Marine and Coastal
National Environmental Science Program

FACT SHEET | JUNE 2026

# Per- and polyfluoroalkyl substances in urban runoff and receiving marine water and sediment in Gamay/Botany Bay

Sampling of water and sediments across Gamay/Botany Bay, New South Wales, is yielding a better understanding of pollutant concentrations in coastal stormwater and receiving waters, implications for the environment, and management considerations for protecting coastal environments.

Contaminants of emerging concern, such as per- and polyfluoroalkyl substances (PFASs), among others, are chemicals that have the potential to cause adverse changes to ecosystems and/or human health. They are commonly incorporated into pharmaceuticals, pesticides, industrial chemicals, and household items, and can be discharged into coastal areas in industrial and residential wastewater, stormwater, and land runoff.

In 2024, the National Environmental Science Program Marine and Coastal Hub launched 'Project 4.22: Environmental concentrations of emerging contaminants in coastal stormwater'. This project led by University of Technology Sydney (UTS) is conducting a program of sampling of water and sediments to assess environmental concentrations of contaminants and their potential impacts on microbes. The sampling will yield a better seasonal understanding of the concentrations of these pollutants in coastal stormwater and receiving waters. This information will help clarify the scale of the problem in studied areas, shape the development of water and sediment quality guidelines, and support better management and protection of coastal environments.


UTS scientists sampling at Yarra Bay, one of the five sampling sites within Gamay/Botany Bay. Image: UTS

## Sample collection

As a first step, UTS scientists collected water and sediment samples across Gamay/Botany Bay, NSW, between January and April 2025. Gamay/Botany Bay is a large coastal embayment in southern Sydney with high economic, ecological, and cultural significance.

The samples were analysed for 49 PFASs (Method US EPA 1633A, with slight modifications). PFASs are a large group of chemicals commonly used to make products resistant to heat, water, grease, and stains. PFASs are commonly grouped based on chemical structure (PFAAs or PFAS precursors), carbon-chain length, and use history, with particular distinction made between historically older, long-chain 'legacy PFASs' (such as PFOS, PFOA) and short-chain or replacement compounds, which differ in mobility, bioaccumulation, and regulatory concern. Often called 'forever chemicals', some PFASs (among others PFOS, PFOA, PFHxS, PFBS) can persist in the environment for long periods and may pose risks to ecosystems and human health because they can accumulate in living organisms and have toxic effects.

The results of the monitoring data are presented in a [journal article published in *Environmental Research*](#).

This fact sheet presents a summary of the results presented in the journal article. Results of the broader study will be available later in 2026.

## Sample locations across space and time

### *Gamay/Botany Bay*

Sampling was done at five sites within Gamay/Botany Bay under low rainfall (low-flow) conditions when pollutant concentrations are most likely to be highest and total loads relatively low. These sites represent a range of adjacent land uses (see map below).

- Frenchmans Beach: R2 Low Density Residential
- Yarra Bay Beach: SP1 Seaport, RU4 Primary Production, RE1 Public Recreation
- Foreshore Beach: SP2 Airport
- Ramsgate Beach: R3 Medium Density Residential
- Kurnell Beach: C1 National Parks and Nature Reserves and C4 Environmental Living

This spatial coverage captures variability in potential PFAS sources associated with different land-use types in the Gamay/Botany Bay catchment.

### *Sample collection at sites*

Sampling was conducted across three compartments:

