WaterAdvisory
Water & Health Advisory Council

Why did PFAS in drinking water become a concern?

By: Jennifer Seed, formerly of the United States Environmental Protection Agency

A SciPinion report underwritten and reviewed by the Water and Health Advisory Council

Why did PFAS in drinking water become a concern?

Summary

- PFAS have been used in consumer products and industries since the 1940s. Regulatory interest in PFAS began in 1999 when the USEPA was notified of new information that showed: 1) the general US population was exposed to at least one PFAS, namely PFOS; 2) PFOS and other PFAS remain in the body for several years; 3) animal toxicology studies showed adverse health outcomes.
- In 2000, 3M, the sole producer of PFOS, announced its voluntary phaseout of PFOS. In 2006, EPA initiates the 2010/2015 PFOA Stewardship Program to remove PFOA and some other PFAS from commerce. EPA regulates the use of other PFAS under the Toxic Substances Control Act.
- Reports of local contamination of drinking water with some PFAS triggered interest in whether PFAS are present in other drinking water supplies. From 2013-2015, using Safe Drinking Water Act authorities, drinking water samples were collected in nearly 5,000 public water systems (PWS) across the nation, accounting for approximately 80% of the U.S. population served by public water systems and analyzed for 6 PFAS. PFOS was measured at or above the minimum reporting level (MRL) by 2% of the PWSs and PFOA was measured at or above the MRL by 2.4% of the PWSs. PFOS was measured at or above the HA of 70 ppt by 0.3% of the PWSs and PFOA was measured at or above the HA of 70 ppt by 0.09% of the PWSs.

What Triggered Interest in PFAS?

PFAS refers to a large class of organofluorinated compounds (compounds that are largely made up of carbon and fluorine atoms) and includes thousands of individual chemicals. The two most well-known PFAS are perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA). Many PFAS are chemically and thermally stable and resistant to biological, chemical and heat degradation. These properties have made many of the PFAS invaluable for a variety of uses in consumer products and industries since the 1940s. These include firefighting foams, chemical processing, building/construction, aerospace, electronics, semiconductor and automotive industries, stain- and water-resistant coatings (e.g., carpets, rain repellent clothing, traces in nonstick pans), food packaging, and in waxes and cleaners.

In order to determine whether a specific PFAS may be a concern for human health, scientists examine the potential health effects due to the specific PFAS and the potential exposures to the PFAS. The potential health effects are generally assessed through toxicology studies that are conducted in laboratory animals. Occasionally, there may be information on people that may have been exposed to high levels of the chemical. The potential for exposure can be informed by examining the presence and amount of the chemical in a variety of media including food, water, air, and consumer product, and sometimes even by measuring the chemical in urine or blood of humans (this is known as biomonitoring). It is important to ascertain both the potential health effects and the potential exposure as a PFAS may cause health effects in high dose animal toxicology studies, but will pose no harm to humans if there is no exposure or much lower dose exposure.

Prior to the late 1990s there was no information that suggested that there was exposure to the general population or that there were potential health effects associated with PFAS. There was the potential for exposure to the various PFAS in occupational settings, but no health effects of the workers had been reported. However, in 1999 EPA was notified of new information for one PFAS, PFOS, that suggested there was widespread exposure to the general population and there were potential health concerns[1]. First, a new toxicology study of PFOS in rats that focused on the potential for effects on fertility and pregnancy outcome showed dramatic effects on the offspring; these effects included substantial mortality in the first few days after birth. Second, samples from public blood banks showed the presence of PFOS in the blood from blood bank donors. This was a surprising finding as it suggested that people who did not work in the industry were somehow being exposed to PFOS. Third, a study of workers suggested that PFOS could remain in humans for many

[1] 3M Reports: "The Science of Organic Fluorochemistry" and "Perfluorooctane Sulfonate: Current Summary of Human Sera, Health, and Toxicology Data", dated February 5, 1999. (8EHQ-0299-373). Administrative Record 226-0548.

