Project Title: **Treatment of Source Zone Chlorinated Solvents Using Emulsified Zerovalent Iron Nanoparticles**

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Collaborators: GeoSyntec Consultants, NASA, US Navy

Background: Source zone dense non-aqueous phase liquid (DNAPL) serves as a persistent source of dissolved contamination, and is a major impediment to cost-effective remediation and attainment of site closure. It is needed to develop effective treatment technologies to deal with the source zones. One such technology is the use of emulsified zerovalent iron (EZVI) – a surfactant-stabilized, biodegradable emulsion that forms emulsion droplets consisting of an oil-liquid membrane surrounding zerovalent iron particles in water. It is expected that increased destruction of chlorinated solvents can be achieved using EZVI through increased contact between the DNAPL and the nanosized iron and through providing vegetable oil to augment biological degradation. This project is a pilot field study that focuses on treatment of source zone chlorinated solvents (PCE and its degradation products) using EZVI nanoparticles at the Parris Island Marine Corps Recruit Depot (MCRD), South Carolina site. The joint project is an ESTCP demonstration that includes collaboration among the EPA's GWERD, GeoSyntec Consultants, NASA, and US Navy. The project is also an OSWER Pilot Program project and a RTDF PRB project.

Objectives: The specific objectives are to: (1) evaluate the ability of two injection technologies (pneumatic and direct push) to evenly distribute the EZVI in the subsurface; (2) evaluate dechlorination pathways (biotic versus abiotic); (3) identify and evaluate the mechanisms of formation of corrosion products of injected EZVI; and (4) evaluate the long-term performance of EZVI to decrease the DNAPL mass.

Approaches: There are both field and laboratory components in this research. Field sampling and analysis are coupled with laboratory instrumentation and detailed analysis using a variety of techniques for wet-chemical and solid phase characterization. Compound specific stable carbon (^{13}C) and overall volatile organic chlorine (^{37}Cl) isotopes analysis will be performed on field collected samples and the results will be compared before and after EZVI injection at the Parris Island site. Although both abiotic and biotic dechlorination reaction will result in enrichment of the heavier carbon isotope (^{13}C over ^{12}C) and heavier chlorine isotope (^{37}Cl over ^{35}Cl) in the residual fraction of chlorinated solvents, there may be significant differences in the degree of the enrichment. These differences may be sufficiently large to be used to separate the biotic and abiotc degradation pathways. Identification of iron corrosion products will be performed and several analytical tools (XRD, SEM, FTIR, ICP-OES) will be used for this purpose. Monitoring of well waters at the Parris Island site will be conducted for at least two years after EZVI injection.

Accomplishments to date (June 2007): Injection of EZVI was conducted in October 2006. Soil cores were taken immediately to evaluate the distribution of EZVI. Baseline characterization of groundwater and sediments was undertaken before injection. Post-injection monitoring of groundwater was performed in November/December 2006 and in January and March 2007. Data summarization and interpretation are being conducted with respect to the changes in geochemistry of groundwater and characterization of solid phases. A potential long-term outcome from this research would be development of novel approaches for site remediation and characterization of the extent and conditions under which nanoparticles may be transported in ground water. The results would enhance ORD's capability to meet new challenges of environmental significance.