

PFAS at Contaminated Sediment Sites: Evolving Technical, Regulatory, and Legal Priorities

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Contaminated sediment sites are among the country's most complex and expensive sites to characterize and remediate. As per- and polyfluoroalkyl substances (PFAS) garner attention in the news, courts, Congress, and regulatory agencies, it is somewhat surprising that this group of compounds has yet to loom large at most contaminated sediment sites. However, the U.S. Environmental Protection Agency (EPA) has proposed listing PFAS as hazardous substances under the Comprehensive Environmental Response, Compensation and Liability Act, and such a listing may shift investigation, cleanup, and enforcement priorities at virtually all contaminated sites, including sediment sites. There is an increasing prevalence of fish consumption advisories and drinking water supply concerns as a result of releases of PFAS. The proximity of those advisories to Superfund sites and industrial facilities suggests that the technical, regulatory, and legal priorities at contaminated sediment sites may shift in the near future. Many factors differentiate PFAS from legacy sediment contaminants, such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), mercury, and lead. The combination of characteristics of these compounds is noteworthy in several respects, as summarized below.

First, PFAS represent a broad array of compounds. The universe of PCB and PAH compounds is well-defined, in that regulators, scientists, and engineers rarely debate whether a substance is or is not a PCB or a PAH.



In contrast, there is no consensus definition of PFAS. Most often, substances are included based on chemical structure—specifically, carbon atoms linked to each other and bonded to fluorine atoms. Structures and properties of PFAS vary widely and include solids, liquids, and gases; neutral, anionic, cationic, and zwitterionic substances; inert to highly reactive substances; insoluble to soluble substances; involatile and volatile substances; virtually immobile and highly mobile substances; and linear and branched structures. But PFAS are not limited to manufactured substances. They also include salts, degradants, impurities, metabolites, by-products, and other transformation products. Depending on the breadth of the definition applied to PFAS, the group may comprise only a few thousand to more than ten thousand individual substances.

Second, PFAS use is ubiquitous, and the sources are diverse. Industrial and commercial activities and products often associated with PFAS are wide ranging.

They include fire suppression (military, fire training, civilian airports, oil refineries, petrochemical facilities), plating/metal finishing, plastics, coatings, tanneries, leather/fabric/carpet treaters, consumer and personal care products, chemical manufacturing, automotive, paint, paper manufacturing, and semiconductor manufacturing. Wastewater treatment facilities that receive effluent from commercial and industrial users of PFAS can be of concern due to both end-of-pipe discharges and disposal of solids generated during treatment.

Third, PFAS are essentially unamenable to destruction or degradation in the environment. Compounds may transform or breakdown—but the fluorinated carbon chains are stable. Transformation processes can cause degradation product concentrations to increase over time since release and distance from release.

Fourth, conceptual site models—mapping sources, migration pathways, unintentional recycling, fate, and receptors—can be extremely complex. Proprietary formulas, complex mixtures that change over time, transformation of PFAS precursors, and other factors greatly complicate analyses. Multiple pathways are available for transport—water, sediment, and air can transport PFAS effectively. Substantial water solubilities, and a propensity for the air–water interface, allow for effective groundwater and surface water transport. Though sorption of PFAS to sediment is less strong than that of legacy contaminants, PFAS do sorb effectively and often irreversibly to sediment. Consequently, like legacy sediment contaminants, sediment can accumulate PFAS and act as a secondary source to surface water and biota.

Fifth, treatment and risk mitigation are currently focused on drinking water. Mitigating risk to humans and ecological receptors posed by PFAS in surface water systems is likely to require administrative controls (e.g., fish consumption advisories), sediment remediation, and surface water treatment. But treatment of drinking water is likely to take priority over treatment of water that is not a drinking water source. EPA and many

states have promulgated or proposed PFAS regulations in drinking water at parts-per-trillion levels. (<https://www.integral-corp.com/our-services/pfas/>). Water standards in the parts-per-trillion range indicate that very low sediment concentrations can drive problematic water concentrations. Regulation of PFAS at sediment sites may occur during the remedial investigation and feasibility study process, as well as after remedies have already been selected and during 5-year reviews.

Sixth, ecological risk is uncertain and stymied by information gaps. Compared to dietary exposures, gill transfer is typically the more important exposure pathway, such that lower trophic level fish may be more highly exposed than higher trophic level birds and mammals. Ecotoxicological data are limited for most substances, mixtures, and wildlife receptors. Standards and guidelines specific to human exposure are overwhelmingly focused on the drinking water pathway. In the absence of robust toxicological data, most state and federal regulatory agencies apply the precautionary principle. Consequently, it can be challenging to interpret concentrations in sediment, surface water, and biota—and to calculate risk-based cleanup levels.

For these and other reasons, PFAS can defy the customary principles of sediment investigation, such as the expectation of a decreasing gradient in chemical concentrations with distance from the source, a predictable relationship between concentrations in sediment and in surface water, increasing exposures up the food chain, and greater prevalence near industrial land uses compared to rural areas.

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In collaboration with Robb Fox, partner at Manko, Gold, Katcher & Fox, LLP, Integral will host a 60-minute webinar on the ramifications of tighter regulation of PFAS on contaminated sediment sites, from both technical and legal perspectives. Join us on October 17, 2023, at 1:00 p.m. Eastern by registering [here](#).

