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Use of Sustainable Remediation to Achieve Source Area Polishing

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Background/Objectives. Initial remedial efforts via bioremediation were successful in reducing TCE mass by 88 percent. Several years after injections ceased, carbon in the aquifer was depleted to less than 10 milligrams per liter (mg/L) and source area groundwater was still impacted with trichloroethene (TCE) at concentrations above 3,000 micrograms per liter (mg/L). Additional polishing would be needed to expedite degradation of TCE and achieve site closure in a reasonable timeframe. Remedial efforts were complicated by challenging site conditions including a low pH aquifer (less than 5 standard units), low permeability aquifer ($K=10^{-4}$ centimeters/second), and deep impacts extending over 100 feet below land surface. Cost constraints prevented re-use of the initial injectate. A novel approach using expired beverages with a high sugar content was developed as a low cost alternative. It offered multiple sustainable benefits with positive community, economic, and environmental impacts.

Approach/Activities. Expired beverages were transported from stores to a central facility. The individual containers were segregated based on sugar content and subsequently crushed. The sugary liquid is captured and donated for re-use as a bioremediation reagent referred to as beverage remediation product (BRP). A single injection event was conducted in 2014 to target residual mass in source area groundwater. An active microbial population was still present from the initial injections (with *Dehalococcoides* and functional gene values exceeding 10^5 cells per milliliter). Approximately 2,500 gallons of BRP was buffered with sodium bicarbonate and injected into an existing permanent well network.

Results/Lessons Learned. Subsequent to injections, aquifer pH increased to near 7 standard units and total organic carbon loading of greater than 10,000 mg/L was achieved in the injection network. TCE concentrations were reduced to below detection limits after one year and rebound has not been observed at two years post injection. Complete dechlorination was achieved in all but one well, which contained low concentrations of TCE degradation products. BRP was successful in remediating residual source area mass and accelerating the site towards closure.

The use of BRP offered several sustainable benefits. By decreasing contaminant concentrations, BRP provided a positive impact on the community by reducing receptor risk. From an economic standpoint, it decreased remediation costs by eliminating the need to purchase a commercial remediation product. It also provided a cost savings to the beverage distribution company by eliminating the need to pay for disposal of expired beverages. The elimination of expired beverage disposal offered an additional benefit to the local municipality by reducing their wastewater load. The use of BRP resulted in positive environmental impacts including waste minimization of expired beverages and expedited remediation of groundwater impacts.