contaminants, reflecting successful AAB degradation of chlorinated solvents. However, after 10 years of treatment, localized elevated concentrations remained, suggesting that parent material remains adsorbed onto the soil within the source area. To optimize the AAB remedy and address residual source material, a detailed delineation was conducted and a focused recirculation system installed.

Approach/Activities. A Membrane Interface Probe-Hydraulic Profiling Tool (MiHPT) survey was conducted in 2016 and revealed contamination in a thin silty zone within the upper portion of the aquifer (10 and 14 feet below ground surface) in the footprint of the former concrete basins and directly upgradient of the monitoring wells with the highest contaminant of concern (COC) concentrations.

Using the MiHPT survey data in conjunction with hydraulic modeling; a groundwater recirculation system of eight injection wells and two extraction wells was installed and screened at optimal locations to flush water through the silty contaminated layer, thereby enhancing COC dissolution into the groundwater. Carbon substrate was injected into the flow stream using a mobile treatment trailer to boost TOC levels in the area.

Results/Lessons Learned. Recirculation started in May 2017 with initial results showing the expected increase in all COCs. The largest increase was in cis-1,2-DCE and chloroethane, indicating that the parent material is desorbing off of the soil matrix and is being quickly degraded within a few feet of the source area. Cis-1,2-DCE concentrations increased from 9,500 to over 81,000 µg/L and chloroethane concentration increased from 3,000 to over 16,000 µg/L during the initial injection phase. To overcome hydraulic conductivity variations within the silty layer, injections were pulsed from one side to the other. Sodium lactate is added periodically to maintain TOC concentrations and a robust anaerobic environment. Optimizing the AAB system to include groundwater recirculation to promote contaminant dissolution will ultimately stop the continued mass flux of contaminants from this source area. The MiHPT Survey, a high resolution site characterization tool, allowed for the direct targeting of the remaining source material. This flexible approach to source area AAB treatment will greatly shorten the active remedial efforts of the larger Area 6 groundwater plume.