Treatment Train for Remediation of Groundwater Impacts to Achieve Remedial Goals in Surface Water and Sediment

Michael T. Jordan (michael.jordan@terracon.com), ***David W. Hawkins*** (david.hawkins@terracon.com) and Michael B. Dail (michael.dail@terracon.com) (Terracon, Raleigh, North Carolina, USA)

Background/Objectives. A grain mill and grain storage facility operated in the coastal plain of North Carolina from the 1960s through the present. A commingled plume of chlorinated ethenes and ethanes originate from two separate source areas prior to discharging into a perennial surface water feature. Chlorinated ethane detections are collocated with carbon disulfide impacts, which are likely from the use of fumigants. Additionally, petroleum hydrocarbon constituents from a former underground storage tank (UST) basin are also commingled with the chlorinated ethenes and ethanes.

The presence of tetrachloroethene (PCE) degradation products (e.g., trichloroethene [TCE], cis 1,2 dichloroethene [DCE] and vinyl chloride [VC]) provides evidence for past natural attenuation. Attenuation of the chlorinated ethenes was likely enhanced by cometabolic processes due to the presence of anthropogenic hydrocarbons. Future degradation will be limited by an inadequate supply of electron donors (e.g., anthropogenic carbon and natural organic carbon). The discharge of impacted groundwater into the stream resulted in exceedances of sediment and surface water regulatory standards.

Approach/Activities. A treatment train approach was developed to treat source area impacts and address downgradient groundwater impacts in riparian areas. Prior to initiating field activities, a lab-scale treatability study was performed in 2017 to estimate aquifer buffer requirements, assess the efficacy of enhanced reductive dechlorination (ERD), and estimate loading rates. Based on the treatability results, a full-scale ERD remedy was designed to remediate contamination in the surficial aquifer. The initial injection, conducted in April 2018, consisted of approximately 4,800 gallons of injectate and was injected through twelve (12) temporary monitoring wells. The injectate solution was comprised of emulsified vegetable oil (EDS-ERTM), a fermentation product (Nutrimens®), a pH buffer (magnesium hydroxide), a bacterial mixture (KB-1 Plus®), and anaerobic water. Subsequent injections are scheduled for completion in 2019.

Downgradient groundwater in riparian areas will be addressed through the installation of a phytoremediation system. The system consists of approximately 150 willow trees planted over a 15,000-square foot area. The trees are installed as bare root poles directly into the water table.

Results/Lessons Learned. Baseline water quality conditions indicated relatively acidic and anaerobic conditions in source area surficial aquifer wells. At three months post-injection, the population of dechlorinating bacteria Dehalobacter increased by three to four orders of magnitude in select source area wells, while *Dehalococcoides* populations have remained stable and have not shown an observable increase. Increases in cis-1,2-DCE, VC, and methane have been observed in select wells. Additional biogeochemical and chlorinated volatile organic compound (CVOC) data from upcoming quarterly performance monitoring events (fall 2018, winter and spring 2019) will further evaluate spatial and temporal trends associated with the injections and phytoremediation system.