EPA
www.epa.gov/nrmrl
NRMRL
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION RESEARCH

In Situ Ferrous Iron Reactive Zone for Treatment of Cr(VI) in Ground Water

Problem Definition

To date, zero-valent iron in the form of iron filings has been the most commonly used PRB media for treatment of reducible metals (e.g., hexavalent chromium) and chlorinated hydrocarbons (e.g., trichloroethylene [TCE]). Although effective, the installation of iron filings-based PRBs can be costly, particularly at depths greater than 30 feet. In addition, iron filings-based PRB systems are rigid systems that offer limited flexibility with respect to installation design and post-installation refinement. Alternative PRB systems may be warranted when installation of zero-valent PRB systems are considered too costly or technically challenging.

Background

Ferrous iron is an effective reductant for treatment of contaminants such as hexavalent chromium (Cr[VI]) and uranium. It can also be effective for treatment of chlorinated hydrocarbons such as TCE under appropriate conditions. Ferrous iron is normally difficult to effectively deliver into the subsurface due to its tendency to rapidly precipitate out of solution. The rapid precipitation of the injected iron may cause well and aquifer formation clogging. However, in the presence of an oxidant inhibitor, such as sodium hydrosulfite (dithionite), the ferrous iron can be stabilized in solution for an extended period of time to allow for its effective dissemination within the subsurface without compromising the hydraulic conductivity of the formation. Existing iron in the subsurface formation is also reduced through contact with the injected sodium hydrosulfite, thereby adding to the total ferrous iron reserve within the reactive zone.

Objectives

- Determine whether ferrous iron, in the presence of sodium hydrosulfite, can be effectively disseminated within a Cr(VI)-impacted aquifer
- Determine whether ferrous iron can be injected without adversely affecting the hydraulic conductivity of the aquifer formation
- Determine whether the injected ferrous iron can effectively form a reactive zone capable of treating incoming dissolved phase Cr(VI)

Approach

Ferrous sulfate was injected in combination with sodium hydrosulfite into a native aquifer formation in the path of a dissolved-phase Cr(VI) plume at the Macalloy Corporation Superfund in Charleston, South Carolina. Monitoring well transects were installed upgradient, within, and downgradient of the injection wells. Ground water samples were analyzed over time for multiple parameters, including cations, anions, oxygen reduction potential, pH, conductivity, alkalinity, total sulfur, and ferrous iron. Comparison of data upgradient, within, and downgradient of injection points was used to evaluate performance of the ferrous iron-based treatment system. Hydraulic conductivity testing within the ferrous iron reactive zone was used to evaluate hydraulic conductivity changes, if any, over time.

Accomplishments to Date

The pilot test was completed, showing that injection of ferrous iron in the presence of sodium hydrosulfite is able to provide sustained in situ treatment of dissolved-phase Cr(VI) for a period of at least 1,020 days. A full-scale system was installed in late 2005 to treat a large Cr(IV) plume at the site. The full-scale system has performed effectively to date.

Near-Future Tasks

The full-scale system installed at the former Macalloy Corporation Superfund site will continue to be monitored for long-term performance.

Investigators

Steven Acree
Frank Beck
Patrick Clark
Kyle Jones
Ralph Ludwig
Randall Ross
Chunming Su