



## These Chemicals Are Forever: Water Contamination from PFOA, PFOS and other PFASs

**The introduction of per- and polyfluorinated substances (PFASs) in the mid-twentieth century unleashed a wave of persistent and toxic chemicals into the environment, contaminating everything from food and drinking water to the dust around us. Also known as “forever chemicals,” these substances continue to persist in the environment and in our bodies even after a partial phase-out of their production in the United States, often resistant to even the most advanced water treatment technologies.**

Now, mounting evidence shows that the emergence of seemingly safer and less persistent “alternatives” to legacy PFASs may pose the same problems as their predecessors. An ineffective and broken regulatory system and weak environmental laws in the United States have done little to stymie the ever-revolving chemical treadmill that has contaminated entire communities and put public health at risk. The federal government must take immediate action to strengthen regulations to stop PFASs from contaminating our environment, and to remove them from our drinking water.

Per- and polyfluoroalkyl substances are a large group of related synthetic compounds that were introduced in the 1940s and 1950s, when chemical regulations were even weaker than today.<sup>1</sup> Due to their stable chemical structure, PFASs are long-lived substances with the ability to repel both water and oil, making them extremely useful in a wide

variety of applications and products.<sup>2</sup> However, the characteristics that have made them attractive for use in an array of products are the very ones that have led to their widespread contamination of the environment and people.

As of 2018, at least 478 PFASs had been reported to the U.S. Environmental Protection Agency (EPA) as being used in U.S. commerce.<sup>3</sup> Other sources report that thousands of PFASs have been produced and used by various industries, in both the United States and around the world.<sup>4</sup>

The most studied and pervasive chemical forms are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS).<sup>5</sup> PFOA has been used in the production of the chemical polytetrafluoroethylene (PTFE), best known by the commercial name Teflon™, which was first synthesized in 1938 by a DuPont scientist and came into widespread

use in the 1960s.<sup>6</sup> The compound also has been used in waterproof textiles, electrical wire casing and more.<sup>7</sup>

Similar to PFOA, PFOS has been used in the production of everyday household items as well. One of the most well-known products that contained PFOS was 3M's line of Scotchgard™ stain repellants.<sup>8</sup> PFOS also has been used in pesticides, surface coatings for carpets, furniture, waterproof apparel and paper goods.<sup>9</sup>

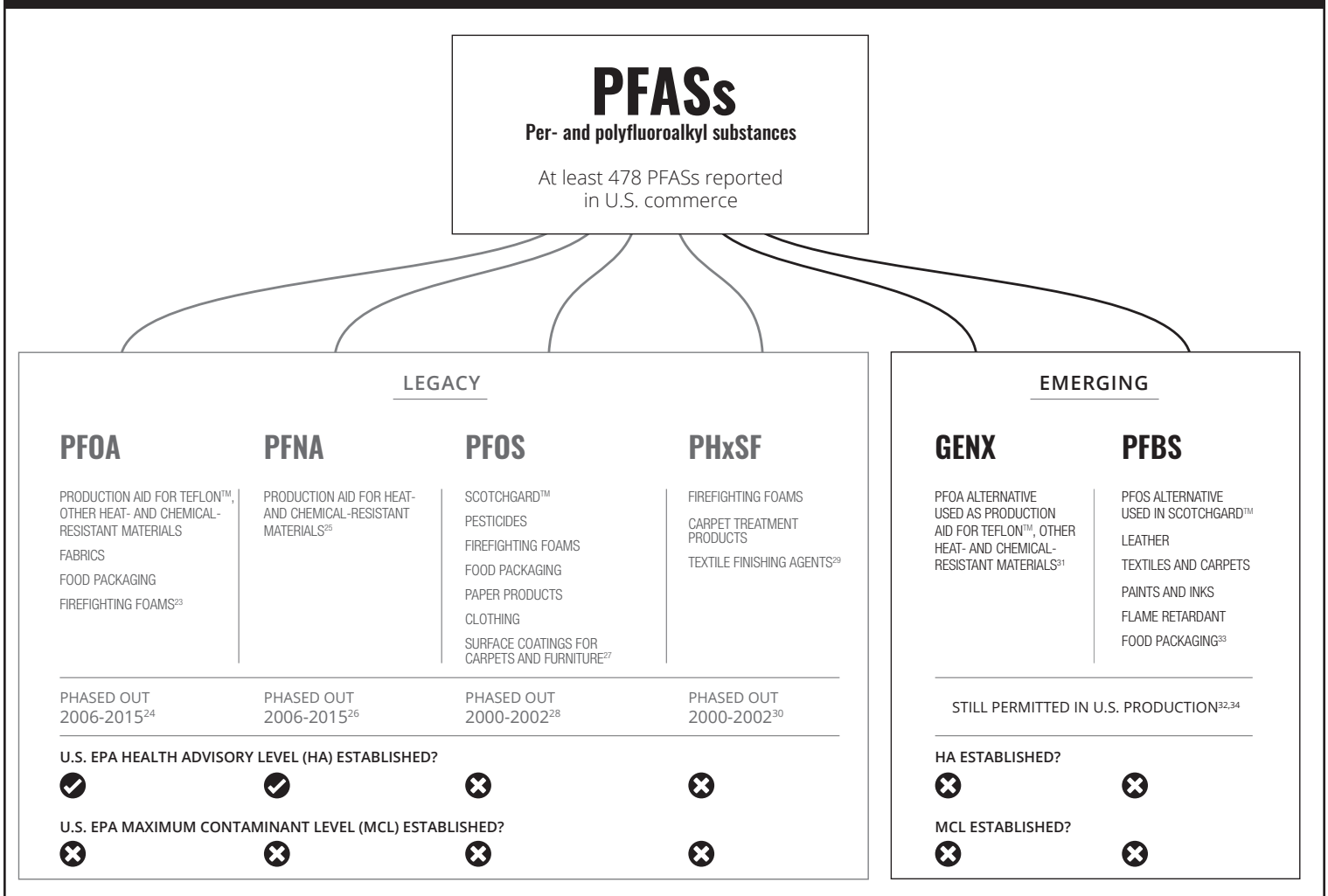
PFOA and other PFASs have been used to produce Teflon™ and other fluoropolymers, which coat a wide range of products to protect against heat, chemicals and corrosion.<sup>10</sup> PFASs also have been used in aqueous film forming foam, which was developed in the late 1960s to extinguish petroleum fires.<sup>11</sup>

PFASs, and PFOA and PFOS in particular, have been in the spotlight due to numerous incidents of widespread con-

tamination and mounting toxicological evidence, much of which came from the producers and users of the chemicals themselves.<sup>12</sup> As a result, PFOA and PFOS have been targeted for control and removal by various cities, states and the federal government. While awareness of these substances seems to have gained momentum over the past 20 years, evidence of PFASs' stubborn persistence and toxicity has been around since the late 1960s and 70s, only to be overlooked until relatively recently. This resulted in delayed intervention, even as the substances continue to be released into the environment.<sup>13</sup>

