Field Studies of PFAS Retention of Groundwater at Freshwater/Saltwater Interfaces

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Background/Objectives. The aqueous solubility of some organic compounds generally displays an inverse dependency on ionic strength, a chemical phenomenon known as "salting out." Newell et al. (2021a) observed that the salting-out effects of PFAS may be an important natural attenuation process in environments where fresh groundwater plumes mix with saline groundwater near marine shorelines. For surface water systems where PFAS in freshwater streams and rivers mix with salt water in estuaries, PFAS can be scavenged by adsorption onto suspended sediment (Hong et al., 2013), with some studies observing an increase in soil sorption coefficients (K_d) of up to a factor of 10 (Chen et al., 2012).

A naturally-occurring hydrologic process referred to as "tidal pumping" likely increases the mixing of fresh groundwater plumes and saltwater near marine shorelines by increasing circulation of inflowing saltwater and discharging fresh groundwater within the zone of the saltwater-freshwater interface zone, enhancing the salting out processes through deposition of dissolved phase PFAS from solution, leaving it within the matrix and minimizing discharge. This process has been demonstrated in modeling studies by Australian researchers to reduce the peak mass discharge of PFAS from groundwater to surface water (Li et al., 2022).

Approach/Activities. While salting out processes have been identified in estuaries and in laboratory studies (e.g., SERDP Project ER-18, 1140, Abriola et al., 2020), we are not aware of any field-scale reports of salting out processes where PFAS in fresh groundwater enters a marine system. To test the groundwater/tidal pumping/salting out hypothesis in the field, the U.S. Navy has funded a high-resolution characterization project at two PFAS sites, the first located immediately adjacent to the shoreline where tidal pumping has been observed, and the second located inland and outside documented tidal influences but with a similar geologic depositional environment to serve as a control. A total of ~15 groundwater-soil sample pairs will be collected at each site in the early winter 2022 at different depths and near shore locations to represent salinities ranging from freshwater to seawater. The samples will be analyzed by commercial labs for key PFAS and the TOP assay to determine if the sorbed PFAS mass increases with salinity. A companion project funded by SERDP Project ER22-3275 will collect another 15 paired samples at a third site in the early spring 2023.

Results/Lessons Learned. Key data from the three sites will be presented to show the overall magnitude of the salting out effect and the factors that correlate and do not correlate to the strength of the salting out effect. General observations about how these detailed field data can be transformed to useful site management information will be provided.