# Aerobic Biodegradation of PFOA/PFOS: Promising Benchtop Studies and Preliminary Field Applications

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**Background/Objectives.** Aqueous film forming foams (AFFFs) release per- and polyfluoroalkyl substances (PFAS) and are a growing environmental concern. These releases typically include multiple PFAS, many of which cannot be analytically quantified. Bio-oxidative transformation of long chain “precursor” to “dead-end,” PFOS and/or PFOA (PFOS/A) can result in increases in these compounds in more aerobic portions of the aquifer (such as downgradient of the release area) based on PFAS data collected from an orphaned state site located in Michigan. PFOS/A are highly toxic and long lasting in the environment. In situ remediation technologies to address PFOS/A are limited. Carbon has been successfully used to immobilize and retard PFAS migration in groundwater. However, without a means to destroy the sorbed PFAS contaminants, carbon alone, does not permanently reduce the risk. Unlocking a biodegradation mechanism to degrade PFAS, including PFOS/A, is needed to create a cost effective, in situ remedy to address these emerging contaminants.

**Approach/Activities.** Microbes were isolated from a suspected AFFF Site in Alpena, Michigan, where PFOS/A concentrations increase when conditions in Site groundwater become more aerobic, downgradient from the source. Six candidate microbes were isolated from Site soil and groundwater that were found to be viable in a PFOS/PFNA growth medium. In an initial microcosm study, the isolated microbes were found to biodegrade PFOS/A in PFOS/A spiked tap water and Site groundwater in 2 and 8 weeks with additions of various bioenhancements. In another microcosm study (2022), the PFOS/A biodegradability is further verified with a diffusive oxygen source, triplicate analyses and whole bottle extraction methods. Additional controls were also included to assess microbe viability at each stage of the test. Qualitative assessment of inorganic fluoride formation was also included.

**Results/Lessons Learned.** PFAS are considered “forever chemicals” because of the strong carbon fluorine bonds and they are not readily biodegradable in the environment. PFOS/A biodegradability is difficult to verify particularly when precursors are transformed into PFOS/A at rates that may be faster than PFOS/A biodegradation. This study isolated a site-specific microbial culture that have acclimated to the high PFAS levels in groundwater. Under aerobic conditions and spiked systems, PFOS/A concentrations in the initial microcosm study were reduced by 97% and 94%, respectively. PFAS levels in Site groundwater treated with microbes and aeration were also decreased by 62% and 52%, respectively, when compared to the control sample at 2 weeks. However, PFOS concentrations in the groundwater systems increased slightly (8%) at 2 weeks due to transient biotransformation of precursors, before declining by 70% at 8 weeks. A preliminary pilot study bioaugmented with the isolated culture and oxygen source also demonstrated PFOS/A degradation potential. However, the kinetics of precursor biotransformation to PFOS/A may cloak ongoing degradation of PFOS and/or PFOA, particularly under field conditions. With the verification of 2022 microcosm study, PFOS/A biodegradation will be further confirmed. Recommendations on in situ biodegradation of PFOS/A will be provided in this presentation based on the lessons learned.