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Dr. Alexander Waller PhD Msc BSc (Hons) CBiol FRSB CChem MRSC

Visiting Professor of Environmental Ethics and Science Education at the American University of Sovereign Nations and Academics Stand Against Poverty (ASAP) Fellow, Yale University.

The Australian Senate have appointed a Select Committee on PFAS (per and polyfluoroalkyl substances), to inquire into the extent, regulation and management of PFAS. This review paper provides some evidence to help answer selected questions raised by the committee. The goal of the committee is to inquire into the extent, regulation and management of PFAS, with particular reference to specific foci including:

(b) sources of exposure to PFAS, including through environmental contamination, food systems and consumer goods;

PFAS are found in water, air and soils. In some locations in Europe PFAS concentrations in soils have deemed them unfit for growing food crops and recent RSC assessments of water bodies in England and Wales found that more than a third exceeded the proposed level of 100 ng/L, Fisher (2025) reports that PFAS were found in all bar one of the tested UK rivers. Bourzac (2024) reported that sixty-eight PFAS were found in food packaging from around the world and sixty-one were unexpected. Wee and Aris (2023) report levels of PFOA as high as 11,000 ng/L in drinking water sources in the USA and up to 8,000 ng/L in some Swedish drinking water supplies. Last year, the Australian National Health and Medical Research Council proposed new, lower guidelines for PFOS, PFOA, PFHxS, and PFBS compared to the existing Australian Drinking Water Guidelines. The NSW Health PFAS Expert Advisory Panel (2025) has reported that in June 2024 two Sydney water supplies were shown to have relatively high levels of PFOS and so they were disconnected from supplying to the water filtration plant. Further discussion of limits is outlined in section (l) below.

(c) the health, environmental, social, cultural and economic impacts of PFAS;

The persistence of PFAS means that bioaccumulation occurs in certain body tissues and organs and as animals consume at higher trophic levels along food chains then biomagnification results in increasing concentrations. This has been observed in carnivorous fish in aquatic systems by numerous researchers including Macorps, Le Menach, Pardon *et al.* (2022), Sun *et al.* (2022), George, Baker and Baker (2023), Miranda *et al.* (2023) and Xing *et al* (2023). Dimitrakopoulou *et al.* (2024) analysed 150,000 scientific publications from food safety authorities and found that fish and seafood had the highest levels of PFAS. Furthermore, Mazzetti *et al.* (2023) found that eight PFAS were found all twenty-six bodies of the marine mammal *Stenella coeruleoalba* that had been stranded on Tuscany beaches earlier this decade.

There are numerous reports of PFAS being associated with negative impacts on human health such as various cancers. The jury is still out on most of these, nonetheless the RSC (2025)[1] declares that there is a high degree of certainty on:

- delayed mammary gland development
- reduced response to vaccines
- lower birthweight
- thyroid disease
- high cholesterol
- liver damage
- kidney cancer
- increased risk of testicular cancer

The RSC assessment is based on numerous recent studies. For example, Eklund, Taj, Dunder. *et al.* (2025) demonstrated a statistically significant correlation between the increases in concentration of some PFAS and a loss of kidney function. Furthermore, Li *et al.* (2025) found associations between PFAS and county level cancer incidence between 2016 and 2021 attributable to drinking water in the USA. The alarming increase in the rates of cancer in Australians under the age of 50 as reported by Swan *et al* (2025) could be in part due to sustained intake of low levels of PFAS over years. This also raises the question of whether PFAS alter the gut microbiome. Lindell (2025) has shown that certain gut bacteria can accumulate

[1] This is contrary to the Australian National University PFAS Health Study (2021), which concluded that PFAS have not been shown to cause disease in humans.

PFAS which may then be egested. Yet this does not mean that the accumulated levels may first enhance the likelihood of concentrated mutagens causing ill effects in the digestive system prior to egestion or that detrimental a shift in the gut microbiome may occur over time.

The degree of the health impact from various PFAS will depend on the concentration and type of PFAS ingested or in contact with the body, which will in turn depend on the location and source of the chemicals; drinking water, firefighting chemicals, airports or military sites, industrial locations, water treatment plants, landfill sites and incinerators etc.

(d) challenges around conducting and coordinating health and exposure research into PFAS, including the adequacy of funding arrangements and the influence of the chemicals industry over the evolving body of scientific evidence on the health effects of PFAS, including in respect to First Nations communities;

First Nations communities that are located close to contaminated industrial land or military bases are disproportionally impacted by PFAS, such as those living in Wreck Bay in Australia[2], or Bay Mills in Michigan, USA as described by Gravelle (2022). Central to indigenous peoples' ways of life is an intimate relationship with the land and the ways knowledge is transferred from elders. Therefore, it is imperative that government authorities respect the community elders and ensure that all investigations are completely transparent, always bearing in mind that these communities themselves are in no way responsible for the contamination of their soil, water and natural resources. Caron-Beaudoin *et al.* (2020) found that from 2004 to 2017 pregnant Inuit women in Nunavik were increasingly exposed to some long-chain PFAS. Furthermore, associations between these levels and the omega-3/omega-6 ratio suggests that the high nutritional quality and cultural importance of country foods in the community may be at risk. Previously Caron-Beaudoin *et al.* (2019) collaborated with four First Nation communities in Quebec found that high levels in children within the communities had levels of some PFAS that may be endocrine disrupting chemicals. This illustrates just how vulnerable these people are to this environmental injustice. As environmental pressures increase with increasing wildfires and / or extreme flooding it should also be incumbent upon authorities to establish research programmes to determine if these events exacerbate the exposure to PFAS and other pollutants to vulnerable groups including indigenous communities and children[3]. It must also be borne in mind that it is likely, due to bioaccumulation and biomagnification, that many traditional food resources will be contaminated with PFAS and therefore whole ways of living will be under threat. This is a significant difference compared to lifestyle adjustments necessary in other communities. If First Nation communities are forced to adopt unhealthy western diets will they be given medical compensation later on?

