Enhanced In Situ Bioremediation and Solar-Irrigated Phytoremediation to Treat a Salty PCE Plume

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Background/Objectives. Historical operations at a former chemical manufacturing facility have resulted in impacts to soil and groundwater. This study focuses on the water table aquifer at this site with a 2,000 foot tetrachloroethylene (PCE) and breakdown product plume. Based feasibility study level remedy evaluations, enhanced in situ bioremediation (EISB) and phytoremediation were selected to treat the source area and plume area, respectively, and monitored natural attenuation (MNA) was selected to manage the low-concentration plume fringes. This study presents the remedy approach, supporting studies, implementation, operation and maintenance, and monitoring of green and sustainable remediation at this high salinity chlorinated solvent-impacted site.

Approach/Activities. Bench scale and field pilot studies were conducted for EISB and phytoremediation, and the results were used to design the full-scale remediation systems. An EISB pilot test was conducted by spreading substrate and pH buffer onto the bottom of an excavation area during a PCE soil source removal action. During the full-scale EISB implementation, approximately 52,000 gallons of water, soybean oil, pH buffer and bioaugmentation culture were injected into 15 vertical wells to treat chlorinated solvent compounds in two source areas. On-site existing eucalyptus and willow tree tissue samples were collected and analyzed for a PCE uptake study. Various species of eucalyptus trees were bench tested for salt tolerance and five species were selected and cultured for full-scale phytoremediation. For the full-scale phytoremediation system, approximately 550 eucalyptus and willow trees were planted in a hydraulic barrier configuration to remove contaminants in plume area. Two solar powered irrigation stations were installed in upland and wetland areas using well water and import water as water sources for the first 2 years of phytoremediation.

Results/Lessons Learned. The remediation systems were implemented from October 2015 to January 2016 and quarterly/annually monitoring has been conducted to monitor and document remedy performance and compliance since inception. Field measurements of neutral pH, negative ORP, less than 1 mg/L DO, and less than 1 mg/L sulfate indicate that anaerobic conditions conducive to biodegradation of PCE have been induced in the treatment zone. The concentrations of PCE and its daughter products (TCE, cis-1,2-DCE and VC) have decreased significantly to non-detection levels in the source area treatment zone since EISB implementation while background and side gradient VOC concentrations remain relatively stable, indicating that the EISB system is successfully destroying contaminant mass in-situ. Order of magnitude increases in DHC and functional gene populations support the conclusion that active biodegradation is occurring in the EISB treatment zone. Phytoremediation plot trees are growing successfully with low mortality rates despite high soil salt concentrations. After 2 years, PCE concentrations in monitoring wells near the wetland plot started to decrease indicating tree roots might have reached to groundwater table and are taking up groundwater.