Firefighting and Forever Chemicals

The Environmental Impact of PFAS in Firefighting Foam

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Clouds of black smoke erupt from a jet fuel–powered blaze at a commercial airport. The high-hazard, intense liquid fire cannot be put out with water alone—like a grease fire in your kitchen, it must be smothered. Firefighters are called to administer a fire suppressant foam that is resilient to heat, pressure, and oxidation. The foamy substance quickly covers the fuel source feeding the inferno and forms a blanket preventing oxygen from reigniting the flames. The emergency is contained, and as firefighters hose down the site, the fuel, water, and foam mix together. Some of this watery discharge is diverted to a holding tank and will be collected, treated, and sent to a disposal facility, while some spills onto a nearby field and soaks into the soil. The liquid percolates into the groundwater, which is later pulled up by wells for drinking water.

A similar scene could occur at a petroleum refinery, military base, chemical plant, or fire training academy—anywhere that Aqueous Film Forming Foam (AFFF) is used. Incredibly effective at containing and extinguishing hazardous fires, AFFF contains fluorine chemicals collectively referred to as per- and polyfluoroalkyl substances (PFAS), which present a variety of risks to human health and the environment.

While PFAS are sometimes referred to as "emerging contaminants," they have been used for over 70 years, and approaches to mitigate their risks have been topics of discussion and litigation for decades. The U.S. Environmental Protection Agency (EPA) launched a PFAS stewardship program in 2006, and one of the first PFAS lawsuits was filed in 1999. *Tennant v. DuPont*. No. 6:99-cv-00488 (S.D.W. Va., filed June 11, 1999). Given their wide use since the 1970s, the exact volume of watery PFAS-laden foam that has entered groundwater is difficult to ascertain. One group's recent search of EPA's National Response Center database found nearly 900 documented spills or usage reports of AFFF entering waterways since 1990, with the amount exceeding 800,000 gallons. Env't Working Grp., *EPA Data Show Almost 900 "Forever Chemical" Foam Releases, Many into Local Waterways* (Mar. 22, 2022).

Fast forward to 2022, and thousands of cases involving AFFF-contaminated groundwater have been consolidated into a multidistrict litigation (MDL). They involve diverse plaintiffs, including water providers, states, and residents, as well as a wide variety of defendants, including manufacturers, formulators, distributors, and users. Firefighters have filed personal injury and medical monitoring class action lawsuits over AFFF exposure, and states have sued manufacturers for groundwater contamination.

While AFFF lawsuits progress, at least 12 states have banned AFFF use in some way. Congress is keeping the pressure on by mandating AFFF phase-outs and the development of alternatives to PFAS-based AFFF, and funding human health monitoring studies around military bases. EPA is in the process of designating two PFAS as hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which could create Superfund liability for AFFF users and recipients of waste from that use, as well as manufacturers. EPA is also sending CERCLA § 104(e) information requests to foam users. In short, the legal, regulatory, and political landscape surrounding AFFF itself could be described as a raging hot fire needing active management and innovative solutions.

PFAS and AFFF

PFAS are a group of over 9,000 synthetic chemicals that have been used since the 1940s. Due to their strong carbon-fluorine bonds, PFAS are persistent in the environment, with degradation periods of years, decades, or longer under natural conditions. These so-called forever chemicals have been widely used in military applications and a range of industries, including aerospace, oil and gas, mining, and medical devices. They are found in consumer products like food packaging; cookware; water-resistant apparel, carpets, and fabrics; and cosmetics. The chemical properties of PFAS make them useful in a variety of applications that require chemical stability, heat resistance, and water and grease repellency.

The ubiquity and bioaccumulative nature of PFAS have translated into broad exposure. Most Americans (97–99%) have some quantity of PFAS in their blood. *See* U.S. Ctrs. for Disease Control & Prevention (CDC), *National Report on Human Exposure to Environmental Chemicals* (2018); CDC, *PFAS in the U.S. Population* (2017). Studies have linked PFAS exposure to an array of health problems, including thyroid hormone disruption, obesity, lipid and insulin dysregulation, kidney disease, cancer, reproductive and immune system issues, problems during pregnancy, and suppressed vaccine response. *See, e.g.*, S.E. Fenton et al., *Per- and Polyfluoroalkyl Substance Toxicity and Human Health Review: Current State of Knowledge and Strategies for Informing Future Research*, 40 Environ. Toxicol. Chem. 606 (2021). Drinking water contaminated with PFAS is one of the most common exposure sources. Ingestion of PFAS-contaminated food and dust are also exposure pathways, as well as using products containing PFAS. *See generally* U.S. Agency for Toxic Substances & Disease Registry, *PFAS and Your Health* (2021).

