Portfolio Assessment of Key Factors Influencing PFASs Fate/Transport Including: pH, DO, ORP, TOC, CEC, and Grain Size Distribution

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Background/Objectives. Per- and polyfluoroalkyl substances (PFASs) are under investigation at various sites across the US where aqueous film forming foams (AFFFs) have been used for fire protection. These sites are located in a wide variety of lithologic/hydrogeologic settings with varying conceptual site models (CSMs) that can influence fate/transport (F&T) of PFASs. PFASs are biologically recalcitrant and highly soluble resulting in large dilute plumes and numerous impacts to drinking water systems. AFFF formulations include anionic, cationic, and zwitterionic PFASs and source areas are often comingled with other contaminants (e.g., petroleum hydrocarbons at Fire Training Areas [FTAs]) further complicating F&T. Therefore, F&T of PFASs is generally complex and poorly understood in many ways. However, some prior studies have identified several key parameters that can influence F&T including: pH, total organic carbon (TOC), grain size, and cationic exchange capacity (CEC) in soil and TOC, dissolved oxygen (DO), and oxidation-reduction potential (ORP) in groundwater. Grain size distribution of source area soils provides percent fines data that may also correlate with leachability, which in turn may correlate to plume length.

Certain PFASs have been shown to readily adsorb to granular activated carbon (GAC) and thus, soil organic matter is also expected to enhance adsorption of longer chain PFASs. In addition, cationic and zwitterionic PFASs in AFFF with a positive charge will be attracted to anionic soils (e.g. silt/clay). This surface charge attraction (i.e. ion exchange) would increase concentrations of cationic and zwitterionic PFASs in soil and reduce their leaching potential. Higher TOC levels in groundwater may also influence (i.e. reduce) PFASs concentrations in groundwater. Long chain poly-fluorinated precursor compounds can biotransform under oxic/aerobic conditions into more heavily regulated PFASs including perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) making DO/ORP important parameters to consider when evaluating the potential for this biotransformation to occur. The assessment of these parameters and their relationship to the distribution of PFASs in soil and groundwater will be utilized in F&T modeling, inform future Remedial Investigations, and inform risk management decisions.

Approach/Activities. This paper describes the results of extraordinary F&T analyses conducted on a portfolio of sites that have experienced extensive PFAS impacts to surface soils as the result of spills or testing of AFFF. Test objectives were to: (1) explore relationship between PFAS concentrations and key F&T parameters; (2) assess whether correlations of these parameters can be made to plume length, peak concentration, and risk management issues (i.e., potential receptor impacts); and (3) develop a fate and transport hypothesis that would inform Site-specific and future CSM development.

Results/Lessons Learned. Results of this sampling/analysis will be presented and will include discussion regarding any correlations made using this data. Lessons Learned during sampling for these extraordinary analyses will be provided and recommendations for when and why to include them in future investigations will be presented.