The manufacture and use of PFOA, PFOS and other similar PFASs have decreased significantly in the United States due to a series of EPA-facilitated voluntary phase-outs by major manufacturers that occurred starting in 2000.<sup>14</sup> Remaining sources of these chemicals may come from existing stocks that might still be in use, from com-

## BACKGROUND: What Are They and Where Did They Come From?



\* These chemicals are the most studied or prominent of the PFAS family and represent a sample of the many hundreds that are known to exist in U.S. commerce.

panies not participating in the voluntary phase-out of these chemicals, and the presence of these substances in imported products.<sup>15</sup> While industrial releases of PFOA and related compounds have declined in the United States, along with production in other industrialized nations, China's production has been increasing, and the country is now the largest emitter of PFOA in the world.<sup>16</sup>

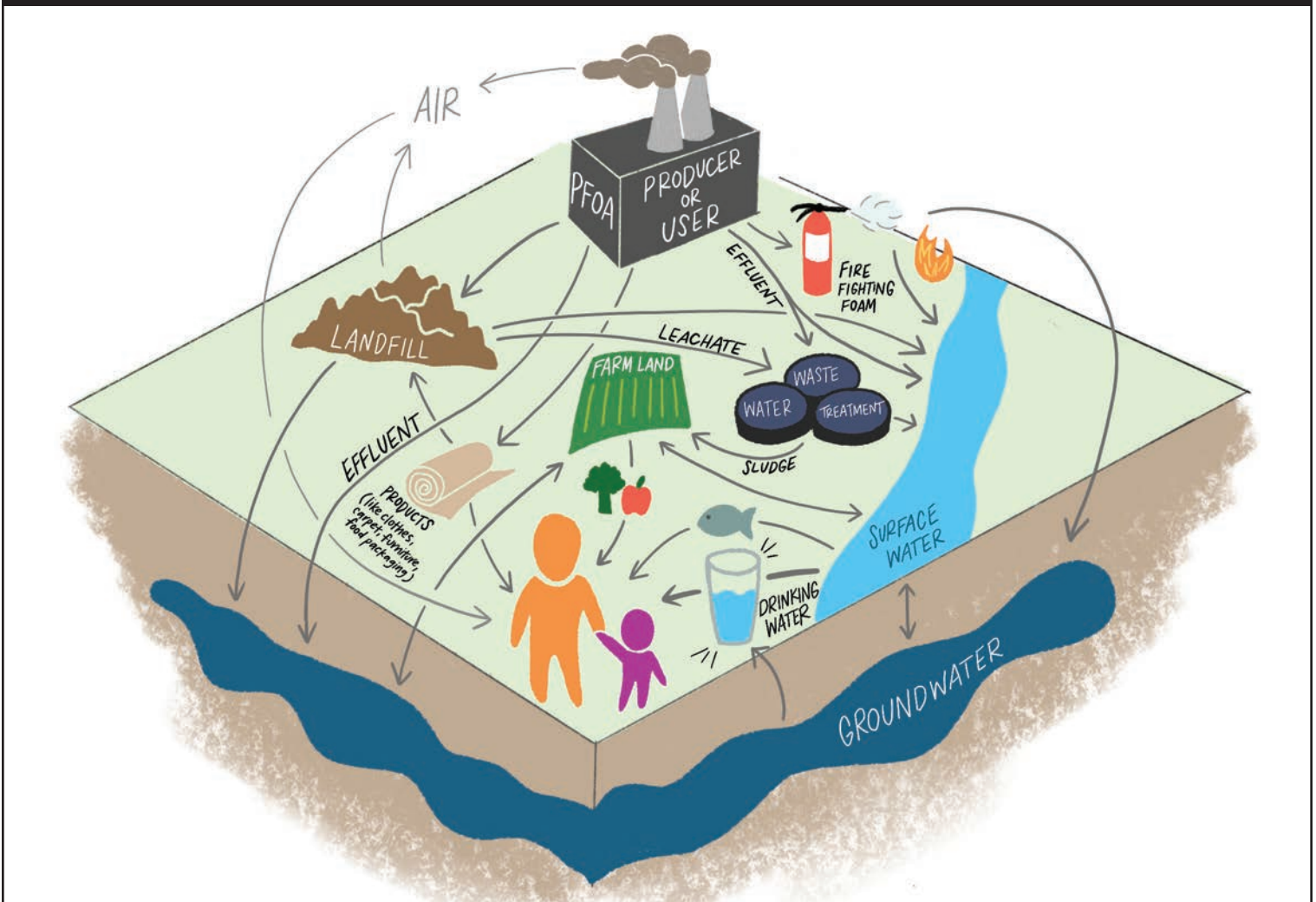
After the phase-out of PFOA and PFOS, manufacturers began replacing them with different, but similar, chemicals, with claims of reduced toxicity and bioaccumulation.<sup>17</sup> However, there are concerns that these alternatives to legacy PFASs may in fact have the same problems as their older relatives.<sup>18</sup> While these chemicals may not be as likely to accumulate in the tissues of people and animals as their predecessors, they are still resistant to breaking down.<sup>19</sup> The emerging PFASs also are less effective,

creating concern that they may be used in larger volumes and thus negate any benefits of lower bioaccumulation.<sup>20</sup> Moreover, there is evidence that they can transform into legacy PFASs.<sup>21</sup> Many of these newer chemicals lack important, publicly available data on characteristics such as their chemical properties and toxicity.<sup>22</sup>

## PFASs Are “Forever Chemicals” That Contaminate the Environment and Animals

PFASs are incredibly prevalent and persistent in the environment, meaning that they stay in the soil and water for long periods of time. Often referred to as “forever chemicals,” PFASs are immune to degradation, regardless of environmental conditions.<sup>35</sup> Natural breakdown over time is assumed to be virtually nonexistent.<sup>36</sup>

### How Are People Exposed to PFASs?



SOURCE: Image based on Oliaei, Fardin et al. “PFOS and PFC releases and associated pollution from a PFC production plant in Minnesota (USA).” *Environmental Science and Pollution Research*. Vol. 20, Iss. 4. April 2013 at figure 1 at 1979.