Two well-characterized sources of PFAS groundwater contamination are PFAS manufacturing plants and AFFF releases. AFFF is manufactured by combining hydrocarbon foaming agents with PFAS-containing fluorinated surfactants. When mixed with water, the solution creates an aqueous film that can spread across the fuel surface to extinguish the flame. The solution also forms a vapor barrier between the fuel and oxygen to prevent reignition.

When allowed to come in contact with soil, the PFAS in AFFF can contaminate it and underlying groundwater during precipitation and irrigation events, or even through cleanup measures, forming plumes of groundwater contamination. And once PFAS enter the environment in any media, the chemical characteristics of PFAS that make them useful make them challenging to remove or treat. Thus far, activated carbons, high-pressure membranes, and anion exchange have promising removal efficiencies. However, all require more study as to their efficacy, cost, consistency, and environmental impacts. Granular activated carbon filtration technology is expensive but is the most consistent method to remove "long-chain" (C8) PFAS from water resources. This technology can also treat so-called short-chain (C6) PFAS. Other filtration technologies remain largely experimental at this point. Removal of contaminated soil presents challenges because it is unclear how disposal sites should manage PFAScontaminated waste. Regulations under the Resource Conservation and Recovery Act, as well as state laws, are evolving, and destruction of PFAS stockpiles have become a management challenge.

Continuing Use of AFFF

AFFF was developed by the U.S. Naval Research Laboratory in the 1960s to improve fire suppression performance and increase safety in the wake of the fatal jet fuel fire on the *USS Forrestal* in 1967. In the late 1960s, the U.S. Navy required all vessels to carry AFFF. Beginning in the 1970s, Department of Defense (DOD) employed the use of AFFF at all military bases; today, military use is still the majority of the AFFF market. J. Field et al., *FAQs Regarding PFASs Associated with AFFF Use at U.S. Military Sites*, Env't Sec. Tech. Certification Program at 4–7 (Aug. 2017). By the late 1970s, many municipal airports and fire departments also began using AFFF. It became an important tool in industries with significant flammable liquid hazards including oil refineries, fuel tank farms, chemical storage and processing facilities, oil tankers, firefighting training centers, and chemical plants.

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A variety of AFFF products are manufactured by many companies under different trade names; this article refers to the foams generally as "AFFF." There are two firefighting foam classes: Class A, designed to extinguish "ordinary combustibles" (paper, wood, fabric); and Class B, to extinguish flammable liquids (oil, gas, alcohol). Class B foams are further categorized based on manufacturer and usage: legacy PFOS and other PFAS such as perfluorohexane sulfonate (PFHxS); and legacy fluorotelomer AFFF brands, produced between 1970 and 2016 that contain polyfluorinated precursors known to degrade into long-chain PFAS. Interstate Tech. Regul. Council, *AFFF Fact Sheet* at 3–4 (Oct. 2018). The modern fluorotelomer AFFF, or "C6 foams," use short-chain fluorosurfactants, which are considered less toxic. *See, e.g.*, J.L. Oprihory, *Debate Continues over Safety of USAF's Firefighting Foam*, Air Force Mag. (Mar. 19, 2019).

While many manufacturers and users have transitioned to C6 foams in response to EPA's 2010/2015 voluntary PFOA Stewardship Program, due to the stability of the chemicals, facilities with flammable liquid hazards still have legacy long-chain AFFF in inventory. Although federal law does not prohibit the use of legacy AFFF from existing stocks, discharges to soil or water may have federal consequences, and some states have stringent regulatory criteria applicable to releases to soil or groundwater. Facilities are left to weigh safety benefits—and the cost of disposal and replacement of legacy AFFF—against potential liability and public health risks. Firefighting industry best practice for Class B foams is fluorine-free foam (FFF) for training and testing, unless a jurisdiction requires AFFF to be used, in which case only C6 foams are permitted. *See, e.g.*, Fire Fighting Foam Coal. (FFFC), *Best Practice Guidance for Use of Class B Firefighting Foams* (2021).

