

What are PFAS?

Per- and polyfluoroalkyl substances are a group of synthetic, man-made chemicals that are referred to as 'PFAS'.

Part of their structure is an extremely strong fluorine-carbon bond that requires an enormous amount of energy to break, making them incredibly stable and resilient.

They are resistant to heat, stains, grease, and water penetration and can take 1000+ years to break down, which is why they are known as 'forever chemicals'. Once in the environment, PFAS are able to spread from their original point of contamination, making them of particular concern for water authorities.

Health Concerns

Of the 4,000+ chemicals in the PFAS group, it is the 'long chain' variants PFOA, PFOS, PFHxS, PFBS and GenX chemicals which are thought to be of the most concern.

While not yet proven through human medical studies, long term exposure to PFAS is suspected to:

- ▲ Lower birth weight in babies;
- ▲ Cause higher levels of cholesterol and uric acid in the blood;
- ▲ Reduce kidney function;
- ▲ Cause thyroid disease;
- ▲ Alter sex hormone levels;
- ▲ Reduce vaccine response; and
- ▲ Cause liver, kidney, and testicular cancers.

Routes of Exposure to PFAS

Most people come into contact with PFAS on a daily basis via trace amounts being present in dust and various consumer products. However, more significant exposure comes from drinking inadequately treated water or consuming contaminated food.

Fig. 1 is the PFAS National Environmental Management Plan's summary of the exposure routes for humans to PFAS where arrow thickness infers the magnitude of exposure for that route:

-  PFAS transport mechanisms within the natural environment.
-  Potential PFAS exposure pathways to humans.
-  Exposure pathways used to calculate health investigation levels for PFAS in soil.
-  Pathways for potential untreated water delivery to households.

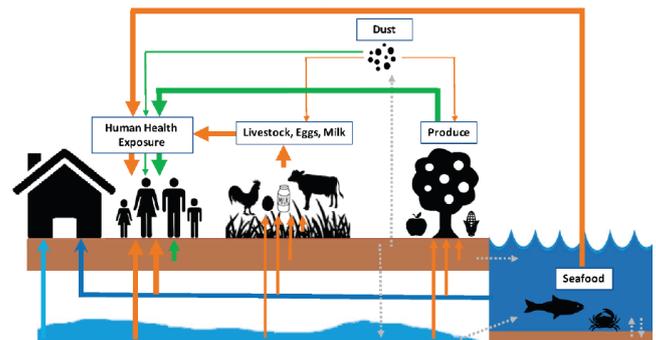


Figure 1 PFAS NEMP's map of exposure routes for humans

PFAS Hotspots

Increased levels of PFAS are commonly found in hotspots where PFAS compounds are able to leach from contaminated soil into aquifers or waterways and be dispersed:

- ▲ Sewage treatment plants
- ▲ Locations where PFAS containing firefighting foams have been used:
 - ▲ Airfields
 - ▲ Department of Defence sites
 - ▲ Firefighting training grounds
- ▲ Landfills
 - ▲ Fuel refineries
 - ▲ Mining operations
 - ▲ Storage facilities

Safe Levels of PFAS Exposure

Guideline values for PFAS are intended to reduce the risks to health from long term exposure through drinking water over a lifetime, not for acute exposure over short periods of time.

The Australian and USA approaches to setting their respective limits for acceptable PFAS exposure follow different methodologies; the USEPA and WHO have based their approaches on the suspicion of PFAS being linked to 'adverse health outcomes', while the Australian approach has been to rely on available clinical evidence which is yet to conclusively link PFAS and adverse impacts on human health. As a result, the NHMRC has set less restrictive limits than those adopted in the USA.

- ▲ In 2018 the Australian NHMRC introduced a recommendation for the accepted maximum health-based guideline values (HBGV) for PFOS, PFOA and PFHxS into the ADWG which was based on the available scientific evidence at the time. This informs drinking water regulators, local health authorities and water utilities as to the maximum safe concentration of PFAS that can be present in Australian drinking water. In 2025, following a review of newer research, the ADWG guideline values were revised to low limits and with the addition of values for two further classes of PFAS species, PFBS and GenX chemicals.
- ▲ The USEPA considers there to be no safe level of exposure to PFAS and hence has adopted an aspirational target of zero. For the purposes of legislating and enforcing this, they have adopted the minimum limit of reporting for PFAS as their legislated maximum. The WHO's Guidelines for drinking-water quality (4th edition, 2022) are yet to include PFAS targets.