PFAS contamination is pervasive and comes from a wide range of sources. These chemicals can enter the environment directly from landfills where products such as carpets and textiles break down and leach into the air, soil and water.<sup>37</sup> They also can indirectly enter the environment when precursor chemicals break down to form compounds like PFOA and PFOS.<sup>38</sup> PFASs have been shown to linger long after their production and use.<sup>39</sup> PFOS, PFOA and other PFASs have been shown to be present in groundwater for anywhere from 5 to 15 years following the end of firefighting activities at a military base in Michigan.<sup>40</sup> PFASs also have been found in a number of plants and animals. Residues have been found in strawberries and lettuce, as well as fish, seals, polar bears and dolphins.<sup>41</sup>

Due to characteristics such as their high water solubility and persistence, PFASs are mobile in soil, are prone to leaching into groundwater and can travel large distances.<sup>42</sup> PFASs have been found to contaminate environments of all sorts, including landfills and wastewater treatment plants, as well as remote and seemingly pristine regions, such as the deep sea and the Arctic.<sup>43</sup>

For decades, PFASs have contaminated drinking water in the United States and around the world, presenting a huge risk to public health.<sup>44</sup> PFASs have been found to frequently

exceed the U.S. EPA's lifetime health advisory level, sometimes many times over.<sup>45</sup> As of 2016, PFASs had been detected in 194 of 4,864 surveyed public water supplies in the United States, potentially exposing 16.5 million people in 33 states.<sup>46</sup>

State- and local-level testing has found evidence of even more widespread contamination. In 2018, the Michigan Department of Environmental Quality found that 50 percent of drinking water and groundwater samples were found to have detectable limits of PFASs.<sup>47</sup> A 2018 report from the Vermont Department of Environmental Conservation found PFOA in over 400 out of the approximately 600 drinking water wells tested, with about 75 percent of these wells containing levels greater than the state's 20 parts-per-trillion (ppt) PFOA/PFOS drinking water standard.<sup>48</sup>

Recent reports show that emerging PFASs, such as GenX, have been on the rise, with concentrations vastly exceeding those of legacy PFASs.<sup>49</sup> Despite claims of low bioaccumulation, emerging PFASs are as environmentally persistent as their predecessors.<sup>50</sup> Additionally, there is evidence that these newer chemicals can break down to form their legacy counterparts.<sup>51</sup>

## PFASs Are Toxic

PFASs have been found in nearly the entire U.S. population, and a growing body of science has been documenting their toxicity and public health impacts. PFOA and PFOS have been most studied of the PFAS chemicals in terms of their health impacts on humans, but there is a dearth of literature for many other PFASs, particularly the emerging chemicals that are now used as substitutes.

Reports of PFAS contamination in humans and the environment began appearing in the 1970s and 1980s.<sup>52</sup> Humans are exposed to PFASs via a large number of sources, including food (both homegrown and store-bought), food packaging, drinking water, the dust inside homes and more.<sup>53</sup> A 2003 to 2004 survey by the U.S. government estimated that over 98 percent of the U.S. population had detectable levels of PFASs in their blood.<sup>54</sup>

PFASs can concentrate in the bodies of humans and animals over time through a process known as bioaccumulation.<sup>55</sup> For example, as a result of PFOA's tendency to bioaccumulate and its long half-life in humans, PFOA's presence in the body can persist even after exposure stops.<sup>56</sup> PFOA's half-life (the length of time it takes for a substance to decrease to half of its original value) in humans is anywhere from over two to nearly four years,



while other PFASs have been shown to have a half-life of over eight years.<sup>57</sup> There is also evidence that some PFASs can biomagnify, or increase in concentration, up the food chain.<sup>58</sup>

Some evidence indicates that even very low levels of PFAS exposure may not be completely safe for human health.<sup>59</sup> Ongoing exposure to low levels of PFOA found in drinking water can substantially increase total exposure in humans and can lead to concentrations in the body high enough to potentially increase health risks.<sup>60</sup> Infants may be especially vulnerable to PFOA, due to PFOA contamination of breast milk and their higher intake of water relative to their body weight.<sup>61</sup> PFOA and related substances have been found in human maternal and cord blood in North America and abroad.<sup>62</sup>

PFASs pose serious risks to human health. There are a number of well-documented health effects associated with exposure to PFOA and other PFASs. This includes high cholesterol, thyroid disease and weight gain.<sup>63</sup> PFOA also has been shown to be associated with reproductive effects, such as decreased fertility and pregnancy-induced hypertension.<sup>64</sup> Increased exposure to PFOA was found to correlate with decreases in birth weight.<sup>65</sup> PFOA exposure also has been shown to cause adverse impacts on the liver and on the immune system — with a link to decreased vaccine response and ulcerative colitis — as well as result in neurobehavioral effects such as attention deficit hyperactivity disorder (ADHD).<sup>66</sup> There also has been increased concern about the link between PFASs and endocrine disruption.<sup>67</sup>

PFASs may cause cancer. The World Health Organization's cancer research arm, the International Agency for Research on Cancer, classifies PFOA as a Group 2B carcinogen, or "possibly carcinogenic to humans."<sup>68</sup> The U.S. EPA concludes that there is "suggestive evidence" of carcinogenicity of PFOA in humans.<sup>69</sup> Highly exposed humans were observed to have correlating increases in testicular and kidney cancer.<sup>70</sup>

## Water Treatment Can Remove Some Forms of PFASs

According to the EPA's Drinking Water Treatability database, PFOA and PFOS can be removed by up to 99 percent by processes such as granular activated carbon, membrane separation, ion exchange and powdered activated carbon.<sup>71</sup> Aside from these technologies, PFAS removal is resistant to many, if not most, water treatment processes, while other technologies may in fact increase their concen-

### PFAS Testing and Cleanup for Concerned Consumers

At the moment, testing for PFASs in drinking water may be difficult and expensive. Food & Water Watch suggests reaching out to your state environmental agency for more information on getting your drinking water tested. The U.S. EPA also recommends a list of approved laboratories participating in the drinking water monitoring program for unregulated contaminants, which meet EPA standards for testing.<sup>74</sup>

NSF International, a global organization that develops standards and provides certifications to improve public health and the environment, recommends water treatment products that are certified to P473 to reduce PFOA and PFOS contamination to below the EPA's health advisory level.<sup>75</sup> The Environmental Working Group has additional recommendations of filters capable of removing PFOA, PFOS and other PFASs on their website at [bit.ly/2q0EgHJ](https://bit.ly/2q0EgHJ).