Other than through firefighter training and equipment testing, AFFF can enter the environment through actual fire suppression events, catastrophic incidents, accidental system discharge, or false activation. In order to minimize the risks of AFFF to the environment, the public, and users, the FFFC and other industry groups have developed best management practices (BMPs) that can be adopted by government fire safety authorities for activities such as foam selection; storage, usage, planning, and mitigation; and disposal.

State and Federal Initiatives to Regulate AFFF

Over two dozen states have legislation banning or limiting AFFF foam use. A 2018 Washington law (S.B. 6413) banned, as of 2020, the manufacture and distribution of AFFF with PFAS "intentionally added" and prohibited using such AFFF for training purposes. Exceptions exist for applications required by federal law (such as military bases and airports), petroleum terminals, chemical plants, and oil refineries. Other states have followed suit, banning AFFF except in absolutely necessary circumstances.

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State laws can also be used to regulate PFAS and AFFF. For example, the New Jersey Spill Act, N.J.S.A. 58:10-23.11 *et seq.*, has been used to require remediation of contaminated AFFF sites. Illinois used the state's water quality act to sue a company for discharging PFAS-containing water after it used AFFF foam to extinguish an underground mine fire. *State of Illinois ex rel. Kwame Raoul v. Sugar Camp Energy LLC*, No. 22-CH-2022CH2 (Ill. 2d Dist., filed Jan. 7, 2022). However, after Wisconsin sued PFAS foam users under the state hazardous substance spill law, an industry organization successfully challenged the state's authority to do so. A state circuit judge recently granted a motion to stay the decision pending appeal to the Wisconsin Supreme Court. *See Wisconsin Mf'rs & Comm., Inc. v. Wis. Dep't of Nat. Res.*, No. 21-000342 (Wis. Cir. Ct. filed Feb. 23, 2021).

By comparison, federal legislation has lagged. One bill that moves annually to the president's desk is the National Defense Authorization Act (NDAA); given the widespread use of AFFF at military facilities, the 2019, 2020, and 2021 NDAAs have contained a variety of PFAS provisions. These include requiring the Navy to establish new standards for AFFF use at military installations by January 31, 2023; prohibiting DOD from purchasing AFFF with more than one part per billion (ppb) PFAS after October 1, 2023; setting an October 1, 2024, deadline for DOD to phase out PFAS-containing AFFF; providing funds for drinking water utilities; adding PFAS to the Toxics Release Inventory; establishing coordinating committees; putting temporary incineration bans in place; and setting up health studies. *See* John S. McCain National Defense Authorization Act for Fiscal Year 2019, Pub. L. No. 115-232, 132 Stat. 1636; National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116-92, 133 Stat. 1198; William M. Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283, 134 Stat. 3388. The "PFAS Firefighter Protection Act," introduced in April 2022, S. 4076 and H.R. 7597, would ban the manufacture, import, and sale of PFAS-based AFFF, but has not moved forward.

Nonlegislative federal action and regulation closely mirror the public's concerns. EPA took a key step in October 2021 by publishing a PFAS "Strategic Roadmap," setting agency goals for 2021–2024, and building on the Agency's 2019 PFAS Action Plan. The roadmap outlines goals and identifies dozens of actions that EPA plans to implement with respect to PFAS. Goals include (1) investing in research, development, and innovation to better understand exposures and toxicities; (2) pursuing a comprehensive approach to proactively prevent PFAS from entering air, land, and water at levels that can adversely impact human health and the environment; and (3) broadening and accelerating PFAS cleanups. One example of EPA's proposed action is leveraging federally issued National Pollutant Discharge Elimination System (NPDES) permits. This would allow EPA to require use of a reasonable alternative to AFFF in industrial processes, adoption of BMPs to address AFFF, and enhanced discharge notifications.

Following the Strategic Roadmap's release, the infrastructure bill signed on November 15, 2021, dedicated $10 billion to PFAS efforts—$5 billion for small and disadvantaged community drinking water, $4 billion for removing PFAS from drinking water supplies or connecting well owners to local water systems, and $1 billion for PFAS in wastewater discharges.

