

Project Title: Performance Evaluation of an Organic Carbon/Zero-Valent Iron Based PRB for Treatment of Arsenic and Heavy Metals

Investigators: Ralph Ludwig, David Jewett, Ann Keeley, Steven Acree, Rick Wilkin, Frank Beck, Patrick Clark (EPA-ORD); and David Blowes, Laura Spink, David Smyth (University of Waterloo)

Problem Definition: The Columbia Nitrogen site in Charleston, S.C. is extensively contaminated with spent pyrite from phosphate fertilizer production at the site between 1905 and 1972. Sulfide oxidation processes (acid rock drainage) have resulted in the subsurface mobilization of arsenic and heavy metals including lead, cadmium, nickel, and zinc. In addition, the groundwater is characterized by a low pH and high acid-producing ferrous iron concentrations. The contaminated groundwater is impacting a tidal marsh located immediately down-gradient of the site. A pilot PRB consisting of a combination of municipal compost and zero valent iron was installed at the site in September 2002. The pilot PRB, measuring approximately 30 ft in length, 12 ft in depth and 6 ft in width, is designed to treat arsenic and heavy metals through the process of microbially-mediated sulfate reduction.

Background: Sulfate reduction based PRB systems are increasingly being recognized as an effective means of removing heavy metals and arsenic from solution. In the process of sulfate reduction, sulfides are produced which combine with the metals and arsenic to produce relatively insoluble secondary sulfide minerals. In addition, during the microbially-mediated sulfate reduction process, carbonate alkalinity is produced which serves to help neutralize acidity and maintain near-neutral pH conditions. Although promising, organic carbon based PRB systems have not yet been fully evaluated. Questions of key interest include the longevity of the organic carbon based systems, the ability of organic carbon based PRB systems to maintain their hydraulic conductivity properties, and the types of organic carbon substrates most suitable for use in PRB systems.

Objectives: The objectives of the study are to determine whether the compost-zero valent iron PRB system is effective in removing arsenic and heavy metals from the groundwater, whether the hydraulic conductivity properties of the PRB are maintained over time, and how long the PRB remains sufficiently reactive to remove the targeted contaminants.

Approach: Two transects of multi-level bundle wells were installed through the PRB allowing for collection of up to 90 groundwater samples up-gradient, down-gradient, side-gradient, and within the PRB. Groundwater samples are being analyzed for multiple parameters including cations, anions, TOC/DOC, TIC/DIC, sulfide, alkalinity, ORP, pH, conductivity, and ferrous iron. Comparison of data up-gradient, within, and down-gradient of the PRB is being used to evaluate performance of the PRB. Hydraulic conductivity testing within and outside the PRB is being used to evaluate hydraulic conductivity changes, if any, during the course of the study. Solid-phase analysis will be conducted on core samples collected from the PRB to determine the types of precipitates being deposited and their potential impact on the long-term performance of the PRB.

Accomplishments to Date: Eight rounds of groundwater sampling spanning a period of 2.5 years have thus far been completed at the site.

Near Future Tasks: Performance evaluation will likely continue for one more year.