Consumers who wish to avoid potential PFAS exposure from drinking water or who live in communities affected by PFAS contamination should keep in mind that PFAS testing is currently not required for bottled water. Testing bottled water is not mandated under federal law, although some companies may voluntarily do it.<sup>76</sup>

trations.<sup>72</sup> Other processes, such as powdered activated carbon, are effective at removing older PFASs, but become less effective with newer PFASs, many of which are replacing the legacy PFASs.<sup>73</sup>

## PFASs Are Weakly Regulated

**Drinking water quality:** There is no current enforceable federal standard for PFASs in drinking water. The EPA has established a lifetime drinking water health advisory level of 0.07 micrograms per liter (mg/L), or 70 ppt, for PFOA and PFOS, but it has not yet issued an enforceable Maximum Contaminant Level for drinking water.<sup>77</sup> The health advisory level falls short not only in lack of effectiveness, but in stringency. Sure enough, emails disclosed in early 2018 found that the EPA suppressed a scientific assessment of PFASs from a federal health research agency that recommended a much more stringent level of protection that was nearly 7 to 10 times lower than the EPA's health advisory.<sup>78</sup>



The EPA collects data for unregulated contaminants in drinking water that the agency has not set a health-based standard for under the Safe Drinking Water Act. This means the agency is only monitoring the prevalence of these chemicals, but does not require drinking water providers to reach any specific contamination level through treatment. Six PFASs were included in the previous 2013 to 2015 monitoring cycle, including PFOA and PFOS.<sup>79</sup>

A handful of states have worked to develop enforceable and more stringent standards. New Jersey is in the process of implementing a limit for PFOA at 14 ppt and has proposed limits for PFOS and PFNA at 13 ppt, constituting some of the lowest standards in the country.<sup>80</sup> Vermont's combined health advisory level for five PFASs (PFOA, PFOS, PFHxS, PFHpA and PFNA) is 20 ppt.<sup>81</sup>

**Partial phase-out:** In 2006, the EPA invited eight major chemical manufacturers to participate in a global stewardship program on PFOA and other related chemicals. The companies — Arkema, Asahi, Ciba, Clariant, Daikin, DuPont, 3M/Dyneon and Solvay Solexis — all agreed to commit to reducing these chemicals from their emissions and products by 95 percent by 2010 and by 100 percent by 2015.<sup>82</sup>

The phase-out has not completely eliminated these legacy PFASs from U.S. production and use. Some companies are not participating in the PFOA Stewardship Program, some companies may be using existing stocks, and there are still limited acceptable uses of these chemicals. Additionally, PFOA and PFOS are allowed in goods imported from other countries.<sup>83</sup>

Limited data are available on ongoing production and use of PFOA, PFOS and other PFASs within the United States, and any relevant data reported are done so as confidential business information.<sup>84</sup> Information on industrial PFAS releases is also sparse. Facilities are not required to test for or report PFAS wastewater discharges since the EPA has not classified any of these chemicals as toxic pollutants or hazardous substances under the Clean Water Act, and are not required to report on environmental releases of these chemicals to the EPA's Toxics Release Inventory.<sup>85</sup>

**International attempts to curb PFAS use:** In 2009, PFOS was added to Annex B of the Stockholm Convention, in which participating countries must restrict the production and use of the substance due to its persistence in the environment, long-range environmental transport and ability to bioaccumulate and biomagnify in mammals and birds.<sup>86</sup> PFOA and PFHxS are currently proposed for listing.<sup>87</sup> The United States signed the Stockholm Convention in 2001 but has not ratified it.<sup>88</sup>

## PFASs Continue to Be Used on Military Installations

PFASs contained in firefighting foam products that are used to put out petroleum fires have contaminated military bases and surrounding communities for decades and continue to do so despite restrictions.<sup>89</sup>

Watersheds that contain military fire training areas have higher concentrations of PFAS chemicals than areas with-

out.<sup>90</sup> In 2017, 401 military installations were found to have a known or suspected PFAS release, and 23 percent of public and private drinking water systems tested off-base were found to have PFAS levels above the EPA's health advisory level.<sup>91</sup>

The cleanup cost of PFOA-contaminated groundwater is estimated to be up to \$2 billion, in addition to the \$200 million that the Defense Department has already spent on treating and testing its water supply and providing bottled water.<sup>92</sup>

The Defense Department is looking for replacements for firefighting foams that do not contain PFASs. In the meantime, the military is allowing ongoing use of PFAS foams with some restrictions.<sup>93</sup>

## Major Incidents of Contamination

As of 2018, there were 172 documented PFAS contamination sites across 40 states.<sup>94</sup> Several of these have constituted major public health crises due to their especially large reach, affecting millions of residents, as well as to significantly high spikes of PFAS levels in drinking water for a number of vulnerable communities. Below are just a few of the examples from many communities around the country dealing with this contamination:

**Hoosick Falls, New York:** In 2014, residents of Hoosick Falls, a small town near Albany, New York, became aware of PFOA when testing revealed high levels of the contaminant in their drinking water.<sup>95</sup> A nearby plastics factory, now operated by Saint-Gobain Performance Plastics, which used PFOA in its manufacturing process, had been contaminating the town's water supplies. The majority of samples revealed PFOA levels over 600 ppt, far higher than the 400 ppt U.S. EPA health advisory at the time.<sup>96</sup> Groundwater under a Saint-Gobain plant was found to have PFOA levels at 18,000 ppt.<sup>97</sup> Many residents were found to have PFOA levels in their blood that were 100 times the national average.<sup>98</sup> The U.S. EPA has since added the Saint-Gobain Performance Plastics site to its Superfund National Priorities List of the most hazardous waste sites in the country, which requires the agency to ensure that the contamination is cleaned up.<sup>99</sup>

**Parchment, Michigan:** As of September 2018, the Michigan Department of Environmental Quality (MDEQ) has identified PFAS contamination in 44 municipal water systems across the state, impacting over 1.6 million residents.<sup>100</sup> At the top of this list is Parchment — at 1,828 ppt, over 25 times the U.S. EPA's health advisory level,



Hoosick Falls, New York / PHOTO CC-BY-SA © Doug Kerr / Flickr.com

the city has the highest level of total PFASs in Michigan.<sup>101</sup> The elevated PFAS levels in Parchment's water supply prompted Michigan state officials to advise residents to stop drinking the water and to declare a state of emergency in July 2018.<sup>102</sup> The MDEQ believes that the sources of contamination include a nearby shuttered paper mill, which used PFAS additives on laminated paper products, and its associated landfill.<sup>103</sup>

**Cape Fear, North Carolina:** Chemours, a company spun off of DuPont, contaminated North Carolina's Cape Fear River with GenX and dozens of other PFASs, affecting over 200,000 residents who depend on the river for drinking water.<sup>104</sup> Since a local newspaper reported on the contamination in June 2017, the controversy over Chemours' operation upstream of Wilmington has continued.<sup>105</sup> The North Carolina Department of Environmental Quality (NC DEQ) has charged the company with multiple violations, including one for failing to report a GenX precursor spill in October 2017 and another in February 2018 for failing to control GenX air emissions, which were causing groundwater contamination.<sup>106</sup> But NC DEQ budget cuts have impeded the regulation of PFAS polluters, and ratepayers are facing a looming increase in water costs due to potential water treatment upgrades needed to deal with PFAS contamination.<sup>107</sup>

## Conclusion and Recommendations

The risks of PFASs far outweigh their benefits. We need to address the existing PFAS contamination of our water, our bodies and the environment. The federal government must take urgent action to stop the production and use of PFAS-containing products, set up enforceable standards that limit their environmental presence, provide funding for their testing and require cleanup of contaminated sites.

