

## Development of a Conceptual Site Model (CSM) Using a Novel Analytical Method

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**Background/Objectives.** PFASs comprise a large group of chemicals that are used in many industries, i.e., aerospace, apparel, auto, construction, chemicals and pharmaceuticals, electronics, energy, healthcare, oil and gas, and semiconductors. Aqueous film forming foams (AFFFs) were developed in the 1960s by the United States Naval Research Laboratory in collaboration with 3M. Through the years other companies using different manufacturing processes developed and sold AFFFs. As a result different types and compositions of AFFFs that varied over the years were sold and used by the Department of Defense, major airports, refineries, and civilian fire departments. The AFFFs are complex mixtures of multiple classes of PFASs and hundreds of individual PFASs. Current available methods available through commercial labs only analyses up to 35 PFASs and university laboratories about 150 PFASs. In many cases a big portion of the total PFASs present in the samples is not analyzed for. In order to address these difficulties a novel method has been developed and validated that is capable of measuring the total fluorine present in aqueous samples. The method involves pre-concentration by solid-phase extraction disks and quantification of  $^{19}\text{F}$  present by Particle-Induced Gamma-ray Emission (PIGE) spectroscopy.

**Approach/Activities.** The former Wurtsmith Air Force Base (WAFB) is situated in northeastern Michigan and only two mile west of Lake Huron. PFASs were first discovered at WAFB in the groundwater collected in 1998 and 1999 (Moody et al., 2003). A couple hundred samples from different biota have been analyzed for PFASs at WAFB over the years. Many samples at WAFB from groundwater, soil, sediments, fish, birds, and muskrats show some of the highest concentrations of PFAS reported in literature. Out of more than 60 sites from the Great Lakes Basin, tree swallows at WAFB had more than twice the highest concentrations of PFASs found anywhere else in the Basin. Recently during the Site Investigation (SI) 20 areas for additional investigation identified during the Preliminary Assessment were investigated for presence of PFASs or additional data was collected for better site characterization. The areas of investigation where areas where AFFF was stored, handled, used or released such as fire training area, aprons, fire station, hangars, AFFF pump station, vehicle operations, AFFF retention lagoons, crash sites, former wastewater treatment plant (WWTP) sludge drying beds and areas where the sludge was spread, WWTP aeration lagoon, WWTP seepage lagoons, sanitary sewer system, and storm water sewer. During the SI work split samples from all the groundwater and surface water were obtained to be analyzed using PIGE.

**Results/Lessons Learned.** The current conceptual site model (CSM) of the PFAS contamination at WAFB will be presented. The frequency of detection of individual PFASs from commercial laboratories as well more extensive list performed by Oregon State University and California Department of Toxic Substances Control. The PIGE results compared to the LC-MS/MS data will be presented in order to show the good agreement between methods. Finally, a CSM based solely on few hundred PIGE results will be presented. The CSM will show the potential of PIGE to be used at other AFFF contaminated sites in order to identify and confirm presence of PFASs, delineate plumes, or monitor plume migration.

