Implementing Complementary Remedies for Source and Distal Plume Areas of a Mixed Chlorinated Plume in a Fractured Shale Aquifer

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Background/Objectives. A 132-acre commingled VOC plume in fractured bedrock extends through a densely populated area located in the Newark Basin of northern New Jersey where residential wells are still in use. The mile-long plume underlies upwards of 200 residential homes and 15 commercial structures. Bioaugmentation technology was applied to bioremediate chlorinated ethenes and methanes, primarily dissolved trichloroethene (TCE) and carbon tetrachloride (CTC), at the head of the plume. However, this technology is not feasible for addressing the large dilute and commingled distal plume. This study will discuss the management and regulatory challenges of addressing the on- and near-Site plume versus the distal plume, portions of which continue to expand because of mass-loading from unaddressed tetrachloroethene (PCE) off-site sources and the pumping of an off-site golf course irrigation well.

Approach/Activities. In November 2015, we implemented source zone bioaugmentation injections that used over 8,500 gallons of customized EVO products, with suitable droplet sizes tailored to discrete fracture zones in bedrock. The EVO was augmented with SDC-9, a DHC-containing bacterial culture. We evaluated the results of six performance monitoring events in 2016 and 2017. The use of custom droplet sizes to address the variable groundwater velocities (<1 to >10 fpd) and vertical extent (>200 feet deep) in fractured rock will be reviewed as will the design basis; a high-resolution mapping of the fracture network, which includes bedding plane partings as well as tectonic fractures, as well as hydraulic conductivity and groundwater velocity data from discrete fracture zones gathered from tracer studies.

Results/Lessons Learned. Bedrock source zone challenges and solutions will be discussed including transient decreases in pH to very low (toxic) levels, excessive iron production, complex geochemistry, biofilm and biocrust formation, and unpredicted distribution of amendments. MNA is the chosen remedy for the distal plume because of the relatively dilute VOC concentrations over a large area, however commingled PCE plumes make it impossible for all wells to meet MNA statistical tests for decreasing trends. Forensic techniques were applied to dissolved contaminants, including compound specific isotope analysis (CSIA) for PCE, TCE, 1,2-DCE, and 1,4-dioxane to rule out any contributions from our client's site to certain areas of the mile-long plume and thereby secure MNA as a remedy for our client's contributions. We will discuss lessons learned on presenting these issues to regulators and implementing a remedial design for bedrock that transitions from bioaugmentation to MNA specific to our client's contributions.