More specifically, Food & Water Watch recommends:

- The U.S. EPA should treat all PFASs as a class, rather than individually. This must apply not only to older PFASs, like PFOA and PFOS, but to their newer substitutes, like GenX and PFBS. After decades of delay and widespread exposure for a large portion of the population, action is urgently needed, and the fastest way to tackle this issue is to regulate PFAS chemicals as a class.
- The U.S. EPA should set a strong enforceable drinking water standard that addresses both old and new PFAS contamination.
- Congress must allocate funds to states and municipalities for the testing and any needed treatment of drinking water from community water systems and individual household wells. If treatment or groundwater remediation is untenable or unsuccessful, support should be provided to connect water systems and households to alternative water supplies.

## Endnotes

- 1 Lindstrom, Andrew B. et al. "Polyfluorinated compounds: Past, present, and future." *Environmental Science & Technology*. Vol. 45, No. 19. October 1, 2011 at 7955.
- 2 U.S. Department of Health and Human Services (HHS). Agency for Toxic Substances and Disease Registry. "Toxicological Profile for Perfluoroalkyls: Draft for Public Comment." June 2018 at 2 and 521; Lindstrom et al. (2011) at 7954.
- 3 U.S. Environmental Protection Agency (EPA). "PFAS laws and regulations." July 30, 2018. Available at <https://www.epa.gov/pfas/pfas-laws-and-regulations>. Accessed October 2018 and on file at Food & Water Watch.
- 4 Lindstrom et al. (2011) at 7956; Organisation for Economic Co-operation and Development Environment Directorate. Environment, Health and Safety Division. "Toward a New Comprehensive Global Database of Per- and Polyfluoroalkyl Substances (PFASs): Summary Report on Updating the OECD 2007 List of Per- and Polyfluoroalkyl Substances (PFASs)." Series on Risk Management No. 39. May 4, 2018 at 6.
- 5 U.S. EPA. "Basic information on PFAS." Available at <https://www.epa.gov/pfas/basic-information-pfas>. Accessed September 2018 and on file at Food & Water Watch; Wang, Zhanyun et al. "A never-ending story of per- and polyfluoroalkyl substances (PFASs)?" *Environmental Science & Technology*. Vol. 51, No. 5. March 7, 2017 at figure 1 at 2510.
- 6 Plunkett, Roy J. "Tetrafluoroethylene Polymers." US 2230654. U.S. Patent Office. July 1, 1939 at 1; Chemours. "Teflon™ — The Original by Chemours!" 2017 at 4 and 7; Lindstrom et al. (2011) at 7956.
- 7 Lehmler, Hans-Joachim. "Synthesis of environmentally relevant fluorinated surfactants — a review." *Chemosphere*. Vol. 58, Iss. 11. March 2005 at 1475.
- 8 Renner, Rebecca. "The long and the short of perfluorinated replacements." *Environmental Science & Technology*. Vol. 40, No. 1. January 1, 2006; Lindstrom et al. (2011) at 7956.
- 9 Lehmler (2005) at 1473; Paul, Alexander G. et al. "A first global production, emission, and environmental inventory for perfluorooctane sulfonate." *Environmental Science & Technology*. Vol. 43, No. 2. January 15, 2009 at 386.
- 10 HHS (2018) at 545 to 546 and table 5-4 at 550; Plunkett (1939) at 2; U.S. EPA. Office of Water. "Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)." EPA 822-R-16-005. May 2016 at 15.
- 11 Association of State and Territorial Solid Waste Management Officials. Federal Facilities Research Center. [Information paper]. "Perfluorinated Chemicals (PFCs): Perfluorooctanoic Acid (PFOA) & Perfluorooctane Sulfonate (PFOS)." August 2015 at 2; Sullivan, Maureen. U.S. Department of Defense. Office of the Secretary of Defense (Environment, Safety & Occupational Health). "Addressing Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)." March 2018 at 4.
- 12 Barboza, David. "EPA says it pressed 3M for action on Scotchgard chemical." *New York Times*. May 19, 2000; Rich, Nathaniel. "The lawyer who became DuPont's worst nightmare." *New York Times*. January 6, 2016.
- 13 Grandjean, Philippe. "Delayed discovery, dissemination, and decisions on intervention in environmental health: A case study on immunotoxicity of perfluorinated alkylate substances." *Environmental Health*. Vol. 17, No. 62. July 31, 2018 at 1, 2 and 5 to 6 .
- 14 Lindstrom et al. (2011) at 7957.
- 15 HHS (2018) at 2; U.S. EPA. Office of Land and Emergency Management. "Technical Fact Sheet — Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)." EPA 505-F-17-001. November 2017 at 2.
- 16 HHS (2018) at 534 and 544; Li, Li et al. "Estimating industrial and domestic environmental releases of perfluorooctanoic acid and its salts in China from 2004 to 2012." *Chemosphere*. Vol. 129. June 2015 at 100 and 104.
- 17 Bowman, Jessica S. FluoroCouncil. "Fluorotechnology is critical to modern life: The FluoroCouncil counterpoint to the Madrid Statement." *Environmental Health Perspectives*. Vol. 123, No. 5. May 2015 at A112.
- 18 Wang et al. (2017) at 2510 and 2513; Scheringer, Martin et al. "Helsingør Statement on poly- and perfluorinated alkyl substances (PFASs)." *Chemosphere*. Vol. 114. November 2014 at 338.
- 19 Scheringer et al. (2014) at 338.
- 20 *Ibid.* at 338.
- 21 *Ibid.* at 338; Wang, Zhanyun et al. "Fluorinated alternatives to long-chain perfluoroalkyl carboxylic acids (PFCA), perfluoroalkane sulfonic



