Immediate and Effective PFAS Treatment in Bedrock Aquifer at a Hazardous Sites Clean-Up Act Site

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Background/Objectives. A pilot study application of colloidal activated carbon (CAC) was completed to address per- and polyfluoroalkyl substances (PFAS) from aqueous film-forming foam (AFFF) used to extinguish a large fire in the 1980s. In 2016, it was discovered that PFAS had impacted public and domestic water supply wells and that a highly concentrated source remained near the fire's origin. The ensuing investigations showed that the PFAS had migrated through a thin, overburden soil layer and into a fractured siltstone/shale/argillite bedrock aquifer. The movement of PFAS impacted groundwater is primarily controlled by the fracture network. The goal of the pilot study was to demonstrate that a CAC in situ permeable reactive barrier (PRB) could effectively stop the migration of PFOS and PFOA, moving from the source area (i.e., the historical fire location) at high concentrations. Pre-test baseline concentrations in the source area were as high as 90,000 nanograms per liter (ng/L) for perfluorooctanesulfonic acid (PFOS) and 1,400 ng/L for perfluorooctanoic acid (PFOA).

Approach/Activities. Before the CAC PRB installation, an injection test using fluorescein dye was conducted to determine the primary fracture-induced groundwater flow pathways controlling PFAS movement within the top 100 feet below ground surface (bgs) near the source area. A straddle packer injection delivery system was used to isolate discrete intervals and gain resolution over the 70 feet saturated zone targeted for treatment. Flow rates were adjusted, and aquifer responses were recorded for each interval. Dye concentrations in nearby monitoring points were compared to baseline. Following the injection test, the pilot test injection plan was developed for the CAC PRB, detailing application CAC volumes and concentrations and an injection sequencing strategy.

Results/Lessons Learned. The combination of a fractured bedrock hydraulic environment and an extensive target vertical treatment interval can present challenges to an in situ remediation approach due to the wide-ranging secondary porosity controlling groundwater movement over the interval. The highly variable porosity observed at this site was quantified during the injection test, leading to a sound CAC PRB injection strategy that achieved the pilot test goal. Following the CAC PRB application, the combined 91,400 ng/L PFOS and PFOA were reduced to approximately 70 ng/L (99.9% reduction), after only one month following the injection event. These results demonstrate the remedy's effectiveness to quickly, sustainably, and safely contain high concentrations of PFAS in fractured bedrock, reducing the risk to downgradient receptors. Expansion of the treatment approach at this site and other sites managed by the regulatory agency is actively being considered.