Combining Enhanced Reductive Dechlorination and Solar-Powered Soil Vapor Extraction to Sustainably Remediate VOCs in Groundwater and Soil

Daniel W. Brown (daniel.brown@ch2m.com) (CH2M HILL, Charlotte, NC, USA)
Natnael Ume (CH2M HILL, Charlotte, NC, USA)
Mike Perlmutter (CH2M HILL, Atlanta, GA, USA)
Matt Louth (CH2M HILL, Virginia Beach, VA, USA)

Background/Objectives. Combined treatment technologies are being evaluated to optimize the removal of chlorinated volatile organic compounds (CVOCs) at a site in eastern North Carolina. Maximum tetrachloroethene (PCE) concentrations in soil and groundwater are 930 micrograms per liter (µg/kg) and 560 micrograms per liter (µg/L), respectively. The depth to groundwater in the target treatment area is approximately 25 feet below ground surface (bgs) and the vadose zone comprises fine silts and sands with intermittent clay stringers. The objective of the treatability study is to evaluate the effectiveness of enhanced reductive dechlorination (ERD) in reducing CVOC concentrations in groundwater and a solar-powered soil vapor extraction (SVE) system in addressing CVOCs in soil and mitigate potential biogas migration.

Approach/Activities. A 3 percent commercial emulsified vegetable oil (EVO) solution and bioaugmentation culture was injected at 17 locations from 22 to 30 feet bgs via direct push technology (DPT) in March 2018. Two 2-inch SVE wells screened from 5 to 10 and 12 to 17 feet bgs and the solar-powered SVE system were installed in May 2018. The SVE system extracts up to 65 cubic feet per minute (cfm) soil vapor at 80 inches of water. The SVE system operates in a pulsing mode as it only runs during daylight hours. Vapor monitoring points (VMPs) were installed 10, 30, and 50 feet from the SVE wells to monitor system performance and radius of influence. A quarterly performance monitoring program was implemented to assess soil and groundwater treatment progress, collect design parameters for a potential full-scale system, and assess vapor intrusion (VI) risk at nearby structures.

Results/Lessons Learned. Geochemical parameter data (TOC, DO, ORP) indicate ERD influence in the three Surficial aquifer performance monitoring wells. The SVE system has been able to run for about 13-14 hours during the summer months without battery backup. One benefit of the solar-powered SVE is pulsing of the extraction system when there is limited solar availability allows mass to re-enter permeable pathways in soil pores through diffusive processes and allows volatilization of contaminants dissolved in pore water both of which may increase mass reduction.

Observed vacuum measurements have demonstrated a response/radius of influence of at least 1 inch of water in vapor monitoring points located up to 50 feet away from the SVE wells. Upwelling of the water table has not been observed in the performance monitoring wells. Analytical soil gas results from the VMPs after 3 months of operation indicate approximately one order of magnitude reduction of PCE.

The presentation will include the design basis, a description of the combined system, nine months of monitoring, and the cost and sustainability impacts of using solar energy for the SVE system. Further details will be provided to evaluate whether full scale ERD combined with SVE is the best approach compared to other alternate technologies in the Feasibility Study to provide long-term protectiveness and achieve the site’s remedial action objectives within a reasonable timeframe.