- acids (PFSAs) and their potential precursors." *Environment International*. Vol. 60. October 2013 at 243.
- 22 Blum, Arlene et al. "The Madrid Statement on poly- and perfluoroalkyl substances (PFASs)." *Environmental Health Perspectives*. Vol. 123, No. 5. May 1, 2015 at 1.
  - 23 Lehmler (2005) at 1475; Lindstrom et al. (2011) at 7956; Schaidler, Laurel A. et al. "Fluorinated compounds in U.S. fast food packaging." *Environmental Science & Technology Letters*. Vol. 4, No. 3. March 14, 2017 at 106 and 107.
  - 24 U.S. EPA. Office of Pollution Prevention and Toxics. "2010/15 PFOA Stewardship Program: Guidance on Reporting Emissions and Product Content." October 2006 at 3 and 27; U.S. EPA. "EPA's Non-CBI Summary Tables for 2014 Company Progress Reports." May 2015 at table 3 at 3; U.S. EPA. Office of Water. "2018 Edition of the Drinking Water Standards and Health Advisories." EPA 822-F-18-001. March 2018 at iii and 6.
  - 25 New Jersey Drinking Water Quality Institute. Health Effects Subcommittee. "Health-Based Maximum Contaminant Level Support Document: Perfluorononanoic Acid (PFNA)." June 22, 2015 at 3 to 4.
  - 26 U.S. EPA (2006) at 3 and 27; U.S. EPA (2015) at table 3 at 3; U.S. EPA (2018) at iii and 6.
  - 27 Lehmler (2005) at 1473, 1475 and 1484; Renner, Rebecca. "The long and the short of perfluorinated replacements." *Environmental Science & Technology*. Vol. 40, No. 1. January 1, 2006; Schaidler et al. (2017) at 106; U.S. EPA. Office of Water. "Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS)." EPA 822-R-16-004. May 2016 at 24 to 25.
  - 28 U.S. EPA, "Technical Fact Sheet — Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)" (2017) at 2 and 4; Weppner, William A. 3M. Letter to Charles Auer, U.S. EPA. "Re: Phase-out Plan for POSF-Based Products." July 7, 2000 at 1, 2 and 11; U.S. EPA (2018) at iii and 6.
  - 29 Wang, Zhanyun et al. "Global emission inventories for C4-C14 perfluoroalkyl carboxylic acid (PFCA) homologues from 1951 to 2030, part II: The remaining pieces of the puzzle." *Environment International*. Vol. 69. August 2014 at 172.
  - 30 Wang et al. (2014) at 172; U.S. EPA (2018) at iii and 6; Weppner (2000) at 1, 2 and 11.
  - 31 Beekman, M. et al. The Netherlands National Institute for Public Health and the Environment. Ministry of Health, Welfare and Sport. "Evaluation of Substances Used in the GenX Technology by Chemours, Dordrecht." RIVM Letter report 2016-0174. 2016 at 15.
  - 32 HHS (2018) at 541; U.S. EPA (2018) at iii and 6.
  - 33 Norwegian Environment Agency. "Sources of Perfluorobutane Sulfonic Acid (PFBS) in the Environment." May 15, 2017 at 11 and 50; Schaidler et al. (2017) at 107.
  - 34 Norwegian Environment Agency (2017) at 11, 39 and 50; U.S. EPA (2018) at iii and 6.
  - 35 Allen, Joseph G. Harvard T.H. Chan School of Public Health. "These toxic chemicals are everywhere — even in your body. And they won't ever go away." *Washington Post*. January 2, 2018; United Nations Environment Programme (UNEP). Stockholm Convention on Persistent Organic Pollutants. "Report of the Persistent Organic Pollutants Review Committee on the Work of Its Second Meeting: Risk Profile on Perfluorooctane Sulfonate." November 21, 2006 at 14; Ahrens, Lutz and Mirco Bundschuh. "Fate and effects of poly- and perfluoroalkyl substances in the aquatic environment: A review." *Environmental Toxicology and Chemistry*. Vol. 33, No. 9. September 2014 at 1924.
  - 36 Prevedouros, Konstantinos et al. "Sources, fate and transport of perfluorocarboxylates." *Environmental Science & Technology*. Vol. 40, No. 1. January 1, 2006 at 39.
  - 37 Oliaei, Fardin et al. "PFOS and PFC releases and associated pollution from a PFC production plant in Minnesota (USA)." *Environmental Science and Pollution Research*. Vol. 20, Iss. 4. April 2013 at figure 1 at 1979, 1981, 1982, 1983 and 1989; Eggen, Trine et al. "Municipal landfill leachates: A significant source for new and emerging pollutants." *Science of the Total Environment*. Vol. 408, Iss. 21. October 1, 2010 at 8; Ahrens, Lutz et al. "Wastewater treatment plants and landfills as sources of polyfluoroalkyl compounds to the atmosphere." *Environmental Science & Technology*. Vol. 45, No. 19. October 1, 2011 at 8098.
  - 38 Ahrens and Bundschuh (2014) at 1923.
  - 39 Sun, Mei et al. "Legacy and emerging perfluoroalkyl substances are important drinking water contaminants in the Cape Fear River watershed of North Carolina." *Environmental Science & Technology Letters*. Vol. 3, No. 12. December 13, 2016 at B.
  - 40 Moody, Cheryl A. et al. "Occurrence and persistence of perfluorooctanesulfonate and other perfluorinated surfactants in groundwater at a fire-training area at Wurtsmith Air Force Base, Michigan, USA." *Journal of Environmental Monitoring*. Vol. 5, Iss. 2. March 10, 2003 at 341 to 342 and 344.
  - 41 Minnesota Department of Health. "Summary of Results: Perfluorochemicals in Homes and Gardens Study." September 2014; Blaine, Andrea C. et al. "Perfluoroalkyl acid uptake in lettuce (*Lactuca sativa*) and strawberry (*Fragaria ananassa*) irrigated with reclaimed water." *Environmental Science & Technology*. Vol. 46, No. 24. December 2014 at A; Prevedouros et al. (2006) at 40; Yeung, Leo W. Y. et al. "A survey of perfluorinated compounds in surface water and biota including dolphins from the Ganges River and in other waterbodies in India." *Chemosphere*. Vol. 76, No. 1. June 2009 at 60.
  - 42 Davis, Katherine L. et al. "Transport of ammonium perfluorooctanoate in environmental media near a fluoropolymer manufacturing facility." *Chemosphere*. Vol. 67, Iss. 10. May 2007 at 2011 and 2018; Prevedouros et al. (2006) at 39.
  - 43 Ahrens et al. (2011) at 8098; Lang, Johnsie R. et al. "National estimate of per- and polyfluoroalkyl substance (PFAS) release to U.S. municipal landfill leachate." *Environmental Science & Technology*. Vol. 51, No. 4. February 21, 2017 at 2197; HHS (2018) at 2; Yamashita, Nobuyoshi et al. "A global survey of perfluorinated acids in oceans." *Marine Pollution Bulletin*. Vol. 51, Iss. 8-12. 2005 at 666 to 667; Prevedouros et al. (2006) at 32, 35, 39 and 40.
  - 44 Post, Gloria B. et al. "Perfluorooctanoic acid (PFOA), an emerging drinking water contaminant: A critical review of recent literature." *Environmental Research*. Vol. 116. July 2012 at 4; Lindstrom et al. (2011) at 7956 and 7958.
  - 45 Sun et al. (2016) at B.
  - 46 Hu, Xindi C. et al. "Detection of poly- and perfluoroalkyl substances (PFASs) in U.S. drinking water linked to industrial sites, military fire training areas, and wastewater treatment plants." *Environmental Science & Technology Letters*. Vol. 3, No. 10. October 11, 2016 at 345.
  - 47 Michigan Department of Environmental Quality. "Taking Action on PFAS." 2018 at 26.
  - 48 Vermont Department of Environmental Conservation. "Perfluoroalkyl Substances (PFAS) Contamination Status Report." July 2018 at 2.
  - 49 Sun et al. (2016) at C.
  - 50 Wang et al. (2013) at 246.
  - 51 Scheringer et al. (2014) at 338.
  - 52 Lindstrom et al. (2011) at 7956.
  - 53 Minnesota Department of Health. "Summary of Results: Perfluorochemicals in Homes and Gardens Study." September 2014; Guerranti, Cristiana et al. "Pilot study on levels of perfluorooctane sulfonic acid

