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Field-Scale Evaluation of Enhanced Reductive Dechlorination for Treatment of a Dilute Trichloroethene Plume in Low pH Aerobic Aquifer

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Background/Objectives. Remedial investigation indicated the presence of chlorinated volatile organic compounds (CVOCs), including trichloroethene (TCE) and its daughter product, cis-11,2-dichloroethene (cis-1,2-DCE), in groundwater at a former manufacturing facility in Barnwell County, South Carolina (the Site). The primary constituent present in shallow groundwater near a suspected source area was TCE at concentrations ranging from 180 to 450 micrograms per liter (µg/L). The selected remedial alternative to address the CVOC-impacted groundwater in the Record of Decision includes in situ enhanced reductive dechlorination (ERD) with monitored natural attenuation. Groundwater at the Site is aerobic with pH ranging between 4 and 5.

Approach/Activities. A field pilot study was performed to evaluate the performance of reductive dechlorination processes in remediating the dissolved CVOCs at the Site. Anaerobic BioChem Plus® (ABC+) (1,200 lbs of micronscale zero-valent iron [ZVI], 1,200 lbs of ABC [organic carbon], and pH buffering agents) was injected from 35 to 45 feet below ground surface at three locations through direct push rods in August 2013. This electron donor was designed to rapidly create reducing conditions, temporarily increase pH and assist in enhancing the reduction of CVOCs in groundwater. Field data collected during injections from the pilot monitoring wells indicated immediate establishment of reducing conditions (decreased dissolved oxygen levels and negative oxidation-reduction potential) and a slight increase in pH. No significant degradation of TCE was observed four months after ABC+ injection.

To increase the groundwater pH, a supplemental injection event, which included a stronger buffering agent, NuBuff, along with additional reagent (ABC and ZVI) was performed in May 2014. As a result, pH increased in performance monitoring wells ranging from 5.1 to 6.8. No *Dehalococcoides spp*. (Dhc) were detected in the baseline sampling and remained low or below detection until bioaugmentation which was performed in June 2014 by injecting 15 liters of an enriched dechlorinating culture (RTB-1). As a result, the Dhc population and their functional genes in groundwater increased by two orders of magnitude and continued to be present after 30 months. TCE daughter products, *cis*-1,2-DCE, VC and ethene were also observed indicating complete degradation.

Results/Lesson Learned. Initial results indicated favorable geochemical conditions for both abiotic and biotic reductions. Because the aquifer is strongly acidic (low pH), alternate pH amendments to raise the groundwater pH were needed for Dhc to grow and degrade CVOCs. If pH amendment was performed earlier, CVOCs would have been reduced in a shorter timeframe. Additionally, the pilot study showed that bioaugmentation was essential to successfully treat the dissolved CVOCs at the Site.