

## Combined Remedy Bioremediation Enhancement to Address a Trichloroethene Source at a Legacy Hydraulic Containment Site

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**Background/Objectives.** Historic releases of trichloroethene (TCE) from incidental discharges resulted in the contamination of the surficial aquifer system at the Precision Fabricating & Cleaning Company site in Cocoa, Florida. TCE was used at the site between 1964 to 1977 for the precision cleaning of aerospace equipment. Detailed investigations revealed the presence of a dense nonaqueous phase liquid (DNAPL) source area and associated dissolved plume extending approximately 1,200 feet downgradient. Remedial measures implemented in 2002 included a hydraulic containment system to provide flux control at the property line with downgradient dissolved plume monitoring, since a majority of the source zone is located under the active facility. After successfully operating and optimizing the hydraulic containment system for over a decade, a cost effective combined remedies approach, which included enhanced in situ bioremediation in the source zone in conjunction with the hydraulic containment system, was implemented with an objective of reducing the remaining on-site TCE source zone to accelerate the shutdown of the hydraulic containment system. The bioremediation design included the injection of a slow release electron donor and a dechlorinating bacterial culture combined with the use of the existing hydraulic containment system to achieve objectives.

**Approach/Activities.** Injection activities were performed in October 2015 and included the injection of approximately 8,500 gallons of diluted electron donor (Terra System's SRS FRL emulsified vegetable oil) and a total of 10 liters of microbial culture (SiREM Laboratories KB-1) via direct push technology injection points. Immediately prior to injection activities the hydraulic containment system was shut down and the system remained off for five days following the completion of injection work. Following the five-day period, the system was re-started and operated for a limited (three day) 'transport period' to enhance electron donor and microbial culture distribution within the treatment area. Following the initial transport period, the system was shut down for three months to promote microbial reductive dechlorination and then, based upon field observations, cycled for limited operational periods to minimize electron donor extraction while also promoting enhanced distribution.

**Results/Lessons Learned.** The combined remedy approach, utilizing the existing hydraulic containment system in conjunction with bioremediation, has proven to be successful in achieving significant ongoing mass reductions at a limited cost (total implementation cost of less than \$50,000). Ongoing groundwater monitoring has documented: (i) successful distribution of electron donor based upon total organic carbon increases, (ii) complete dechlorination of TCE and daughter products, as indicated by the average ethene concentration increase from 2.7 micrograms per liter ( $\mu\text{g/L}$ ) at baseline to 200  $\mu\text{g/L}$  at six months, (iii) successful distribution of *dehalococcoides* and vinyl chloride reductase, as indicated by increases from non-detect at baseline to  $4 \times 10^8$  to  $1 \times 10^9$  gene copies per liter at six months, and (iv) significant VOC concentration decreases (maximum TCE concentration reduction from 71,000  $\mu\text{g/L}$  to 14  $\mu\text{g/L}$  [total VOC molar reduction of 99.8%]) after six months of monitoring. The results suggest that incorporating bioremediation into existing hydraulic containment system remedies offers the potential to cost effectively reduce flux and ultimately transition sites from active operations.