- (PFOS) and perfluorooctanoic acid (PFOA) in selected foodstuffs and human milk from Italy." *Food Chemistry*. Vol. 140, Iss. 1-2, 1-15. September 2013 at 197; Schaider et al. (2017) at 108.
- 54 Calafat, Antonia M. et al. "Polyfluoroalkyl chemicals in the U.S. population: Data from the National Health and Nutrition Examination Survey (NHANES) 2003-2004 and comparisons with NHANES 1999-2000." *Environmental Health Perspectives*. Vol. 115, No. 11. November 2007 at 1596.
- 55 HHS (2018) at 535.
- 56 Post et al. (2012) at 3 and 17.
- 57 U.S. EPA. "Long-Chain Perfluorinated Chemicals (PFCs) Action Plan." December 30, 2009 at 8 to 9.
- 58 HHS (2018) at 535.
- 59 Post et al. (2012) at 1 and 9; Grandjean, Philippe and Richard Clapp. "Perfluorinated alkyl substances: Emerging insights into health risks." *New Solutions: A Journal of Environmental and Occupational Health Policy*. Vol. 25, No. 2. 2015 at 147 and 156.
- 60 Post et al. (2012) at 1 and 17.
- 61 *Ibid.* at 17.
- 62 Fisher, Mandy et al. "Concentrations of persistent organic pollutants in maternal and cord blood from the maternal-infant research on environmental chemicals (MIREC) cohort study." *Environmental Health*. Vol. 15, No. 59. 2016 at 1; Inoue, Koichi et al. "Perfluorooctane sulfonate (PFOS) and related perfluorinated compounds in human maternal and cord blood samples: Assessment of PFOS exposure in a susceptible population during pregnancy." *Environmental Health Perspectives*. Vol. 112, No. 11. August 2004 at 1206.
- 63 U.S. EPA. Office of Water. "Health Effects Support Document for Perfluorooctanoic Acid (PFOA)." EPA 822-R-16-003. May 2016 at 3-52 and 3-53; C8 Science Panel. "Probable link evaluation for heart disease (including high blood pressure, high cholesterol, coronary artery disease)." October 29, 2012 at 1; C8 Science Panel. "Probable link evaluation of thyroid disease." July 30, 2012; Cardenas, Andres et al. "Association of perfluoroalkyl and polyfluoroalkyl substances with adiposity." *JAMA Network Open*. Vol. 1, No. 4. August 31, 2018 at 1.
- 64 U.S. EPA. "Health Effects Support Document for Perfluorooctanoic Acid (PFOA)" (2016) at 3-54 to 3-55; C8 Science Panel. "Probable link evaluation of pregnancy induced hypertension and preeclampsia." December 5, 2011 at 1; Trasande, Leonardo et al. American Academy of Pediatrics. "Technical report: Food additives and child health." *Pediatrics*. Vol. 142, No. 2. August 2018 at 3 to 4.
- 65 U.S. EPA. "Health Effects Support Document for Perfluorooctanoic Acid (PFOA)" (2016) at 3-54; Trasande et al. (2018) at 4.
- 66 U.S. EPA. "Health Effects Support Document for Perfluorooctanoic Acid (PFOA)" (2016) at 3-53 and 3-55; C8 Science Panel. "Probable link evaluation of autoimmune disease." July 30, 2012 at 1.
- 67 Jensen, Allan Astrup and Henrik Leffers. "Emerging endocrine disruptors: Perfluoroalkylated substances." *International Journal of Andrology*. Vol. 31, Iss. 2. March 3, 2008 at 161.
- 68 World Health Organization. International Agency for Research on Cancer (IARC). "Perfluorooctanoic Acid." In *IARC Monographs: Some Chemicals Used as Solvents and in Polymer Manufacture*, Vol. 110. (2017). Lyon: IARC at 98.
- 69 HHS (2018) at 6.
- 70 C8 Science Panel. "Probable link evaluation of cancer." April 15, 2012 at 1.
- 71 U.S. EPA. "Perfluorooctanoic Acid — Treatment Processes." Drinking Water Treatability Database. Available at <https://iaspub.epa.gov/tldb/pages/general/home.do>. Accessed August 2018 and on file at Food & Water Watch; U.S. EPA. "Perfluorooctane Sulfonate — Treatment Processes." Drinking Water Treatability Database. Available at <https://iaspub.epa.gov/tldb/pages/general/home.do>. Accessed August 2018 and on file at Food & Water Watch.
- 72 Rahman, Mohammad Feisal et al. "Behavior and fate of perfluoroalkyl and polyfluoroalkyl substances (PFASs) in drinking water treatment: A review." *Water Research*. Vol. 50. March 1, 2014 at 318 and 329; Sun et al. (2016) at C.
- 73 Sun et al. (2016) at C and figure 3 at D.
- 74 U.S. EPA. "EPA drinking water laboratory method 537 Q&A." Available at <https://www.epa.gov/pfas/epa-drinking-water-laboratory-method-537-qa>. Accessed October 2018 and on file at Food & Water Watch; U.S. EPA. Office of Water. "EPA Approved Laboratories for UCMR 3." EPA-815-B-16-025. October 2016.
- 75 NSF International. [Press release]. "New protocol certifies products proven effective for reducing PFOA and PFOS to below EPA health advisory levels." November 30, 2016.
- 76 Carignan, Sylvia. "Chemicals in your bottled water? Companies could test to find out." *Bloomberg Environment*. November 1, 2018.
- 77 U.S. EPA. "Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)" (2016) at 9 and 10; U.S. EPA. "Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS)" (2016) at 10; U.S. EPA (2017) at 4.
- 78 Volcovici, Valerie. "EPA-recommended chemical levels in water too high: U.S. report." *Reuters*. June 20, 2018; HHS (2018) at 15; Snider, Annie. "White House, EPA headed off chemical pollution study." *Politico*. May 14, 2018.
- 79 U.S. EPA. "The Third Unregulated Contaminant Monitoring Rule (UCMR 3): Data Summary, January 2017." January 2017 at 1 and 4..
- 80 State of New Jersey Department of Environmental Protection. [Press release]. "Christie administration takes action to enhance protection of New Jersey's drinking water." November 1, 2017; Hurdle, Jon. "New Jersey seeks stricter limit on chemical in drinking water." *New York Times*. December 6, 2017.
- 81 Vermont Department of Health. "Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in Drinking Water." July 9, 2018.
- 82 U.S. EPA (2006) at 3.
- 83 HHS (2018) at 538 and 540; U.S. EPA, "Technical Fact Sheet — Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)" (2017) at 2.
- 84 HHS (2018) at 544.
- 85 33 USC §1317(a)(1); 33 USC §1318(a) & (b); 40 CFR Pt. 423, App. A; 33 USC §1321(b)(2)(A) & (b)(5); 40 CFR §116.4; HHS (2018) at 546; U.S. EPA. "Toxic Chemical Release Inventory Reporting Forms and Instructions: Revised 2016 Version." EPA 740-B-16-001. December 2016 at 47 to 48 and table II at II-1.
- 86 UNEP. Stockholm Convention on Persistent Organic Pollutants. "Stockholm Convention on Persistent Organic Pollutants (POPs): As Amended in 2009." August 2010 at 41 and 45 to 46; UNEP. Stockholm Convention on Persistent Organic Pollutants. "SC-4/17: Listing of perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride." 2009; UNEP (2006) at 29.
- 87 UNEP. Stockholm Convention on Persistent Organic Pollutants. "Proposal to list pentadecafluorooctanoic acid (CAS No: 335-67-1, PFOA, perfluorooctanoic acid), its salts and PFOA-related compounds in Annexes A, B and/or C to the Stockholm Convention on Persistent Organic Pollutants." June 9, 2015 at 1; UNEP. Stockholm Convention on Persistent Organic Pollutants. "Proposal to list perfluorohexane sulfonic acid (CAS No: 355-46-4, PFHxS), its salts and PFHxS-related