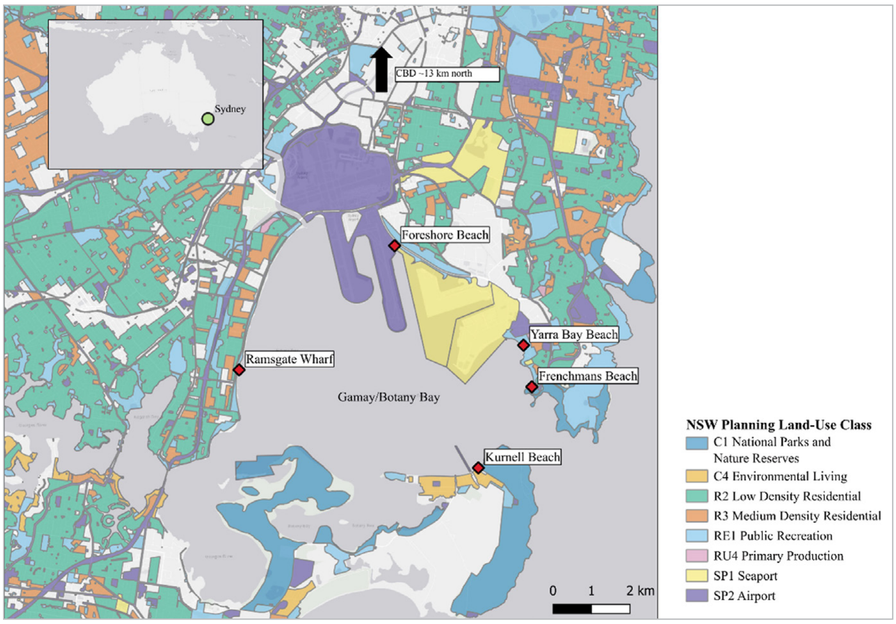
- Urban runoff: surface water was collected from impervious urban surfaces at ground level.
- Adjacent seawater: shallow coastal water was sampled at knee-high depth (approximately 0.4-0.6 m below the water surface) adjacent to the runoff discharge point.
- Co-located sediments: surface sediments (upper 0–10 cm) were collected directly beneath the urban runoff discharge and seawater sampling locations using a plastic tube pushed into the sediment.

This study focuses exclusively on PFASs concentrations within these defined compartments. Loss or dispersion of PFASs to surrounding environments (such as groundwater, deeper sediments, or atmospheric pathways) was outside the scope of this study.

### *Coverage over time*

Sampling was conducted monthly from January to April 2025. This timeframe provided representative data for each sampling point during the study period and focussed on low rainfall and low-flow scenarios.


Above: Urban runoff collected from impervious surfaces at ground level (a–b), adjacent shallow seawater sampled near the discharge point (c), and co-located surface sediments collected below runoff and seawater sites (a–c). Images: UTS




Left: Sampling locations (stormwater outlets and adjacent marine water and sediment) across multiple land uses (Botany Bay, NSW, Australia). Land use classifications are based on NSW Planning Portal (NSW Planning Portal Spatial Viewer, 2020).

## What the study found

***PFASs were widespread across water and sediments***

The study analysed 49 different PFASs chemicals and found that many of them were present in both water and sediments (see Appendix Table 2). 26 of the PFASs tested were detected in water from urban runoff and adjacent seawater in the bay. Seven of the tested PFASs were detected in sediments collected at the urban runoff discharge and seawater sampling locations. Only 5 PFASs were detected in water and sediment.

PFASs levels were highest in urban runoff ($\Sigma PFAS_{n=49}$ = 0.175 μg/L)*. Levels were lower in adjacent receiving seawater ($\Sigma PFAS_{n=49}$ = 0.0035 μg/L), where they are diluted, but PFASs were still detectable. PFASs were also found in sediments near stormwater runoff outlets ($\Sigma PFAS_{n=49}$ = 0.31 μg/kg) and in nearby marine sediments ($\Sigma PFAS_{n=49}$ = 0.34 μg/kg), suggesting that some PFASs can accumulate in the marine ecosystems, particularly sediments, over time.

*Median total detected PFASs ($\Sigma PFAS_{n=49}$)

***Different PFASs link to water or sediment samples (important for monitoring and risk analysis)***

Water samples were dominated by ultrashort and short-chain PFASs. These PFASs are persistent in the environment and more hydrophilic, meaning they solubilise easily in water, and are therefore more mobile, allowing them to persist in water and spread widely through the bay.

In contrast, sediments contained longer-chain PFASs, which are more adsorptive, meaning they more easily stick to sediment surfaces. Hence, intertidal sediments act as a long-term sink for PFASs, where they accumulate and persist for extended periods of time.

