First In Situ Treatment of PFAS Ever?
Lessons Learned and Questions Raised

Jeremy Birnstingl, Ph.D. (jbirnstingl@regenesis.com) (Regenesis Ltd., Bath, UK)
Rick McGregor (InSitu Remediation Services Limited, St. George, Ontario, Canada)
Grant Carey PhD (Porewater Solutions, Ottawa, Ontario, Canada)

Background/Objectives. Per- and Polyfluoroalkyl Substances (PFAS) are a growing environmental concern. Distribution is widespread. Impacts to groundwater are exacerbated by their resistance to in situ remediation through common physical, chemical and biological means, and to destructive attenuation processes. Groundwater plumes may be very large owing jointly to this recalcitrance and to often extremely stringent clean-up standards. Source-removal, hydraulic control, and point-of use treatment are the principal groundwater clean-up approaches employed to date. However, all are intrusive, and present treatment and disposal challenges for excavated wastes and/or spent activated carbon. There is a pressing need for additional remediation tools and options to address these species.

Approach/Activities. This paper presents a case study of what is believed to be the first in situ remediation of PFAS using injectable reagents. Treatment was of a former fire-training area of a facility formerly used for furniture manufacture. Initial contaminants of concern driving the remediation were hydrocarbons. However, given the site context, PFAS were tested for – and found – during the remediation performance baseline monitoring. The response of these species to the already-planned hydrocarbon remediation using dispersive colloidal activated carbon injection (*PlumeStop*®) was monitored over time. The novelty of the approach naturally raises performance questions. A range of additional validation and evaluation measures were therefore undertaken. These included extension of the analytical suite to evaluate impacts on shorter-chain PFAS species, soil-core analysis, and post-application installation of confirmatory monitoring wells to complement the initial six wells in the immediate application area.

The study was further expanded through pre- and post-injection plume modelling using In-Situ Remediation (ISR-MT3DMS). The purpose of the modeling was to confirm the attenuation processes and evaluate the longevity of the remedy. Such modeling tools may then be used for effective scenario planning and project design in other settings. They would further serve as a 'backbone' for ongoing project management and performance monitoring and calibration.

Results/Lessons Learned. Pre-treatment hydrocarbon concentrations ranged from 100 to 5,000 µg/L (mixed chain-length), and initial indicator PFAS species (PFOS, PFOA) from 250 – 3,500 ng/L. Post treatment, all were reduced to below detection limits (<0.2 to 200 µg/L hydrocarbons; <20 ng/L PFAS) and have remained at such to date (11 months at the time of abstract). Modelling data suggest the fate and transport of know species may be reasonably predicted. This is simplified by the absence of a degradation term owing to the species' recalcitrance, but is complicated by the potential range of unidentified PFAS species and their propensity for partial transformation and 'biological funneling' to dead-end products. Data for 4-, 6- and 8-carbon PFAS compounds nevertheless suggest plume and modest source-management through this approach may provide an effective medium to long-term measure, even in mixed contaminant settings. Although non-destructive, the approach promises an effective means of limiting or avoiding plume formation and expansion. The avoidance of excavation, long-term pumping and disposal requirements provides an additional advantage.