## These Chemicals Are Forever: Water Contamination from PFOA, PFOS and other PFASs

- compounds in Annexes A, B and/or C to the Stockholm Convention on Persistent Organic Pollutants." June 5, 2017 at 1.
- 88 UNEP. Stockholm Convention on Persistent Organic Pollutants. "Status of ratification." Available at <http://chm.pops.int/Countries/StatusofRatifications/PartiesandSignatoires/tabid/4500/Default.aspx>. Accessed August 2018 and on file at Food & Water Watch.
- 89 Filipovic, Marko et al. "Historical usage of aqueous film forming foam: A case study of the widespread distribution of perfluoroalkyl acids from a military airport to groundwater, lakes, soils and fish." *Chemosphere*. Vol. 129. June 2015 at 39; Sullivan (2018) at 4.
- 90 Hu, Xindi C. et al. "Detection of poly- and perfluoroalkyl substances (PFASs) in U.S. drinking water linked to industrial sites, military fire training areas, and wastewater treatment plants." *Environmental Science & Technology Letters*. Vol. 3, No. 10. October 11, 2016 at 345 and 347.
- 91 Sullivan (2018) at 8 and 9.
- 92 Sokol, Chad. "Cleanup bill for toxic firefighting chemicals at military bases could reach \$2 billion." *Spokesman-Review* (WA). September 6, 2017; Bennet, Michael F. et al. Letter to Senate Appropriations Committee on water contamination near military bases. August 31, 2017. On file at Food & Water Watch; Lepore, Brian J. and J. Alfredo Gómez. U.S. Governmental Accountability Office. [Testimony]. "Drinking Water: Status of DOD Efforts to Address Drinking Water Contaminants Used in Firefighting Foam." GAO-18-700T. September 26, 2018 at 6 to 7.
- 93 Lepore and Gómez (2018) at 10 and 11.
- 94 Walker, Bill. Environmental Working Group. "Update: Mapping the Expanding PFAS Crisis." April 18, 2018. Updated July 30, 2018.
- 95 McKinley, Jesse and Vivian Yee. "Water pollution in Hoosick Falls prompts action by New York State." *New York Times*. January 27, 2016.
- 96 U.S. EPA. [Press release]. "EPA adds Saint-Gobain Performance Plastics site in Hoosick Falls, N.Y. to the federal Superfund list." July 31, 2017; McKinley and Yee (2016); New York State Department of Health. Center for Environmental Health. "Perfluorooctanoic Acid (PFOA) in Drinking Water, Hoosick Falls, New York." December 2015 at 5.
- 97 Lyons, Brendan J. "A danger that lurks below." *Times Union* (NY). December 14, 2015.
- 98 McKinley, Jesse. "Hoosick Falls residents take anger over tainted water to New York's Capitol." *New York Times*. June 15, 2016; New York State Department of Health. "Hoosick Falls Area PFOA Biomonitoring Group-Level Results." June 2018 at table 3a at 4, table 3c at 6, table 4b at 7 and table 7 at 10.
- 99 U.S. EPA (July 31, 2017).
- 100 Ellison, Garret. "All known PFAS sites in Michigan." *MLive* (MI). July 10, 2018. Updated September 17, 2018.
- 101 *Ibid*.
- 102 Office of Governor Rick Snyder. [Press release]. "Lt. Gov. Calley declares emergency for Kalamazoo County." July 29, 2018.
- 103 Michigan PFAS Action Response Team. "Crown Vantage Property." October 2018. Available at [https://www.michigan.gov/pfasresponse/0,9038,7-365-86511\\_82704-479889--,00.html](https://www.michigan.gov/pfasresponse/0,9038,7-365-86511_82704-479889--,00.html). Accessed October 15, 2018 and on file at Food & Water Watch.
- 104 Wagner, Adam. "What's happened since we first learned of GenX a year ago? A lot." *StarNews* (NC). June 27, 2018; Food & Water Watch analysis of GenX Sampling Sites — Sampling Results Spreadsheet. North Carolina Department of Environmental Quality. Available at <https://deq.nc.gov/news/hot-topics/genx-investigation/genx-sampling-sites>. Accessed October 2018.
- 105 Wagner (2018).
- 106 Wagner (2018); North Carolina Department of Environmental Quality. [Press release]. "DEQ issues violation notice to Chemours for unreported chemical spill." November 14, 2017; North Carolina Department of Environmental Quality. [Press release]. "State orders Chemours to control additional sources of GenX contamination." February 13, 2018.
- 107 Doran, Will. "As NC pollution concerns grow, so do environmental budget cuts." *News & Observer* (NC). September 22, 2017; Cape Fear Public Utility Authority. "Special Update: More on CFPWA board action on emerging contaminants." May 11, 2018. On file at Food & Water Watch; Vandermeiden, Carel. Cape Fear Public Utility Authority. "Water Treatment and the Challenge of PFAS." August 14, 2018 at 78.

**foodandwaterwatch.org**

info@fwwatch.org

202.683.2500 (DC) • 510.922.0720 (CA)

Copyright © February 2019 Food & Water Watch



**Food & Water Watch champions healthy food and clean water for all. We stand up to corporations that put profits before people, and advocate for a democracy that improves people's lives and protects our environment.**