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Factsheet on PFASs in Consumer Products:

Key Points for Decision Makers

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Introduction

Perfluoroalkyl and polyfluoroalkyl substances (PFASs) have received increasing attention from researchers, policymakers, regulators, and the public due to their potential long-term adverse impacts on humans and the environment. Even if we could stop all PFAS uses today, the widespread contamination and adverse impacts will continue for generations to come.

Despite limited research into the adverse impacts of PFASs, the known costs of PFAS exposure to humans are significant. In Europe, the Nordic Council estimates health costs between 52 and 84 billion Euros per year. In addition to costs related to human health, California's billions of dollars' worth of agricultural commodities are also susceptible to PFAS contamination. While treatment systems can be installed on individual wells and contaminated sites to mitigate drinking water exposure, cleaning up widescale PFAS contamination in the environment will be costly and time consuming.

This factsheet summarizes some key points about this complex class of chemicals – what they are, why they are a problem, and how to assess the extent of compliance with restrictions on their use in consumer products.

PFASs are a large and complex class of chemicals

There is no widely accepted definition of what a PFAS is, and not all PFASs are alike. PFASs have various chemical structures and range in size from small molecules to large polymers. However, all PFASs share the presence of bonds between carbon and fluorine atoms. These carbon-fluorine bonds give PFASs their useful properties, including their resistance to heat, harsh chemicals, and microbial decay. This kind of resistance to breakdown is a useful feature of a chemical in a consumer product, but it is problematic once the chemical reaches the environment.

Certain PFASs known as perfluoroalkyl acids (PFAAs) take so long to degrade in the environment that scientists have nicknamed them "forever chemicals." But PFAAs are representative of the entire PFAS class because most other PFASs either are manufactured using them, contain them as impurities, or degrade into them (i.e., they are PFAA precursors).

PFASs have hundreds of uses

The unique chemical properties of PFASs have led to their use in hundreds of products and industrial applications, from rain jackets and non-stick pans to firefighting foam and semiconductors. A recent study documented more than 200 different uses for PFASs in consumer products and other applications.

However, most PFASs found in the environment or in humans are not intentionally manufactured. Rather, they are either impurities or the result of the degradation of the relatively small number of PFASs used in commerce.

Takeaway: If you are wondering whether you or your organization are purchasing PFAS-containing products, the answer most likely is yes. PFASs are difficult to avoid. Here's a list of some known PFAS-free products and a guide to PFAS-free purchasing.

PFAS contamination has become widespread in the environment, leading to widespread exposures

Because PFASs are used in large quantities and are highly persistent, they have become pervasive contaminants. As of late 2022, PFASs were detected in 79 percent of the 150 public water systems tested throughout California; however, only 34 percent of those systems exceeded an advisory response level. PFASs are also found in human food sources. For example, PFOS has been detected in 14 of the 15 fish species tested across the state between 2009 and 2015.