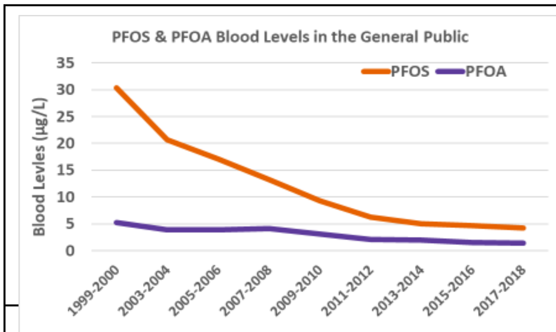
years. The fact that PFOS was in the blood of the general population (i.e. exposure) and the finding that PFOS posed a significant health effect in laboratory rats raised concern for the potential harm to humans.

After receiving this information, EPA initiated a formal evaluation of the toxicology and exposure information of PFOS. Shortly thereafter, EPA also began an evaluation of PFOA due to its similarity in chemical structure to PFOS and therefore concerns that it may pose similar concerns for human health. Interest in PFOS and PFOA, as well as other PFAS, rapidly extended to other federal agencies, the states, and to academic scientists.

Did EPA Take Regulatory Action on the Commercialization of PFAS?

EPA's initial focus was the regulation of PFAS, primarily PFOS and PFOA, in commerce. Shortly after the new information on PFOS became available, 3M Company, which was the sole US producer of PFOS (Scotchguard®) announced on May 16, 2000 that they would voluntarily phase out production of PFOS[2]. With PFOS out of commerce, EPA shifted its focus to PFOA. In 2006, EPA invited eight major leading companies in the PFAS industry to join in a global stewardship program with two goals: 1) to commit to achieve, no later than 2010, a 95 percent reduction, measured from a year 2000 baseline, in both facility emissions to all media of PFOA, precursor chemicals that can break down to PFOA, and related longer chain PFAS compounds (e.g., >6-8 carbon chain alkenes), and product content levels of these chemicals; 2) to commit to working toward the elimination of these chemicals from emissions and products by 2015. This program was known as the 2010/2015 PFOA Stewardship Program and was highly successful[3].

The removal of PFOS and PFOA from the market reduced exposure to the general population, and this was readily apparent in the reduction in blood levels of the two compounds. Since 1999, the Center for Disease Control (CDC) has measured several types of PFAS in the U.S. population as part of the National Health and Nutrition Examination Survey (NHANES). NHANES is a survey that measures the health and nutritional status of adults and children in the United States. In particular, the survey has measured PFOS and PFOA in blood samples from the participants. With the decrease in production and use of some PFAS, the national PFAS levels also have



from the U.S. CDC National Health and Nutrition Examination

[2] https://archive.epa.gov/epapages/newsroom_archive/newsreleases/33aa946e6cb11f35852568e1005246b4.html

[3] https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/fact-sheet-20102015-pfoa-stewardship-program

dropped over time. From 1999 to 2014, blood PFOA and PFOS levels declined by more than 60% and 80%, respectively[4] (Figure 1).

In addition to the removal of PFOS and PFOA from the market, EPA issued several "Significant New Use Rules" that require manufacturers (including importers) and processors of certain PFAS chemicals to notify the EPA at least 90 days before starting or resuming new uses of these chemicals. This notification provides EPA the opportunity to review the potential exposures from the new uses, and, in conjunction with the toxicology data, take any regulatory action, if appropriate, including preventing introduction into commerce.

What Triggered Interest in PFAS in Drinking Water?

The EPA successfully removed some PFAS from commerce in the U.S. and was able to regulate the commercialization of other PFAS. However, since PFOS and PFOA, as well as some other PFAS, had been in production and use in the U.S. (and other countries) for many decades there was the possibility that PFAS had been released to the environment. It was known that some PFAS are highly persistent in the environment and might remain in various environmental media like water or air for long periods of time. Therefore, the focus of EPA, the states, and academic scientists switched to monitoring and managing the presence of these chemicals in the various media like water, air, and food.

In the early 2000s, scientists conducted additional toxicology studies and monitoring studies of various PFAS in the environment. These monitoring studies demonstrated the presence of several PFAS, predominantly PFOS and PFOA, in wildlife around the world including birds, fish, polar bears, dolphins, and terrestrial animals. PFAS were also found in environmental media like surface waters, air, municipal wastewater discharges, sludge, soils, sediments, and ice caps around the world; the levels were typically in the part per trillion range[5].