Current ADWG PFAS Guideline Recommendations Compared Against USEPA

Variant	ADWG Recommendations (as of June 2025)	USEPA Limits for Drinking Water (as of April 2024)
PFOA	≤ 0.0002 mg/L 0.2 µg/L 200 ng/L	The sum of the concentrations of PFOA and PFOS is ≤ 0.00004 mg/L 0.004 µg/L 4 ng/L
PFOS	≤ 0.000008 mg/L 0.008 µg/L 8 ng/L	
PFHxS	≤ 0.00003 mg/L 0.03 µg/L 30 ng/L	≤ 0.00001 mg/L 0.01 µg/L 10 ng/L
PFBS	≤ 0.001 mg/L 1 µg/L 1000 ng/L	Not included in the current limits.
GenX	No health-based guideline value can be derived at this time.	Not included in the current limits.

Management of PFAS Contamination

Source control to prevent additional PFAS contamination is generally lower cost, less energy intensive and more effective than implementing treatment technology to remove PFAS from drinking water. Restrictions have been introduced both nationally and internationally to restrict non-essential PFAS uses in an effort to limit the amount of new PFAS contaminations.

However, because of their longevity, PFAS compounds will remain in the environment for the foreseeable future and are now commonly detected at trace levels in groundwater, surface water and soils in most urban areas worldwide.

Treatment Options for PFAS Removal

- ▲ While the research remains young, the consensus is that the removal of PFAS by existing conventional water treatment processes is typically inadequate due to their high solubility and very strong chemical structure.
- ▲ Of the treatment options available, GAC filtration is very efficient in removing PFAS, however, this efficiency declines with GAC age. Determining a universal age at which carbon media needs replacement is not possible due to the complex factors that influence media condition; following a risk-based approach with an emphasis on ongoing monitoring of PFAS removal efficacy is recommended to guide decisions on the need for carbon media replacement.
- ▲ As GAC will also remove other organic compounds, these will compete with the PFAS for the adsorption sites and so NOM should be minimised upstream where possible. To lengthen the operating lifespan of the media, GAC is normally located towards the end of the treatment process so that other contaminants which may compete with the PFAS for the adsorption sites have already been reduced. Enhanced Coagulation may improve PFAS removal, potentially as a result of improved NOM removal leading to reduced competition for adsorption sites on carbon media.
- ▲ More advanced treatment options such as reverse osmosis, nanofiltration and ion exchange can be effective at removing PFAS, however they are high pressure and energy intensive which incurs a high OPEX cost and disrupt WTP gravity fed hydraulics. They also produce a reject (brine) stream that is highly contaminated with concentrated PFAS and which itself requires disposal and/or further treatment.
- ▲ For wastewater treatment, most current wastewater treatment plants do not reduce PFAS, so PFAS can remain present in treated water discharged to the environment, as well as recycled water and biosolids so need to be considered when assessing reuse applications.

Monitoring for PFAS in Water Supplies

The NHMRC recommends taking a site-specific and risk-based approach to monitoring PFAS in drinking water supplies as outlined in the ADWG risk management framework. It is recommended that PFAS testing be incorporated into standard monthly water quality assessments.

Note that when collecting samples for PFAS testing, the potential for sample contamination during both sample collection and analysis is very high due to the prevalence of PFAS being used in the manufacturing of the involved products (e.g., plastic sample containers and their waterproof labels, disposable gloves, laboratory consumables, etc). As a result, appropriate sampling, storage and transportation are critical for accurate analysis and therefore should be carried out by trained personnel.

Useful Additional Resources

1. National Chemicals Working Group of the Heads of EPAs Australia and New Zealand, 2020, *PFAS National Environmental Management Plan v2.0*, <https://www.dcceew.gov.au/sites/default/files/documents/pfas-nemp-2.pdf>
2. Australian Government PFAS Taskforce, *Per- and Polyfluoroalkyl Substances (PFAS) Australian Information Portal*, <https://www.pfas.gov.au/about-pfas/faq>
3. NHMRC, *NHMRC Review of PFAS in Australian Drinking Water Portal*, <https://www.nhmrc.gov.au/health-advice/environmental-health/water/PFAS-review>
4. NHMRC, *National Water Quality Management Strategy, Australian Drinking Water Guidelines 6 2011 (version 3.9 updated December 2024)*, <https://guidelines.nhmrc.gov.au/australian-drinking-water-guidelines>
5. United States Environmental Protection Agency Office of Water, Office of Groundwater and Drinking Water, Standards and Risk Management Division, 2024, *Technologies and Costs for Removing Per- and Polyfluoroalkyl Substances (PFAS) from Drinking Water*, https://www.epa.gov/system/files/documents/2024-04/2024-pfas-tech-cost_final-508.pdf