Implementing an In Situ Reactive Zone to Mitigate Off-Site Migration: from Field Test to Full-Scale

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Background/Objectives. At an operating manufacturing plant in Western Europe, a multi-level remedial strategy has been developed to address chlorinated solvent impacts present in soil and groundwater. The impacts are associated with historical degreasing activities performed at the Site, and remediation is required to address potential risks to human health and the environment. The main compounds observed at the Site are tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (TCA), and its breakdown products. The Site remedial strategy includes remediating the on-site source areas, installing an in situ reactive zone (ISRZ) at the downgradient Site border, and stimulating the biodegradation processes naturally occurring at the Site. This presentation shall focus on the field pilot test performed as part of the ISRZ installation at the Site border, including a detailed description of the activities performed as part of the pilot study and a summary of the results obtained during a 2-year monitoring program implemented after the injection activities.

Approach/Activities. The ISRZ field pilot test aims at determining whether a significant mass reduction at the site border would be attainable through enhanced reductive dechlorination (ERD). In order to assess that, a quadruple long-term field pilot study has been conducted to test different substrates as well as different injection techniques. Two test zones with comparable hydrogeological properties and chemical conditions have been selected for the pilot test, and at each zone two products have been injected. The selection of substrates for the pilot was based on their estimated effectiveness for the compounds of concern, their applicability considering the local hydrogeological conditions, and the local availability of the amendment to avoid having them shipped overseas. In Zone 1, the reagent EHC® was injected via direct-push, and the reagent Plume-Stop® was injected via vertical injection wells. In Zone 2, the reagent V-CS® was injected via direct-push, and the reagent 3-D Microemulsion® was injected via vertical injection wells. An elaborate study on the post injection radius of influence (ROI) has been performed for all injected substrates, and a total of seven groundwater monitoring campaigns spread through a 2-year period have been performed following the substrate injections to evaluate both groundwater quality and the presence of micro-organisms indicating biodegradation.

Results/Lessons learned. Given the local hydrogeological conditions and the practical restraints on desired injection pressures, only three out of the four selected substrates were able to be successfully injected and met the established project goals. Both injection via direct push as well as via vertical injection wells seem valuable techniques for the full-scale ISRZ application. ROI estimates varied from 1.0 to 2.5 meters, depending on the reagent characteristics and volumes injected, as well as the local hydrogeological conditions. Based on the groundwater monitoring results, a significant bio-stimulation and associated mass reduction in line with the project expectations can be attainable by two out of the four tested substrates. The assessment on preferred substrate and injection technique for full-scale application has been based on the contaminant mass reduction achieved by each product, the estimated longevity of the substrates, the method of injection and the required spacing between injection points and the associated costs for maintaining the ISRZ in place for a period of 10 to 15 years.