In addition, there were reports of localized contamination around some manufacturing facilities and in areas where fire-fighting foam had been released. For example, in Little Hocking, Ohio there was widespread contamination of groundwater from a manufacturing facility located across the Ohio River in West Virginia. Between 2002 and 2005, PFOA concentrations in Little Hocking, Ohio, ranged from 1.5 and 7.2 ppb (1,500 and 7,200 ppt) in the municipal water distribution system and up to 14 ppb in private wells[6]. Several other studies conducted in the early 2000s reported concentrations of PFOS and PFOA in source water and drinking water. For example, in New Jersey, monitoring of raw and finished

---

[4] www.cdc.gov/exposurereport

[5] Reviewed in https://academic.oup.com/toxsci/article/99/2/366/1679065

[6] Emmett, E.A., H. Zhang, et al. 2006. Community Exposure to Perfluorooctanoate: Relationships between Serum Concentrations and Certain Health Parameters. *Journal of Occupational Medicine* 48:771–779.

water between 2006 and 2008 showed concentrations of PFOA as high as 0.14 ppb and of PFOS as high as 0.019 ppb (or 19 ppt) in finished drinking water[7]. With the finding of PFAS in source and drinking water in several locations, the question arose as to how widespread PFAS occurred in public water systems.

Are PFAS Present in Public Water Systems?

At the national level, the EPA gathers information on microbes and chemicals that might be present in drinking water through the Candidate Contamination List[8] (CCL) and the Unregulated Contaminant Monitoring Rule[9] (UCMR). The drinking water CCL is a list of microbes and chemicals that are currently not subject to any national primary drinking water regulations, but may be present in public water systems (PWS). The CCL is published every five years. The EPA is required to select five of the microbes or chemicals on the current CCL and determine whether regulatory action is necessary. This decision is based on information on the potential health effects and the presence and levels in drinking water. PFOS and PFOA were included in CCL3 which spanned 2012-2016 and CCL4 which spanned 2017-2021

The UCMR is used to gather information on which microbes and chemicals are present, and at what levels, in public water systems. Every five years EPA develops a new list of UCMR contaminants, largely based on the CCL. The UCMR can only require monitoring for 30 microbes and chemicals per 5-year cycle that had not been included in previous UCMRs. . EPA has proposed that 29 PFAS chemicals be included in the upcoming UCMR5.

The UCMR can include monitoring of all large public water systems serving greater than 10,000 people and those serving between 3,300 and 10,000 people and a random selection of smaller systems. That would involve about 10,000 water supplies serving about 275 million people. The higher concentrations to date have typically been is some small groundwater supplies in the vicinity of manufacturing facilities and airports and airbases where firefighting foams are used.

The EPA collected data for six PFAS in UCMR3 including PFOA, PFOS, perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), perfluoroheptanoic acid (PFHpA) and perfluorobutanesulfonic acid (PFBS). From 2013-2015, drinking water samples were collected and analyzed in nearly 5,000 public water systems which included all PWSs serving > 10,000 people, and a representative sample of 800 smaller PWSs across the nation, accounting for approximately 80% of the U.S. population served by public water systems. The results of UCMR3 were published in January, 2017[10] and are presented in

[7] https://www.nj.gov/dep/dsr/dw/final_pfoa_report.pdf

[8] https://www.epa.gov/ccl

[9] https://www.epa.gov/dwucmr/learn-about-unregulated-contaminant-monitoring-rule

[10] https://www.epa.gov/sites/production/files/2017-02/documents/ucmr3-data-summary-january-2017.pdf

Table 1. Results were reported for 36,972 samples for 4920 PWSs. PFOS was measured at or above the minimum reporting level (MRL) by 2% of the PWSs and PFOA was measured at or above the MRL by 2.4% of the PWSs.

Table 1. January 2017 UCMR 3 Data Summary for Some PFAS

PFAS	MRL (μg/L)	Total Number of Results	Number of Results ≥ MRL	Total Number of PWSs with Results	Total Number (%) of PWSs with Results ≥ MRL (out of 4,920)
PFOS	0.04	36,972	292	4920	95 (1.9%)
PFOA	0.02	36,972	379	4920	117 (2.4%)
PFNA	0.02	36,972	19	4920	14 (0.3%)
PFHxS	0.03	36,971	207	4920	55 (1.1%)
PFHpA	0.01	36,972	236	4920	86 (1.7%)
PFBS	0.09	36,972	19	4920	8 (0.2%)

The EPA and the states use this information, in conjunction with the toxicology data, to make decisions on whether to regulate the levels of PFAS in drinking water.