***Runoff is actively contaminating the nearshore marine environment***

PFASs detected in urban runoff, even under low-flow conditions, indicate that urban runoff is a source of nearshore PFASs contamination in Botany Bay.

The similarity in PFASs profile between stormwater discharge and marine sediments (except at one residential discharge sediment case) suggests that runoff contributes to PFASs contamination in intertidal sediments.

***Land use is likely to have caused PFASs contamination***

### Airport and port/agricultural runoff

The highest marine receiving-site concentrations were observed across two different land uses, at the port/agriculture site and the national park/residential site. Yarra Bay and Kurnell Beach showed median PFAS concentrations of 0.16 $\mu g\ L^{-1}$ in seawater and 1.12 $\mu g\ kg^{-1}$ in marine sediments, respectively. Although the airport site did not show the highest median values between January and April, the seawater PFASs profile closely resembled that of the associated runoff, suggesting strong local urban runoff contamination. Runoff from this airport- and port/agriculture-influenced site was dominated by regulated PFASs, including long-chain PFOS, PFOA, PFHxS (PFAS NEMP 3.0)1, and related sulfonamide precursors.

### Residential runoff

The highest stormwater runoff concentrations were detected at Frenchman's Beach, with median total PFAS ($\Sigma PFASn_{=49}$) concentrations of 0.39 μg/L in water and 5.34 μg/kg in sediments. Residential runoff showed a more diverse PFASs profile, dominated by short-chain alternatives and precursor compounds such as PFHxA and polyfluoroalkyl phosphate esters (PAPs; e.g. 6:2 diPAP, 8:2 PAP), consistent with post–phase-out shifts in consumer product use. The composition of PFASs in residential runoff is likely linked to intermittent household sources such as washing, cleaning, and consumer product use.

***Contamination of ultrashort PFASs in water stood out as an emerging concern***

Compounds such as PFPrA and bis-FMeSI were highly abundant in seawater, despite relatively low levels in runoff. This pattern suggests strong mobility and persistence in the marine environment, as well as possible additional diffuse or local sources and/or long-range transport. The presence of bis-FMeSI-related compounds has been linked to battery and lithium-ion applications, raising the possibility of new industrial source pathways in urban areas.

There are guideline values for only a small number of PFASs (PFOS, PFOA and in some contexts PFHxS). Comparing PFASs concentrations of the current project with guideline values highlights potential ecological exposure risks. PFOS concentrations detected in urban runoff discharge and seawater exceeded the default guideline value for freshwater for 99% species protection (ANZG)[2], although concentrations remained below the recreational water guidelines (NHMRC)[3] for PFOS and PFHxS. At present, Australia lacks sediment quality guidelines for PFASs, which limits the ability to fully assess the ecological significance of persistent PFASs in intertidal sediments (NEMP 3.0[5]).

[1] PFAS National Environmental Management Plan 3.0 (2025).

[2] Toxicant default guideline values for aquatic ecosystem protection: Perfluorooctane sulfonate (PFOS) in freshwater (ANZG 2026).

[3] NHMRC Guidance on Per and Polyfluoroalkyl substances (PFAS) in Recreational Water (2019).

[4] HEPA 2025, PFAS National Environmental Management Plan Version 3.0, Heads of EPA Australia and New Zealand 2025. CC BY 4.0.

# Implications for the environment

***Chronic, multi-pathway exposure is likely***

Chronic multi-pathway exposure to PFASs is likely in Botany Bay. In the water column, exposure is dominated by ultrashort and short-chain PFASs, creating a continuous exposure risk for pelagic marine organisms and allowing contaminants to spread across the bay. In sediments, exposure is dominated by long-chain PFASs and strongly sorbing precursors, such as diPAPs, which can form persistent hotspots. These hotspots have the potential to affect benthic organisms and act as long-term sources of contamination.

