Trichloroethene (TCE) is a chlorinated volatile organic compound (CVOC) that can be found in industrial and household products. Federal and state regulatory drivers determine the need to assess and remediate soil and groundwater contaminated with CVOCs. There are many different methods for remediation; however, bioremediation has the ability to breakdown TCE all the way to harmless gasses. Bioremediation requires dechlorinating, electron donor (food source), and an electron acceptor (CVOCs). Electron donors are typically injected into the target area and are distributed naturally throughout the subsurface. A partitioning electron donor (PED) has the ability to partition from the dissolved phase into low permeability zones and/or dense nonaqueous phase liquids (DNAPLs), and then be slowly released and readily metabolized at the DNAPL:water interface.

This thesis summarizes the first field scale PED implementation with the main research objective of evaluating whether utilizing a PED for bioremediation of a TCE source zone is achievable. Based on laboratory studies, nâ€”butyl acetate (nBA) was selected as the PED for application in a TCE source area, selected at Cape Canaveral Air Force Stationâ€”s Launch Complex 34, identified as Hot Spot 1. Implementation included the recirculation of groundwater above and below the clay layer without PED injection for comparative analysis (baseline flux), then with PED injection in, above, and below the layer (system operation phase).

Confirmation sampling was conducted to assess the PED distribution after injection activities. The recirculation system was then restarted and operated for approximately one year. Groundwater sampling was performed regularly to assess mass flux and microbial reductive dechlorination.

PED amendment was successfully injected into the subsurface, as evidenced by positive detections of nBA from soil and groundwater sampling within the treatment area immediately following the injection event. The implementation was also successful in reducing contaminant mass from both soil and groundwater.

In general, TCE and cisâ€”1,2â€”dichloroethene (cDCE) concentrations decreased during the baseline flux phase with no increase in vinyl chloride (VC) concentration, indicating removal via extraction and dilution and no reductive dechlorination. Following the PED injection, TCE and cDCE concentrations generally decreased with increases observed in VC concentrations, indicative of reductive dechlorination.

Average ethene concentration detected in samples collected from treatment zone monitoring wells increased from preâ€”injection to postâ€”injection, indicating complete dechlorination of CVOCs is occurring. In addition, dechlorinating microbial biomass increased significantly, as evidenced by increases in average Dhc and vcrA concentrations detected in samples collected from treatment zone monitoring wells. Total organic carbon (TOC) concentration was shown to generally increase following the injection activities, then decrease through the system operation period, indicating the electron donor was successfully injected into the subsurface, and was being utilized by the indigenous dechlorinating microbial population.

The reduction of CVOC concentrations at the site are likely due to reductive dechlorination, as evidenced by: (i) the production of daughter products relative to the degradation of TCE; (ii) the production of ethene; (iii) the production of dechlorinating microbial mass; and (iv) the reduction of electron donor.
Educational Career:
Bachelor's of Environmental Engineering, BS, 2010, University of Central Florida
Bachelor’s of Civil Engineering, BS, 2010, University of Central Florida

Committee in Charge:
Dr. Andrew Randall, Chair, Civil, Environmental, and Construction Engineering
Debra Reinhart, Civil, Environmental, and Construction Engineering
Dingbao Wang, Civil, Environmental, and Construction Engineering
Rebecca Daprato, Rice University / Geosyntec Consultants

Approved for distribution by Dr. Andrew Randall, Committee Chair, on November 6, 2016.

The public is welcome to attend.