(k) areas for reform, including legislative, regulatory, public health and other policy measures to prevent, control and manage the risks of PFAS to human health and the environment, including the phasing out of these harmful substances;

In the USA the EPA has made significant progress since 2021 by addressing PFAS under several different pieces of legislation including:

- Comprehensive Environmental Response, Compensation, and Liability Act that ensures polluters pay for clean-up
- Resource Conservation and Recovery Act to designate certain PFAS as hazardous
- Significant New Use Rule (SNUR) to prevent the resumption of manufacture banned PFAS or the processing of inactive PFAS, without stringent reviews
- Issuing SNURs to substances already covered by the Toxic Substances Control Act
- Safeguarding waterways through the Clean Water Act

The wide number of different pieces of legislation may benefit from being placed under one umbrella for ease of implementation, ensure effective and rapid remediation and to reduce loophole use and prevent stalling or inaction.

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[2] The exposure of the Wreck Bay community to PFAS is documented by The Senate (2025) in Chapter 6 of the Select Committee on PFAS (per and polyfluoroalkyl substances) *Interim Report* March 2025.

[3] Children inhale more air and ingest more food and water per kilogram bogy mass in comparison to adults (with the exception of pregnant women).

(l) any other related matters.

It is important to recognise in all the above sections that, as Lendewig *et al.* (2025) argue, the classification and definitions of PFAS impacts upon how regulations are framed. For example, trifluoroacetic acid (TFA) may not come under some definitions of PFAS even though it is acutely toxic and environmentally stable. Salvidge (2025) warns that re-defining PFAS from the wider OECD to the narrower definition proposed by the International Union of Pure and Applied Chemistry (IUPAC) could lead to countries taking less protective measures against PFAS. Brazil (2025) points out that TFA has been proven to arise from drugs that contain trifluoromethyl groups such as fluoxetine. Some definitions of PFAS include up to 10,000 different substances. Although pharmaceuticals may be a contributory source of PFAS Brazil adds that, according to David O'Hagan of the University of St. Andrews, the main route of PFAS into the environment is from refrigerants, such as 2,3,3,3-tetrafluoropropene, that break down into TFA. This illustrates the importance of clear definitions of what is and what is not covered in PFAS regulations, as the widest definitions will include numerous pharmaceuticals, agrichemicals and some renewable energy technology materials for which it may prove to be extremely challenging to find alternatives and yet in reality many of these uses are likely to be relatively minor contributory sources of PFAS into the environment.

The Stockholm Convention on Persistent Organic Pollutants (POPs) only specifies a very small number of the PFAS family of chemicals (namely PFOS, PFOA and PFHxS). This means that countries in the Asia Pacific region that are largely relying on this legislation as a framework for their national regulations are only scratching the surface of the PFAS problem, as discussed by Dadhania (2024). There are countries within the region such as South Korea that are identifying a wider list of potential PFAS chemicals to ban. However, this is still dwarfed by the EU potential policy as this economic group of countries are deliberating a complete ban on the production, import and use of all PFAS as defined by the OECD, which covers at least 5,000 compounds. A similar approach to the EU is already in place in some states, such as Maine and Minnesota in the USA. However, at the federal level the EPA has not banned PFAS completely but regulations are in place for a phased transition to becoming PFAS free. In the UK new regulations have been introduced with the RSC pushing for a reduction in allowable limits in drinking water to 100 ng/L. This is in line with the EU limit for twenty specific PFAS, whereas the USA has more stringent regulations of 4ng/L for PFOS and PFOA. The Australian proposals for 4ng/L for PFOS is the same as the USA however the Australian proposed allowable level for PFOA is significantly higher than that for the USA. Does this latter guideline merit review in light of research that shows some PFAS can breakdown into TFA under environmental conditions?

Although public awareness of PFAS has increased over the last decade results from international surveys indicate that there are still significant knowledge gaps and this provides space for misinformation and disinformation to be spread. Kemper *et al.* (2024) found, in a survey of nearly 1000 adults in New Zealand, that although approximately half were aware of PFAS there were significant misunderstandings. In a sample of 1,100 respondents to a survey in the USA Berthold et al. (2023) found there were extremely inconsistent responses depending on their location. Generally, this American sample were unaware of the presence in PFAS in drinking water. In the UK Cotton *et al.* (2024) report that in a YouGov survey of over 4000 adults only 29% had heard of PFAS, and within that minority approximately two-fifths believe that all or most PFAS have significant health or environmental risks associated with them. Therefore, there is a need for an ongoing education regarding the extent of PFAS, any associated possible health risks and the remediation measures to enable for citizens to make informed choices about best to protect themselves.

Abbreviations

EPA Environmental Protection Agency
OECD Organisation for Economic Co-operation & Development
IUPAC International Union of Pure and Applied Chemistry
PFAS perfluoro and polyfluoro alkyl substances
PFHxS perfluorohexane sulfonic acid
PFOA perfluorooctanoic acid
PFOS perfluorooctane sulfonic acid
POPs persistent organic pollutants
RSC Royal Society of Chemistry
TFA Trifluoroacetic acid

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