

## DNAPL DESTRUCTION THROUGH A GREEN TECHNOLOGY – TCE SOURCE AREA BIOREMEDIATION

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A single-injection event using the beta-version of the proprietary BioStryke® electron donor additive ERDenhanced™ remediated a trichloroethene (TCE) dense non-aqueous phase liquid (DNAPL) source, reducing TCE concentrations by 99.99 percent in approximately 9 years. The injection program demonstrated the amendment enhanced reductive dechlorination (RD) of chlorinated volatile organics (cVOCs) within an overburden groundwater source area at a site located in central New Hampshire, USA. Site stratigraphy includes two distinct hydraulically conductive zones consisting of fine sand with silt and clay bounded by non-conductive clay. The cVOC concentrations in the lower zone, consisting of primarily TCE, were consistent with the presence of a DNAPL (concentrations were approximately 9 percent of TCE aqueous solubility). Approximately 2,600 pounds of the pourable slurry-phase amendment were injected utilizing direct-push technology (DPT). The remedial strategy included amendment injection into the source area to enhance an anaerobic treatment zone and biostimulate the dechlorination of residual DNAPL such that, dissolved-phase plume management via monitored natural attenuation (MNA) can be implemented.

Groundwater monitoring was conducted to evaluate the performance of this green amendment. Between September 2001 and May 2010, TCE concentrations decreased from 97,400 micrograms per liter (µg/L) to less than 10 µg/L. As TCE source mass was removed, concentrations of ethene and chloride, the end products of RD, increased from 1.7 µg/L to 110 µg/L ethene and 27,000 µg/L to 120,000 µg/L chloride. The increase and eventually decrease in the concentrations of these end products within a year of DNAPL removal is consistent with the complete transformation of TCE to ethene. During DNAPL dechlorination concentrations of the interim daughter product cis-1,2-dichloroethene (DCE) increased in groundwater. The concentration of DCE, which is dechlorinated less rapidly than TCE, began to decrease approximately 6 months after the DNAPL was destroyed and has since decreased by over 99 percent from its peak. Prior to amendment injection, background TCE concentrations at the property boundary exceeded regulatory standards and increased over time before peaking at 828 µg/L approximately 1 year after DNAPL destruction. The TCE concentrations at the property boundary are currently less than 2 µg/L and over the 8-1/2-year period, the molar percentage of parent compounds to total cVOCs decreased from 99.6 percent (baseline) to the current percentage of less than 0.3 percent.

The additive injection program, which involved a single injection event, generated a small carbon footprint and did not require any infrastructure (e.g., pumps, motors) post injection. The additive program also included the use of material that had been scheduled to be landfilled, enhancing the programs green technology credentials.

Currently, Site TCE concentrations are non-detect and DCE concentrations are continuing to decrease. The ethene and chloride concentrations have similarly decreased and are currently approximating background conditions. No additional remedial injections have been performed since the initial 2001 event, and the site is anticipated to enter a formal MNA program in the near future with the New Hampshire Department of Environmental Services (NHDES).

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