***Food-web implications***

The food web may also be affected. While ultrashort PFASs may bioaccumulate in primary producers and consumers and less in top predators, evidence from the literature suggests that shorter-chain PFASs can accumulate in planktonic primary producers and consumers, potentially seeding exposure throughout the entire food web. Ongoing work by the research team at UTS and Sydney Institute of Marine Science is examining the impacts of contamination on aquatic microbes.

***Sensitive/co-existing values at risk***

There are sensitive and high-value habitats at risk. Botany Bay's proximity to national parks and the Ramsar-listed Towra Point wetland of international importance means that PFASs inputs intersect with areas of high conservation value, raising questions about long-lived contamination in sediments and nearshore waters.

# Implications for people

***Seafood and cultural use pathways***

PFASs in Botany Bay create potential exposure pathways through seafood consumption and cultural practices. Long-chain PFASs, like PFOS, remain in sediments for many years and do not break down, and because they can accumulate in organisms, seafood harvested from the bay could be a route of human exposure, intersecting with both recreational fishing and cultural connections to Gamay.

***Recreational activities***

Australian recreational water quality guidelines, set by the National Health and Medical Research Council (NHMRC)[5], establish concentration limits for chemicals in water to protect human health during swimming and other recreational activities. Measured PFASs concentrations in Gamay/Botany Bay were below these guideline limits, meaning the water is considered safe for direct recreational contact.

[5] Guidance on Per and Polyfluoroalkyl (PFAS) in Recreational Water, Canberra: National Health and Medical Research Council (2019)

# Management considerations

The hazards and exposure patterns identified in this study suggest that more intensive monitoring of both water and sediment quality is required (they tell different stories: 'recent inputs' vs 'long-term sinks'). Consideration should be given to:

- monitoring selected marine biota, to better assess potential risks to marine ecosystems and human health; and
- expanding monitoring beyond legacy PFOS/PFOA/PFHxS to include ultrashort PFASs, precursors (such as PAPs), and newer alternatives that are now frequent and sometimes dominant.

Targeted land-use interventions should prioritise:

- airport/industrial precincts: legacy PFASs source control and site investigations for potential ongoing inputs;
- residential catchments: diffuse-source strategies (product stewardship, community education, stormwater/urban runoff discharge treatment options); and
- industrial catchment inputs: identify upstream trade waste inputs and direct further research to understanding those sources.

There is also a need to develop sediment quality guidance and marine ecotoxicology evidence.

Repeated detection of long-chain PFASs in sediments, paired with guideline gaps, supports urgent work on sediment benchmarks and marine toxicity/food-web studies, especially for ultrashorts that are often analytically overlooked.

# Additional project activities

Subsequent to these initial analyses, the project team has conducted:

- monthly sampling throughout 2025 to capture temporal changes in PFASs and water quality;
- event-driven sampling following rainfall was conducted to assess stormwater contributions and contaminant dynamics; and
- microbial investigations to determine how microbial communities respond to water quality changes and potential PFAS exposure.

These additional activities will be covered in the final report published at completion of the project.

