

Fate and Transport of PFASs in Surface Waters and Sediments: Potential for Long Range Transport?

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Background/Objectives. Poly- and perfluoroalkyl substances (PFASs) comprise a large group of several thousand xenobiotics, with varying fate and transport characteristics. Many PFASs can exhibit long range transport in water bodies, but some are significantly less mobile and may constitute a long term, more localised ongoing source. The differing sources of PFASs, such as from coatings or firefighting foams can play a very significant role in their fate and transport characteristics.

The current US federal regulatory focus is on two “long chain” perfluoroalkyl acids (PFAAs), perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). However, there are also multiple chain length PFAAs including “short chain” PFAAs and polyfluoroalkyl substances which are increasingly being regulated by differing US states and internationally. There are thousands of polyfluoroalkyl substances which tend to biotransform aerobically to create the perfluoroalkyl substances as ultra-persistent “dead end” daughter products, Hence, the polyfluoroalkyl substances are termed “PFAA precursors” as they represent a source of the persistent PFAAs. Some polyfluoroalkyl substances are more mobile than the PFAAs they create or conversely can also be much less mobile. The long and short chain PFAAs have differing motilities and partitioning properties to soils and sediments, with shorter chain PFAAs being potentially more water soluble and mobile than the more amphiphilic longer chain compounds. The polyfluoroalkyl substances may exhibit a wide range of differing fate and transport properties as a result of potentially containing anionic, cationic, zwitterionic or non-polar functional groups. Environmental conditions such as pH, ionic strength (e.g. salinity), aqueous biogeochemistry, presence of dissolved natural organic matter (NOM) and the aquifer or sediment fraction of organic carbon (f_{oc}) can also play a significant role in fate and transport of PFASs. The widespread use of PFASs has led to background concentrations in soils, surface waters, groundwater, rainwater, snow and thus biota. So confirming the PFASs detected in multiple matrices do not comprise background will be essential. To develop an effective conceptual site model (CSM) to evaluate the risks PFASs may pose to identified site-specific receptors an understanding of the nature and location of the dominant PFASs present on each site seems essential.

Approach/Activities. This initial aims to provide a general review fate and transport properties of PFASs considering differing broad groups of compounds within the class and relate this to site specific environmental conditions. Then site specific examples of long and short chain PFASs partitioning to sediments from surface waters will be presented. The detection of high concentrations of polyfluorinated precursors to short chain PFAAs in surficial soils using advanced analytical tools, will also be described.

A review of background concentrations of PFASs in multiple matrices will provide some pragmatism for assessment of PFASs. An overview of the biotransformation characteristics of the two main classes of PFAA precursors will aim to assess their relative importance when

developing site-specific conceptual models, with examples of precursor concentrations in surface waters from recent spills of firefighting foams versus more weathered and attenuated sources and plumes.

Results/Lessons Learned. Some PFASs are commonly detected in surface waters as a result of their mobility and extreme persistence, but low level detections may sometimes be considered as a background concentrations and may not originate at the local site under investigation. Atmospheric long range transport of PFASs needs to be considered when investigating sites impacted with PFASs. From some site investigation it is clear that the “long chain” amphiphilic PFAAs demonstrate far greater sorption to sediments and NOM than their shorter chain analogs. Some PFAA precursors are suggested to be more mobile than the PFAAs they form, but they may also suffer biotransformation to PFAAs whilst moving through aerobic surface and groundwater. Results from recent site investigations shows some classes of precursors are less mobile and constitute a long term source of PFAAs. Recent losses of some products dominated by precursors do not contain significant PFAAs and advanced analytical tools seem necessary. Differing sources of PFASs products can play an important role in defining site specific conceptual site models. Fate and transport characteristics of differing PFAAs and their polyfluorinated precursors can influence CSM development and where to focus the remedy.