Successful In Situ Pilot-Scale Test Design and Implementation to Treat Groundwater Impacted with PCE and TCE through Organic Carbon and Soluble Iron Injections

Jim Claffey (JClaffey@brwncald.com) (Brown and Caldwell, Upper Saddle River, NJ, USA)
Reinhard Ruhmke (Brown and Caldwell, Raleigh, NC, USA)
Jim Nguyen and Kevin White (Brown and Caldwell, Irvine, CA, USA)
Karnam Ramanand (Brown and Caldwell, Cherry Hill, NJ, USA)

Background/Objectives. Groundwater at a site in the Los Angeles area is impacted with perchloroethene (PCE) and other chlorinated volatile organic compounds (CVOCs) and petroleum hydrocarbons due to past onsite PCE releases and migration from upgradient sources. A pilot test was initiated in April 2016 to evaluate the potential for enhanced in-situ anaerobic biotic and abiotic degradation to control migration of the onsite plume and mitigate downgradient impacts. The pilot test results indicated that successful treatment was achievable, thus a full-scale remedy is under consideration.

Approach/Activities. The key design elements included the selection of appropriate electron donor, determining appropriate injection volumes, employing proper drilling and injection methods, and designing a system that can radially distribute the injection mixture in the formation. The in situ pilot test was conducted through the injection of EHC-Liquid® mixture (EHC-L), comprising of ELS (Emulsified Lecithin Substrate) and iron mix. This mixture was intended to serve as an electron donor for the enhanced reductive dechlorination of PCE. The mixture was added through one injection point with three monitoring wells spaced at 5 feet, 10 feet, and 15 feet from the injection point serving as performance monitoring wells. These wells were sampled periodically to determine the radius of influence and extent of PCE and CVOCs dechlorination. The injection and monitoring wells depths are approximately 83 feet below ground surface (bgs) and screened from 68 to 83 feet bgs. Approximately 495 gallons of ELS and 220 lbs. of iron mix were delivered into the groundwater as a mixture along with rhodamine dye and bromide tracer. *Dehalococcoides* sp. was injected along with the EHC-L.

Results/Lessons Learned. The EHC-L injections enhanced the reductive dechlorination activity in the groundwater. This activity was noted based on the decline of PCE and trichloroethene (TCE) concentrations and a steady increase in the concentration of daughter products, cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). During the 6-month test period, the radius of influence (ROI) of EHC-L was estimated at up to 10 feet based on the detection of daughter products, with the effect far less pronounced at 15 feet from the injection location. This ROI and dechlorination data are continually collected and an 18-month test results will be presented. One-month post-injection, in a performance monitoring well located 10 feet away from the EHC-L injection point, the average molar ratio of (cis-1,2DCE+VC) to (PCE+TCE) was approximately 25 times greater relative to the baseline pre-injection data, underlining the promise and potential for full-scale in-situ treatment at the Site. This ratio declined with time as the daughter products (cis-1,2-DCE and VC) continued to dechlorinate to ethene and ethane in a majority of the test monitoring wells, implying that PCE and TCE are sequentially dechlorinated to innocuous end products. Reductive dechlorination was supported by relevant biogeochemical shifts: sulfate was reduced to sulfide; an increase in ferrous iron was observed; evidence for substantial methanogenic activity; and about 2 orders of magnitude increase in *Dehalococcoides* sp. population. Based on the successful pilot test proof-of-concept, a full-scale remedy, mimicking a biobarrier design, is planned to address offsite migration of impacted groundwater at the Site.