## Guidelines and policy frameworks relevant to this study

| Guideline/policy | What the guideline covers | PFAS guideline |
|---|---|---|
| PFOS Fresh Water Guideline Values: Technical brief (2026) | The ANZG water quality guideline provides a nationally endorsed framework used across Australia and New Zealand, establishing safe PFOS concentrations in freshwater to protect aquatic life (up to 99% of species) and support environmental risk assessment. | Default guideline values for PFOS in freshwater:<br>- 99% species protection: 0.02 µg/L<br>- 95% species protection: 0.9 µg/L<br>- 90% species protection: 4 µg/L<br>- 80% species protection: 20 µg/L |
| PFAS National Environmental Management Plan 3.0 | Australia's national guide for managing Per- and poly-Fluoroalkyl substances (PFAS) contamination in the environment. The following guidelines are for soil. | Land use scenario:<br>Residential with garden/accessible soil (HIL A)<br>- 0.003 mg/kg Sum PFOS + PFHxS<br>- 0.06 mg/kg PFOA<br>Residential—minimal soil access (HIL B)<br>-2 mg/kg Sum PFOS + PFHxS<br>- 20 mg/kg PFOA<br>Public open space (HIL C)<br>- 1 mg/kg Sum PFOS + PFHxS<br>- 10 mg/kg PFOA<br>Industrial / commercial (HIL D)<br>- 20 mg/kg Sum PFOS + PFHxS<br>- 50 mg/kg PFOA |
| Australian Drinking Water Guidelines (ADWG) (NHMRC) | Guide States and Territories to regulate safe drinking water. Jurisdictions will now determine the timelines for which water providers will be expected to meet the new values. | PFOS 0.008 µg/L<br>PFHxS 0.03 µg/L<br>PFOA 0.2 µg/L<br>PFBS 1 µg/L |
| Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG/WQG) | Used to help assess potential ecological risks in surface waters. | Exposure scenario:<br>Interim marine/Freshwater, 99% species protection – high conservation<br>- 0.00023 µg/L PFOS<br>- 19 µg/L PFOA<br>Interim marine/Freshwater, 95% species protection – slightly to moderately disturbed<br>- 0.13 µg/L PFOS<br>- 220 µg/L PFOA<br>Interim marine/Freshwater, 90% species protection – highly disturbed<br>- 2 µg/L PFOS<br>- 632 µg/L PFOA<br>Interim marine/Freshwater, 80% species protection – highly disturbed<br>- 31 µg/L PFOS<br>- 1824 µg/L PFOA |
| Guidelines for Managing Risks in Recreational Water (NHMRC) | National guidance for protecting public health in recreational waters, addressing microbial, chemical and algal hazards in coastal, estuarine and freshwater systems. | Recommended:<br>- 2 µg/kg Sum PFOS + PFHxS<br>- 10 µg/kg PFOA |

# PFASs detected in water and sediment samples from Gamay/Botany Bay

| PFAS | Chemical group | Chain length and number of fully fluorinated carbons | Detected in water and/or sediment |
|---|---|---|---|
| PFPrA | PFAA | Ultrashort (C2) | Water |
| PFBA | PFAA | Ultrashort (C3) | Water |
| PFPeA | PFAA | Short (C4) | Water |
| PFHxA | PFAA | Short (C5) | Water |
| PFHpA | PFAA | Short (C6) | Water, Sediment |
| PFOA | PFAA | Long (C7) | Water, Sediment |
| PFNA | PFAA | Long (C8) | Water |
| PFDA | PFAA | Long (C9) | Water, Sediment |
| PFUnA | PFAA | Long (C10) | Water |
| PFDoDA | PFAA | Long (C11) | Sediment |
| PFTeDA | PFAA | Long (C13) | Sediment |
| PFPrS | PFAA | Ultrashort (C3) | Water |
| PFBS | PFAA | Short (C4) | Water |
| PFPeS | PFAA | Short (C5) | Water |
| PFHxS | PFAA | Short (C6) | Water |
| PFHpS | PFAA | Long (C7) | Water |
| PFOS | PFAA | Long (C8) | Water, Sediment |
| FBSA | PFAA | Short (C4) | Water |
| FHxSA | PFAA | Short (C6) | Water |
| 6:2 FTS | PFAS precursor | Short (C6) | Water |
| 3:3 FTCA | PFAS precursor | Ultrashort (C3) | Water |
| 5:3 FTCA | PFAS precursor | Short (C5) | Water |
| 8:2 PAP | PFAS precursor | NA | Water |
| 6:2 diPAP | PFAS precursor | NA | Water, Sediment |
| bis-FMeSI | PFAS precursor | NA | Water |
| 5:1:2 FtB | PFAS precursor | NA | Water |

PFASs detected in water and sediment samples from Gamay/Botany Bay, with chemical classification and chain length. PFAA refers to stable, end-product PFASs (such as PFOS, PFOA). PFASs precursors are compounds that transform into PFAAs in the environment. Only bold PFASs are currently covered in guidelines.



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