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Remediation of Poly- and Per-fluoroalkyl Substances: New Remediation Technologies for Emerging Contaminants

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Background/Objectives. Poly- and perfluoroalkyl substances (PFAS) comprise a diverse class of contaminants, which include PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoic acid). PFAS are not amenable to bioremediation or conventional chemical treatment, and this greatly complicates in situ remediation of soil and groundwater systems. Further complicating in situ remediation is the presence of “precursor” PFAS that are often present in aquifers, but are not included on the analyte list for standard laboratory analytical methods (USEPA Method 537). Precursors can biotransform over time forming perfluorinated carboxylates and sulphonates, and can therefore act as an in situ source of perfluoroalkyl acids (PFAAs). PFAS are relatively ubiquitous in the environment at low concentrations (100s of micrograms per liter), but source areas, such as landfills, fire training areas, biosolids applications, and historical PFAS manufacturers all exhibit higher PFAS concentrations (> 1 milligram per liter). While the USEPA Health Advisory Limit of 70 nanograms per liter for the summation of PFOA and PFOS is not a maximum contaminant level (MCL), to be protective of potential beneficial reuse aquifers, PFAS groundwater plumes emanating from source zones will require some form of active management.

Approach/Activities. The use of conventional sorbents, such as granular activated carbon (GAC) and anion exchange (AIX) resins, to address PFAS in water have become a “de facto” interim measure in response to immediate needs for PFAS removal from drinking water. Challenges of more comprehensive PFAS treatment in drinking water may also be addressed using technologies such as reverse osmosis or nano-filtration. Extending these technologies to extracted groundwater for remediation purposes, which have various degrees of geochemical and co-contaminant competition, often requires a treatment train, combining conventional sorbents and engineered filtration with more innovative and emerging remediation solutions for PFAS. These emerging solutions include many types of technologies to address source zones, mitigate mass flux in aquifers, or address PFAS in extracted water to improve the efficiency of conventional drinking water treatment technologies. There are new flocculation technologies, novel AIX resins, new engineered sorptive media, electrochemical oxidation, electrocoagulation, sonolysis, and advanced oxidation processes combined with advanced reductive processes.

Remediation technologies for PFAS source zones in soil are primarily limited to excavation with on-site or off-site incineration and in situ soil stabilization. For in situ soil stabilization to be considered viable, ongoing research and development is being conducted to evaluate the longevity of fixation amidst circumneutral pH and biotransformation, which may enhance PFAA dissolution.

Results/Lessons Learned. Remediation of PFAS source zones and the associated groundwater plumes presently requires multiple technologies to protect human health in a cost-conscious manner. An investment in research and development to explore new technologies is part of a key initiative for groundwater preservation and protection of human health. The technologies discussed here will be presented, and their applicability/readiness to the remediation market will be assessed.