Source Differentiation of Per- and Polyfluoroalkyl Substances in Environmental Source Inputs

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Overview. Per- and polyfluoroalkyl substances (PFASs) impart unique water and oil repellent properties, and are applied in numerous sectors including in and on consumer products, manufacturing, and in aqueous film forming foams (AFFFs) which suppress hydrocarbon fuel fires. Consequently, use and improper disposal of PFASs contribute to environmental contamination from sources such as landfill leachates, wastewater treatment plants, and AFFF application. The focus of quantification is currently on select PFASs such as perfluorooctanoate and perfluorooctane sulfonate, although there are potentially thousands of unique PFASs. Only a few studies have attempted to differentiate input sources using the most prevalent PFASs with moderate success. While these studies have indicated that there are differences between source inputs, they do not include enough data to support distinct PFAS source trends (e.g., landfill leachate versus AFFF).

This study attempts to distinguish input sources (e.g., landfill leachate) using a more robust approach by targeting ~250 individual PFASs. Samples selected to represent source inputs to the environment from a mixture of archived samples as well as freshly collected samples. Although temporal differences occur between samples (e.g. AFFFs applied in the 1970s versus current WWTP effluent), this study attempts to represent each source of environmental contamination and matrix. Collected data will be evaluated using a statistical approach to compare data in a comprehensive way and aid in the differentiation or fingerprinting of the following matrices: landfill leachate, wastewater treatment plant effluent, and AFFFs, based on both concentration and unique PFAS distribution/species.

Specific Aims.
1. Selection of sample size, distribution, and locations in landfill leachates, AFFFs, wastewater treatment plant effluents (with and without landfill leachate input) are chosen to represent each matrix.
2. Extraction, quantification, and analysis, from each source input will be developed.
3. Source differentiation using statistical analysis.

Experimental Approach: Sample selection and matrix types have been collected to be spatially similar for direct comparison and differentiation from one another. Samples used to represent landfill leachates will be selected from an archive used as part of a nationwide survey and evaluated to ensure stability over time. This landfill leachate archive, from 2014, is the only known national survey collection currently known to exist. AFFFs from a large archive dating from 1989 to current day (military approved for fire-fighting use) will be used to collect a representative sample of AFFFs that were applied at military sites. Wastewater treatment plant effluent samples will be selected to include municipalities with and without landfill leachate added for disposal. Municipalities will be selected to match as spatially as closely as possible to matched landfill leachate samples. Samples will be extracted, quantified, and statistically differentiated.

Significance. The differentiation of PFASs from different input sources will allow for fingerprinting which can directly account for environmental PFAS contamination and ultimately remediation.