Use of Blast Fracturing and *In Situ* Treatment Agents for Passive Treatment of a Chlorinated Solvent Plume in Bedrock

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Groundwater beneath the Princeton Plasma Physics Laboratory (PPPL) site Area C is contaminated with chlorinated volatile organic chemicals (CVOCs). The primary chemicals of concern are PCE, TCE, TCA and their natural breakdown products. Groundwater beneath the site occurs in a weathered and fractured bedrock aquifer in the Triassic-aged Stockton Formation. Vertical CVOC distribution is generally limited to the shallowest 30 feet of the bedrock aquifer near a former source location at Area C. Contaminated groundwater is captured by PPPL's Area C building foundation drain system and is not flowing off-site. PPPL proposed, and had accepted by the NJDEP, a "natural remediation" remedy that will require site-wide groundwater monitoring for an extended period of time. Successful clean ups have been implemented using "Permeable Reactive Barriers" (PRBs) in unconsolidated aquifers, however very little field experience exists for applying PRBs to fractured bedrock aquifers. PPPL sought and has identified a proposed method of effectively treating low-level chlorinated VOCs in this fractured bedrock aquifer. The system is intended to create significant baseline cost savings by reducing the area of the site requiring groundwater monitoring (thus reducing the number of wells to be sampled) and by significantly reducing the duration of monitoring. The project involves design and deployment of a bedrock blast-fractured trench in two parallel alignments, and installation of *in situ* treatment in each alignment. This program provides the opportunity to combine a set of three previously developed, but never combined, innovative remediation methods – bedrock blast fracturing to refractively channel flow of groundwater, reactive iron (abiotic) treatment, and a hydrogen slow-release agent (enhanced bioremediation). Blast fracturing involves design and placement of an engineered alignment of relatively high permeability blast-fractured bedrock. The blast fractured trench is intended to passively (i.e., without pumping) collect contaminated groundwater flow across a significant portion of the plume; refract the collected flow into the blast fractured zone and through the installed treatment zones, reducing or destroying the contaminant concentrations; and then disperse the treated water back into the native bedrock formation. The reactive iron and hydrogen release agents will be installed separately in the two parallel blast-fractured alignments to separately evaluate their effects on hydraulics in the blast-fractured zones, treatment results, and geochemical characteristics. PPPL desires to use the relatively limited, shallow plume at Area C to characterize the hydraulics resulting from application of the blast-fractured refractive flow system, results of each treatment separately, and reduce monitoring requirements. Factors in scaling the application to other sites will also be determined. Resulting data can be used for design and application to other, more significant bedrock plumes near PPPL Area C and other DOE facilities with bedrock contaminant plume issues.