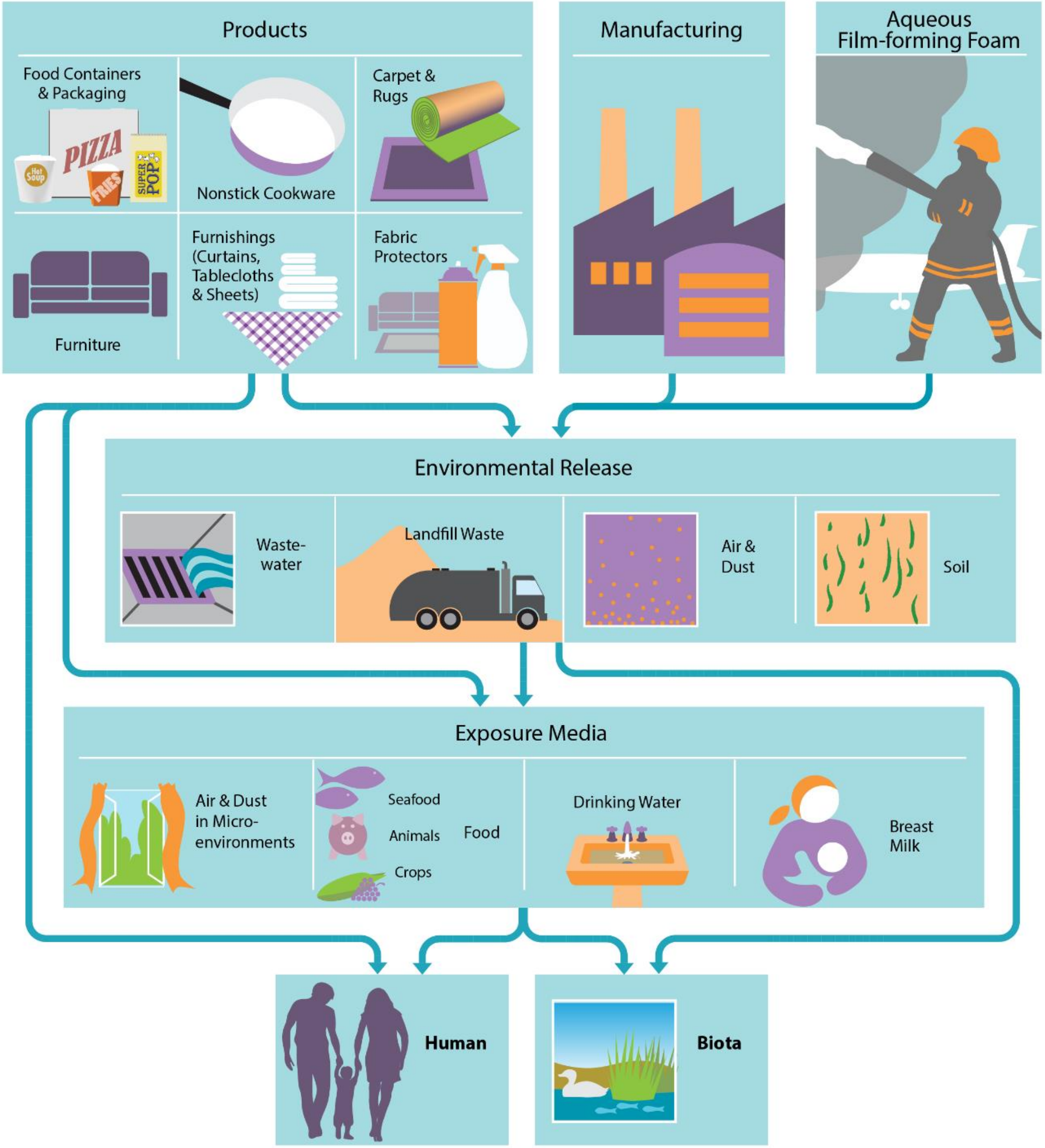
PFASs can be released into the environment during manufacturing activities, consumer product use, and the end-of-life management of consumer products (e.g., landfilling and composting). Some PFASs released from industrial uses and consumer products make their way to wastewater treatment plants (WWTPs), which are not typically designed to remove these chemicals. Once PFASs pass through WWTPs, they can be released to the environment through either treated wastewater or biosolids (i.e., solid organic matter recovered from WWTPs). More than half of all biosolids generated in California are applied to land as a soil amendment. This practice, as well as the growing use of recycled wastewater for irrigation, may inadvertently result in the movement of PFASs into soil, crops, livestock, and nearby drinking water sources.

People are exposed to PFASs in many ways:

- consumption of contaminated drinking water and food, including breastmilk
- contact with PFAS-containing products
- contact with contaminated air, dust, soil, or water
- *in utero*. Babies receive PFASs from their mothers through the placenta and are born with measurable quantities in their bodies.

As a result of these exposures, the California Environmental Contaminant Biomonitoring Program (also known as Biomonitoring California) found at least one PFAS in the blood of nearly all study participants from across the state.

Takeaway: Due to decades of widespread use and their high persistence, PFASs are found virtually everywhere across the globe and in nearly every living organism, including in humans.



Reversing PFAS contamination is expensive and complicated

Cleaning up PFAS contamination from the environment is technically challenging and expensive. For example, Orange County, California, estimated that it will cost at least $1 billion to address PFAS contamination in the groundwater basin that supplies much of its drinking water. Similarly, a North Carolina drinking water utility impacted by industrial PFAS releases spent $99 million to construct a reverse osmosis plant, which will cost $2.9 million annually to operate. While existing technologies such as granular activated carbon filtration, ion exchange, and reverse osmosis are effective at removing PFASs from drinking water, they concentrate the PFASs in a separate waste stream that must then be carefully managed.

Recent efforts have developed improved methods to destroy the carbon-fluorine bond and safely degrade PFASs. While these destruction technologies may be helpful for treatment of concentrated PFAS waste streams or cleanup of discrete contaminated sites, they cannot reverse large-scale PFAS contamination. Therefore, reducing PFASs at the source is essential to reducing future PFAS contamination.

Takeaway: Failure to reduce uses of PFASs will ensure many more decades of drinking water and environmental contamination and the associated negative health impacts.

Some PFASs are known to be toxic at low levels, and even those that have yet to be studied for toxicity raise concerns due to their high persistence

The majority of PFASs have not yet been assessed for their potential toxicity. However, exposure to the most thoroughly studied PFASs has been linked to several adverse impacts, such as increased incidence of thyroid disease, immunotoxicity (e.g., reduced response to routine vaccination), carcinogenicity (kidney and testicular), elevated cholesterol, and reproductive and developmental toxicity.

Exposure to even very low levels of certain PFASs is now known to cause harm. For example, drinking water guidance levels for the two most studied PFASs – PFOA and PFOS – are now thousands of times lower than they were a decade ago. In some cases, these guidance levels are now lower than what can even be measured.

Takeaway: We don’t know everything about the toxicity of all members of the PFAS class, but what we do know is concerning. The more these chemicals are studied, the more reasons for concern are found. This warrants a precautionary approach when regulating these chemicals to protect human health and the environment. Waiting for data on thousands of PFASs can allow time for untold harm to occur.