Despite state and federal action, there are still limitations to PFAS regulation. Over 9,000 compounds in the PFAS family have been manufactured and used for decades worldwide; over 600 remain in commerce today. EPA, *Comptox Chemicals Dashboard: Master List of PFAS Substances* (2022); CDC Nat'l Inst. for Occupational Safety & Health, *PFAS* (2022). However, EPA's testing methods only measure 29 PFAS in drinking water. EPA, *EPA PFAS Drinking Water Laboratory Methods* (Mar. 2020). Further, PFAS levels generally are measured in parts per trillion (ppt), as compared to contaminants regulated to the ppb—a degree 1,000 times less than ppt. Reflect that one ppb is equivalent to adding one drop of water to 10,000 gallons of water, while one ppt is equivalent to a grain of granulated sugar in approximately18 million gallons of water. On June 21, 2022, EPA announced lower health advisory levels for four PFAS, some down to parts per quadrillion (ppq): 0.004 ppt (4 ppq) for PFOA, 0.02 ppt (20 ppq) for PFOS, 10 ppt for the chemicals considered to be replacements for PFOA and PFOS—hexafluoropropylene oxide dimer acid and its ammonium salt (GenX chemicals)—and 2,000 ppt for perfluorobutane sulfonic acid and its related compound potassium perfluorobutane sulfonate (PFBS). EPA, Lifetime Drinking Water Health Advisories for Four Perfluoroalkyl Substances, 87 Fed. Reg. 36,848, 36,849 (June 21, 2022) (2022 PFAS Notice).

Health advisory levels are published under the Safe Drinking Water Act for contaminants not subject to a primary drinking water regulation. 42 U.S.C. § 300g-1(b)(1)(F). They describe concentrations "at which adverse health effects are not anticipated to occur over specific exposure durations." 2022 PFAS Notice at 36,849. EPA notes a variety of adverse health "associations between PFOA and/or PFOS exposure"; links GenX chemicals to "health effects in the liver, the kidney, the immune system, and developmental effects, as well as cancer"; and states that PFBS adversely affects the thyroid, reproductive system, development, and kidneys. *Id.*

Measuring contaminants at such low concentrations makes obtaining reliable and accurate laboratory results very difficult. And because PFAS are so prevalent, sampling equipment containing common combinations of ethylene and polyethylene products could cause crosscontamination.

There are also challenges in disposal and remediation of AFFF PFAS contamination. First, EPA-approved sampling methods focus on water and soil, leaving other media such as air, or receptors like animals, without test methods for now. EPA, *EPA Announces First Validated Laboratory Method to Test for PFAS in Wastewater, Surface Water, Groundwater, Soils* (Sept. 2021). While lab tests can still be conducted, this can result in variations and inconsistent data, which can make identifying appropriate remediation levels difficult. When PFAS are found in soil, remediation can be conducted via excavation for incineration or landfilling, or with emerging remediation techniques that immobilize contaminants. The first two options are the most expensive of all remediation methods, typically between four and 15 times more than others. Fed. Remediation Techs. Roundtable, *Technology Screening Matrix* (2022). Immobilization solutions are in their infancy and may be unavailable in some jurisdictions, and even after site remediation, "forever chemicals" are difficult to completely remove.

Litigation Overview

Much of the nation's PFAS groundwater contamination was first inventoried under EPA's Third Unregulated Contaminant Monitoring Rule (UCMR 3) from 2013–2015. EPA, Revisions to UCMR 3 for Public Water Systems, 77 Fed. Reg. 26,072 (May 2, 2012). This required 4,920 water utilities—supplying nearly 80% of the U.S. population—to test for certain contaminants without health-based standards, including six types of PFAS. The dataset released in 2017 is one of the first national-level inventories of PFAS occurrence in drinking water.

AFFF case law—and precedents around liability, causes of action, and remedies—is evolving, and will continue to as more PFAS contamination is discovered and affected parties go to court for redress. So far, litigation has resulted in landmark studies of PFAS impacts on human health and the environment. *Leach et al. v. E.I. du Pont de Nemours & Company*, for example, involved PFOA contamination of drinking water in six water districts near the DuPont Washington Works facility in West Virginia. No. 01-C-698 (Wood Cnty., W. Va., Cir. Ct., settled Feb. 28, 2005). One component of the eventual settlement included funding for scientific research on the connection between PFOA and various afflictions. The resulting "C8 Health Project" collected PFAS health data from nearly 70,000 individuals from 2005–06—the largest known population study of a PFAS-exposed population at that time. *See* S.J. Frisbee et al., *The C8 Health Project: Design, Methods, and Participants*, 117 Env't Health Persp. 1873 (Dec. 2009). The study found the population geometric mean for blood serum PFOA at levels 500% higher than any previously reported for a representative American population, and PFHxS and perfluorononanoic acid levels elevated by 39% and 73%, respectively. *Id.* In 2011 and 2012, the C8 epidemiologists concluded that "probable links" exist between PFOA and kidney cancer, testicular cancer, thyroid disease, high cholesterol, pre-eclampsia and ulcerative colitis. C8 Sci. Panel, *C8 Probable Link Reports* (2011–12).

