Enhanced In Situ Bioremediation Pilot Study for Treatment of 1,1,1-TCA

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Background/Objectives. The subject site is located in southern New York State, and was occupied by a chemical company operating as a distributor of bulk chemicals from 1950 to 1963. Operations were halted in 1963 when a fire released a number of volatile organic compounds (VOCs) from an on-site warehouse. During firefighting efforts, a large amount of chemicals impacted the subject site, including 1,1,1-TCA, 1,1-DCA and 1,1-DCE. The site is listed as a NYSDEC Superfund Site, and the Record of Decision identified enhanced in situ bioremediation (EISB) as the selected remedy. Project objectives were to attain, to the extent practicable, Class GA Ambient Water Quality Standards and Protection of Groundwater Soil Cleanup Objectives.

Approach/Activities. To evaluate the potential of an enhanced in situ bioremediation approach, an anaerobic bench-scale pre-design test was performed on soils and groundwater from the site. The electron donor used was emulsified vegetable oil (EVO). Results indicated that intrinsic bioremediation at the site was limited by the lack of an electron donor since indigenous bacteria were present at moderate levels. Addition of EVO alone (no supplemental microbes) generated favorable geochemical conditions, increased degrading microbes to high levels, and completely treated chlorinated ethenes to ethene and TCA/DCA to chloroethane. The conclusion of the bench-scale test was that the site could undergo EISB through the addition of an electron donor. Implementation of the EISB pilot study included: characterization of groundwater geochemistry, oxidation-reduction conditions, and bacterial populations; direct-push injections of soluble electron donors (EVO and EHC® with zero valent iron [ZVI] solution in areas with CVOC concentrations greater than 100,000 micrograms per liter); and evaluation of EISB performance via post-injection groundwater monitoring. The total injection quantities applied to the subject site during the pilot study were 4,152 gallons of 60% EVO and 7,825 pounds of EHC.

Results/Lessons Learned. Over the four to 16 months following injections, pH decreased in several monitoring wells; however, by October 2016, pH was within a favorable range in all but three of the 16 wells. Oxidation-reduction potential (ORP) decreased to less than -75 mV in all on-site wells. Injected carbon substrate was successfully distributed throughout the pilot study area, and total organic carbon (TOC) increased by two to three orders of magnitude in several wells. Results indicate that there is evidence of reductive dechlorination conditions and biodegradation within the groundwater at the subject site. The concentrations of parent compounds (1,1,1-TCA, PCE, TCE, and 1,1-DCA) decreased, and temporary increases in daughter products (chloroethane, cis-1,2-DCE, vinyl chloride, and ethene) were observed. Dechlorinating microbe analysis indicated healthy, thriving populations of dechlorinating bacteria. Additionally, remaining TOC, methane generation, increasing molar concentrations of degradation byproducts, and negative ORP were favorable. With these parameters in place, a successful dechlorinating environment is expected to persist.