

Lessons Learned from the Design, Operation, and Performance of 19 Subgrade Biogeochemical Reactors

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Background/Objectives. The subgrade biogeochemical reactor (SBGR) technology has been successfully applied at 19 sites since 2008, as a unique green and sustainable remediation (GSR) technology for treatment of contaminant source areas and to support in situ treatment recirculation strategies for large groundwater plumes. Based on the contaminants to be treated, SBGRs have been configured for enhanced reductive dechlorination, sulfate-enhanced biodegradation, and aerobic biodegradation pathways. SBGRs have been used to effectively treat chlorinated volatile organic compounds and/or fuel related contaminants in soil and groundwater. Configurations for treatment of hexavalent chromium, brominated volatile organic compounds, 1,4-dioxane, n-nitrosodimethylamine (NDMA), and hexahydro-1,3,5-trinitro-triazine (RDX) are also in development.

Approach/Activities. SBGRs typically consist of the following elements: 1) construction of a soil void space via excavation or large diameter augers, 2) backfill with gravel and several types of in situ treatment media tailored to the contaminant(s) of concern, and 3) installation of a solar-powered pumping system to recirculate groundwater through the SBGR for treatment of the surrounding soil and groundwater. The use of off-grid groundwater pumping, locally sourced farm and tree byproducts, reclaimed construction materials, and other non-refined, recycled, or waste products, has created a low-cost, low-maintenance, and sustainable remediation approach.

Recirculation strategies are often limited by injection well fouling; however, SBGRs have avoided fouling issues due to the geochemistry and relatively large surface area for infiltration within the SBGR. This recirculation approach has allowed multiple pore volume exchanges per year within the target treatment areas, greatly accelerating in situ treatment processes with minimal operations and maintenance costs. SBGRs have been constructed in multiple configurations, including designs capable of working around limited access restrictions from complex underground utilities at heavily industrialized sites, or land surface disturbance restrictions due to sensitive species and wetland habitat issues.

Results/Lessons Learned. Performance results and lessons learned from several chlorinated solvent SBGRs will be presented, some of which are achieving 95 to 99% total molar reduction. Another case study will present a recently constructed petroleum hydrocarbon SBGR where source area concentrations have been reduced by 98 to 99%, based on initial performance monitoring data. Biological and biogeochemical indicator data will be presented to provide insights into the degradation processes that are occurring within the SBGRs, along with a discussion of ongoing research to better understand and document these degradation processes.