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Several disputes involving PFAS contamination and exposure have since been settled for billions across the country and abroad. The C8 personal injury litigation parties, for example, settled for $671 million. *See In re E.I. du Pont de Nemours & Co. C-8 Personal Injury Litig.*, No. 13-2433 (S.D. Ohio, transferred from MDL Apr. 9, 2013); A. Nair, *DuPont Settles Lawsuits over Leak of Chemical Used to Make Teflon*, Reuters (Feb. 13, 2017). In July 2021, Corteva, Chemours, and DuPont settled with Delaware for $50 million in damages related to manufacture, use, and disposal of PFAS. The companies negotiated a $4 billion cost-sharing arrangement to cover certain PFAS liabilities. *See* Press Release, Chemours, DuPont, Corteva, and Chemours Announce Resolution of Legacy PFAS Claims (Jan. 22, 2021).

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The largest AFFF litigation as of July 2022 included over 2,800 cases. *In re AFFF Prods. Liab.* (MDL No. 2:18-mn-2873-RMG). In December 2018, the U.S. Judicial Panel on MDL, at defendants' request, consolidated multiple personal injury cases pending in courts across the country into the MDL. U.S. Jud. Panel on MDL, Transfer Order No. 2873 (Dec. 7, 2018). Today, 12,000-plus plaintiffs—individuals, local governments, states, tribes, water districts, airports, companies, and colleges—allege harm from AFFF-based PFAS contamination and exposure. Defendants (nearly 200) span the supply chain (i.e., manufacturers of AFFF and its component chemicals and distributors) and also include AFFF users, such as the U.S. Air Force, Army, and Navy.

The AFFF MDL sweeps more cases in daily. Presiding Judge Richard M. Gergel is using a "bellwether" process to guide the MDL for different case types, commencing with public and private water provider cases. The first bellwether trial will begin in April 2023, allowing the parties' executive committees to test legal theories in a trial setting, discern potential trends, gauge the potential success of future trials, and possibly foster settlements.

Where We Go from Here

Prioritization is imperative when facing this burning landscape of policy, regulation, legislation, and litigation. What legal, scientific, and management approaches are most necessary to control the blaze? At the forefront is developing viable alternatives to PFAS-containing foams. Such alternatives need to enter the marketplace soon. Related actions include advancing scientifically accepted destruction protocols for C8 foam stockpiles at facilities nationwide.

As the AFFF MDL and other cases progress, another priority will be building jurisprudential and legislative doctrines around liability and responsibility for AFFF cleanup. Presently, any entity that used AFFF foam could be found potentially responsible for some portion of this massive task—which raises questions around equities. Our society needs to answer difficult questions. Should rural airports and fire training academies be saddled with cleanup costs? Should local utilities and their ratepayers pay for remediation of received AFFF-contaminated wastewater? Does this raise fairness and environmental justice concerns that must be addressed, as many disadvantaged communities are host sites for industrial, military, and aviation facilities? Is the AFFF legacy the responsibility of the manufacturers and users, requiring a "polluter pays" model, where AFFF sites may become Superfund sites? Will Congress release small businesses, municipalities, water districts, and others from liability? What precedent will the bellwether MDL cases set, and how will that affect other cases?

Another priority is to anticipate what to do when the next fire occurs. Is first responder safety and preservation of critical infrastructure of higher importance than groundwater protection? Already AFFF users face almost certain litigation, but will the position that there was no alternative be a viable defense?

As we stand at the intersection of fire, water, and PFAS, the legal, scientific, and policy communities must work together to answer the difficult questions before us, develop policies that work, and implement strategies to effectively respond to widespread environmental and human health impacts. While the timing of this work might be uncertain, one fact is: More cases will be filed daily by those impacted by AFFF who cannot wait for our collective answer.

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