Specially-Configured Subgrade Biogeochemical Reactor to Treat Chlorinated Solvents in Low-Permeability Vadose Zone and Underlying Groundwater

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Background/Objectives. Subgrade biogeochemical reactor (SBGR) technology is a unique green and sustainable remediation technology for treatment of contaminant source areas and groundwater plumes, and has been shown to be particularly effective for chlorinated solvent contamination. These systems are a low-cost, low-maintenance, and sustainable remediation solution.

SBGRs typically consist of an excavated void space backfilled with amendments tailored to degrade the contaminant(s) of concern, and a pumping system to recirculate groundwater through the SBGR for treatment of the surrounding soil and aquifer. With few exceptions, the 19 previously installed SBGRs have been installed into or within a few feet of the saturated zone. One of these SBGRs was installed farther above the saturated zone and is the subject of this paper. Operation of this SBGR shows the value of “top-loading” the contaminated vadose zone with carbon-rich groundwater during treatment.

Approach/Activities. An SBGR was installed in July 2015 at a site at Hill Force Base, Utah contaminated with tetrachloroethene (PCE) and trichloroethene (TCE). Due to the depth to groundwater (>45 feet below ground surface [ft bgs]) and the desire to use standard excavation equipment, the SBGR excavation and backfill addressed only a portion of the vadose zone contamination. The bottom of the SBGR extended to 20 ft bgs, although one portion was extended to 30 ft bgs to excavate higher concentrations of contaminants. The SBGR was installed in silty clay / clayey silt in the vadose zone, using locally-sourced mulch and gravel as the backfill. Silty sand / sand is present in the saturated zone, from which groundwater is extracted and recirculated through the SBGR.

Recirculation of groundwater through the SBGR treats the groundwater and loads it with organic carbon. Infiltration of dissolved organic carbon-rich groundwater from the SBGR is intended to treat remaining contamination in the vadose zone and saturated zone. Treatment of vadose zone contamination also occurs by leaching contaminants into the saturated zone for treatment. In situ treatment may also occur within the vadose zone. Contaminants within the saturated zone below the SBGR are treated in situ through enhanced reductive dechlorination.

Results/Lessons Learned. This paper will summarize operational and analytical data for the first 18 months of SBGR operation. Analytical data for a monitoring well screened in the saturated zone below the SBGR suggest that the positive effects of SBGR operation were observed in the saturated zone between two and five months after system initiation. This conclusion is based on increasing concentrations of TOC and cis-1,2-dichloroethene in the monitoring well, as well as changes in concentrations in PCE, TCE, and nitrate. The latter three compounds are leached out of the vadose zone with the carbon-rich groundwater for treatment in the saturated zone.