Regulations and legislative bans are beginning to tackle some PFAS uses, but more work is needed to prevent future contamination

The high persistence of PFASs and the known health hazards of the well-studied PFASs has led to calls for the phaseout of the entire chemical class, especially for uses that are not essential, such as where safer alternatives are already available. Here are some examples of class-based regulation and legislation targeting PFASs in consumer products:

- Regulating PFAS as a Chemical Class under the California Safer Consumer Products Program
- **DTSC SCP's Priority Product Listings that address PFASs:**
    - "Carpets and Rugs with Perfluoroalkyl or Polyfluoroalkyl Substances (PFASs)" – effective July 1, 2021
    - "Treatments Containing Perfluoroalkyl or Polyfluoroalkyl Substances for Use on Converted Textiles or Leathers" – Effective April 1, 2022
- **California Laws prohibiting the use of PFASs in various consumer product applications:**
    - AB 1200 – Food packaging – Effective January 1, 2023
    - AB 652 – Juvenile Products – Effective July 1, 2023
    - AB 2771 – Cosmetic products – Effective January 1, 2025
    - AB 1817 – Textile Articles – Effective January 1, 2025
- **In October 2021, the U.S. EPA established a three-year commitment to address PFASs**:
    - "PFAS Strategic Roadmap"

Takeaway: Non-essential uses of PFASs are, well, non-essential. Phasing them out can protect human health and the environment. Eliminating unnecessary sources of PFASs is more protective and far less expensive than trying to deal with these persistent chemicals after they are already in products and the environment.

Measuring PFASs is complicated, but total organic fluorine tests can identify products made without PFASs

Assessing the presence of PFASs in products, or the extent of PFAS contamination, is difficult because available methods for targeted analysis can only quantify a small subset of PFASs – mainly PFAAs and a few of their precursors. Even the most extensive targeted methods are limited to fewer than 100 PFASs (i.e., fewer than 1-3 percent of all PFASs, depending on the definition of the class).

While PFAAs are the most problematic PFASs known to date, targeted analytical methods focused on these substances miss the wide range of PFAA precursors present in consumer products. Exposure to these precursors could be even more problematic than exposure to PFAAs, since the precursors become PFAAs when they metabolize inside the human body, sometimes producing even more toxic intermediate substances in the process.

Because all PFASs contain fluorine bound to carbon atoms (i.e., organic fluorine), total organic fluorine methods can detect the presence of any kind of PFAS by using fluorine as a proxy. However, these methods cannot specify which PFASs are present in a sample. In some cases, the organic fluorine detected could be from other, non-PFAS sources, such as certain pharmaceuticals that contain a single fluorine atom in their molecule. These total organic fluorine methods are relatively fast and inexpensive and can help identify samples suspected of containing PFASs. Using a total organic fluorine method is currently the only way to prove that a consumer product is free of intentionally-added PFASs. However, even if no organic fluorine is detected, the sample could still contain trace levels of PFAS contaminants. Targeted analysis may be used to detect such trace level PFASs.

Type of method	What it can tell you	What it cannot tell you
Targeted analysis	Can quantify the levels of PFAAs and some non-polymeric PFAA precursors	Cannot determine whether a sample is PFAS-free (because these methods cannot detect most PFASs)
Total Oxidizable Precursors (TOP) assay	Can give an indication of the amount of PFAA precursors present in a sample	Cannot determine which specific precursors are present and cannot quantify them precisely
Non-targeted analysis	Can tentatively identify thousands of PFASs using spectral libraries	Cannot quantify the PFASs detected
Total organic fluorine methods such as Combustion Ion Chromatography (CIC) or Particle-Induced Gamma Emission Spectroscopy (PIGE)	• Can quantify the amount of organic fluorine in a sample (useful for assessing compliance with certain laws and regulations) • Can confirm the presence of PFASs but only in samples where inorganic fluorine has been removed and other sources of organic fluorine can be ruled out • Can confirm that PFASs were not intentionally used in a sample (if no detectable levels of fluorine are found)	• Cannot specify which PFASs are present in a sample • Cannot detect trace levels of PFASs (i.e., these methods have higher detection limits than targeted methods) • Cannot always confirm the presence of PFASs (some samples could have non-PFAS sources of organic fluorine)

Takeaway: Targeted analytical methods provide an incomplete picture of the PFASs used in consumer products. These methods are skewed toward PFAAs, ignoring most of their precursors, which could pose risks to human health and the environment. Total fluorine measurements can be used to verify the presence of PFASs in some samples or demonstrate the absence of intentionally-added PFASs.

Curious to learn more?

PFAS information from the U.S. EPA

Information on PFOA and PFOS from the Office of Environmental Health Hazard Assessment (OEHHA)

Information on PFASs and study results from Biomonitoring California

PFAS fact sheets from the Interstate Technology Regulatory Council

PFAS Data Hub from the Green Science Policy Institute

PFAS Portal from the Organisation for Economic Co-operation and Development (OECD)