Eliminating Risk of Exposure to PFAS in Groundwater: Full-Scale In Situ Remediation with Colloidal Activated Carbon

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Background: Successful full-scale remediation of PFAS with colloidal activated carbon indicates the technology is emerging as a low cost in situ method for the remediation of these compounds in groundwater. By coating flux zones of an aquifer with colloidal activated carbon, a permeable sorption barrier is created in situ, purifying groundwater as it passively migrates. PFAS constituents from up-gradient source zones are rapidly sorbed to the carbon and removed from the mobile dissolved phase. By removing PFAS from the mobile phase, the route of exposure to down-gradient receptors is eliminated, thereby eliminating the down-gradient public health risk associated with PFAS.

Approach: Colloidal activated carbon can be easily emplaced onto the surfaces of aquifer flux zone matrices by simply flowing the micron-scale carbon suspension into wells or direct push points. PFAS compounds rapidly sorb to the carbon bound to the flux zone surfaces. As PFAS compounds are not known to biodegrade, the retardation of migrating species by colloidal activated carbon is therefore finite – albeit variable with carbon dose, placement dimensions, and the concentration, nature and mix of the PFAS species. Retardation factors in the order of thousands may nevertheless be secured using colloidal activated carbon placements representing a fraction of soil mass in the order of 0.001 to 0.01 (a similar range to natural foc). Impact on groundwater flow is therefore negligible, whereas capture / retardation is significant.

Results: Data are presented from actual field case sites where a single application of colloidal activated carbon resulted in orders of magnitude reduction in PFAS groundwater concentrations to below USEPA health advisory levels. Colloidal carbon isotherm data and sorption test data are presented for specific PFAS compounds indicating excellent sorption capability and increased performance with decreasing carbon particle size. The potential for competitive sorption/elution is discussed. Plume modeling is presented indicating longevity of in situ colloidal carbon treatment for PFAS to be on the order of multiple decades before reapplication is required. Design considerations for plume management are discussed including amending existing pump & treat systems to reduce project cost and to eliminate down-gradient risk to public health.