

## Full-Scale Application of Colloidal ZVI and EVO via Liquid-Phase Injection for Treatment of Lesser Chlorinated Ethenes to Accelerate Site Closure

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**Background/Objectives.** A variety of colloidal-sized (~2 to 4 micron) zero valent iron (ZVI) in situ reagent products have recently become available from different commercial suppliers. These products have an advantage over larger particle-size ZVI products in that they can be injected as liquid-phase solutions at low pressure in a manner similar to emulsified vegetable oil (EVO) products, using either conventional injection wells or DPT methods. Fracturing is not required for its subsurface delivery. Because the degradation pathway for chlorinated ethenes with ZVI largely bypasses formation of sequential dechlorination products and because the degradation of the lesser chlorinated ethenes (such as cis-1,2-DCE and VC) via reductive dechlorination is often the rate-limiting step for chlorinated ethene degradation, these ZVI products have the potential to accelerate closure of sites impacted by chlorinated ethenes compared to the use of reductive dechlorination alone. At a former commercial site in Pinellas County, Florida, treatment of TCE in groundwater using reductive dechlorination has been implemented since 2004. During that period, TCE concentrations have been reduced from 15,000 micrograms per liter (µg/L) to non-detect throughout the site. Only cis-1,2-DCE and VC remain present in groundwater above their respective target cleanup standards, at concentrations ranging from approximately less than 50 to 1,830 ug/L. Although continued use of reductive dechlorination is expected to eventually fully remediate the remaining VOC concentrations, the site owner is seeking alternative remediation approaches to accelerate site closure. The use of an injectable ZVI product, combined with EVO, was selected for implementation to accomplish this objective.

**Approach/Activities.** A commercial colloidal ZVI product was selected for injection at the site. A ZVI injectate concentration of 5 grams per liter (g/L) was selected based on discussions with the supplier. EVO, at a concentration of 20 g/L, and calcium carbonate, at a concentration of 10 g/L, were also included in the injectate, to provide an electron donor and for pH buffering, respectively. A target injectate volume was selected to achieve a radius of injection of up to 10 feet. A total of 2,850 pounds of ZVI was injected into 19 injection wells. Post-injection performance monitoring was conducted monthly and quarterly to evaluate system performance.

**Results/Lessons Learned.** The presentation will describe the results and lessons learned from the overall design, permitting, injection, and post-injection monitoring program. Injection methods, pressures, and flow rates achieved during injection will be described along with lessons learned from the field work. The results of the ZVI on reducing VOC concentrations throughout the plume will be presented. Geochemical changes to water quality parameters, including dissolved oxygen, pH, oxidation-reduction potential, dissolved iron, sulfate, and other parameters, will be presented and discussed. The results of this full-scale application can be used to better inform subsequent field activities using similar methods and materials.