Three Years of Reductive Dechlorination at a Chlorinated Solvent Site

Jessica Yeager, PE (jyeager@geosyntec.com), Alice Blayney, and Julianna Connolly, LSP (Geosyntec Consultants, Brookline, MA, USA)
Chapman Ross, PE, and Douglas G. Larson, PhD, PE, LSP (Geosyntec Consultants, Acton, MA, USA)

Background/Objectives. Geosyntec Consultants (Geosyntec) is supporting a confidential Brownfields redeveloper with the environmental cleanup of a former industrial property in the metro Boston area. The groundwater at the property is impacted with chlorinated solvents — primarily trichloroethene (TCE) and tetrachloroethene (PCE). The groundwater impacts are located primarily in a clay layer that is present between 30 and 45 feet below ground surface. The hydraulic conductivity of this clay layer is very low; amendments do not travel significantly within this aquifer.
The objectives of groundwater remediation at this site are to (1) provide source control by treating source material and (2) reduce groundwater chlorinated solvent concentrations to concentrations that achieve a condition of no significant risk in accordance with the Massachusetts Contingency Plan (MCP).

Approach/Activities. To address elevated concentrations of chlorinated solvent in groundwater and achieve regulatory closure under the MCP for this complex site, Geosyntec employed three bioremediation strategies.
In December 2015, we injected emulsified vegetable oil (EVO) and KB-1® bacteria culture into areas with elevated concentrations of PCE and TCE in groundwater and then monitored the groundwater for one year. Specifically, Geosyntec oversaw the direct-push injection of approximately 4,125 gallons of anoxic water amended with 1,375 gallons of emulsified vegetable oil (EVO) and 135 liters of KB-1® at 27 direct-push locations. Injections were focused in areas where TCE and PCE concentrations exceed MCP cleanup standards. While TCE and PCE concentrations decreased and concentrations of daughter products increased after the first injection and many monitoring wells, portions of the target treatment area had not been contacted with the EVO due to the tightness of the soils, and high pH appeared to be inhibiting biodegradation at one location.
In March 2017, we conducted a second round of remedial injections and expanded the area of injection relative to the December 2015 injection area. To address persistently high chlorinated solvent concentrations, we injected a combination of EVO, emulsified zero valent iron (EZVI), and KB-1® bacteria culture. We injected EZVI near wells where the highest groundwater concentrations remained. Because KB-1® bacteria growth is inhibited by elevated pH levels, during this March 2017 injection round, we also injected lactic acid near one monitoring well to address the elevated pH level.

Results/Lessons Learned. Concentrations of TCE and PCE in groundwater have been significantly reduced (95+%) in the 1.5 years since the first remedial injections. The EVO, EZVI, and KB-1® bacteria appear to be contributing to enhanced dechlorination of groundwater, though the lactic acid injection has not had a sustained effect on pH. The dechlorination of groundwater is demonstrated at this site by increases in daughter compound concentrations, including ethene. We expect to have three more rounds of groundwater data by April 2018.