Enhanced Bioremediation in Weathered Bedrock: Modifying ROD Selected Remedy, Design, and Implementation

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Background/Objectives. At a former Department of Defense base, tetrachloroethene (PCE) impacts groundwater within a multi-acre plume at an undeveloped site consisting of a heavily wooded wetland. Like many sites, the Remedial Investigation focused on impacts in overburden and in competent bedrock. The selected remedy in the Record of Decision (ROD) consisted of enhanced biodegradation injections and the installation of mulch permeable reactive barriers (PRBs). Biodegradation was chosen for the treatment of bedrock and overburden source area target treatment zones (TTZs). Two mulch PRBs were designed to intercept PCE in overburden at the downgradient edge of the plume before discharging to a surface water feature. Overburden soils at the site consist primarily of glacial till composed of densely compacted sand, silt, gravel and clay, which is underlain by granite bedrock. During installation of monitoring wells to evaluate performance of enhanced biodegradation injections, weathered bedrock zones and highly fractured bedrock zones were identified with thicknesses ranging from 5 to 60+ feet where PCE was present.

Approach/Activities. Additional investigation was performed of the weathered bedrock layer across the site, including thickness of the weathered layer and nature and extent of PCE concentrations within it. Notably, in the area of the proposed mulch PRBs the additional investigation indicated that refusal was shallower than assumed (5 to 9 feet bgs compared with 15 feet assumed in the ROD), that PCE in overburden groundwater was below site-specific site cleanup levels, and detected PCE concentrations in weathered bedrock were over double the concentrations observed in overburden and above clean-up levels. As a result of the weathered bedrock investigation, the Remedial Design (RD) was modified to replace the downgradient mulch PRBs in overburden with biobarriers established with a network of injection wells screened in the weathered layer to apply emulsified vegetable oil as a longer persistent electron donor. In addition, due to the extent of PCE impacts in groundwater identified during the investigation, the RD was enhanced to include an upgradient weathered bedrock TTZ and an additional weathered bedrock biobarrier.

Results/Lessons Learned. Injections of emulsified vegetable oil and sodium lactate with bioaugmentation were completed during Summer 2017. In the three biobarriers, injection wells were spaced approximately 10 to 15 feet apart to establish a PRB. In the TTZ, a network of injection wells screened in weathered bedrock and highly fractured bedrock were used to apply electron donor solutions to areas of higher PCE concentrations, including injecting as deep as 60+ feet below ground surface. During injection, water level rises and detection of substrate were measured in monitoring wells approximately 40 feet from the injection points as well as in adjacent injection wells indicating influence of injected solutions and connectivity of the weathered bedrock fractures. Groundwater performance monitoring will be conducted to evaluate distribution of injected electron donor, establishment of reductive dechlorination reactive zones, and the successful reduction in concentrations of CVOCs.