DEFENCE PFAS CONSTRUCTION AND MAINTENANCE FRAMEWORK

Guidance for managing the risks of PFAS contamination for works on the Defence estate

INFRASTRUCTURE DIVISION
DIRECTORATE OF PFAS INVESTIGATION AND REMEDIATION

Version 3.0
August 2021
## Change history

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<td>Alison Clifton</td>
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### KEY MESSAGES

#### Objective
- To support decision-makers in managing risks from per- and poly-fluoroalkyl substances (PFAS) contaminated soil, water and demolition waste in the context of construction and maintenance works on the Defence estate.

#### Application
- This document applies to construction and maintenance works on the Defence estate where there is evidence of potential for PFAS contamination. It is to be applied in conjunction with the requirements of the Defence Contamination Management Manual.
- This document does not apply to PFAS remediation or PFAS contaminated site investigation programs managed by the Directorate of PFAS Investigation and Remediation.
- Managing PFAS consistent with guidance in this document does not replace the need for additional risk assessment when managing large volumes of soil and water. Decisions should be supported by consideration of PFAS load, not just PFAS concentration.
- This document does not provide specific guidance for managing very small volumes of displaced soils or water (in aggregate for the works, approximately <10 m³ soil or <1000 L water) where it is reinstated within the work site. Standard operating procedures apply.
- Where the volume of soil to be managed is > 1,500 m³, additional risk assessment is required.
- Construction and demolition waste is to be managed in accordance with relevant Defence, State and Territory standards and procedures. This document provides additional guidance for infrastructure associated with aqueous film forming foam (AFFF) or where there is reason to believe that the material has been in direct contact with AFFF concentrate and foam.
- Vegetation including trees, grasses and mulch should not be tested for PFAS unless directly adjacent to a primary source area such as a Fire Training Ground.

#### PFAS sampling and analysis
- Significant testing has occurred across the Defence estate. Review available PFAS data before sampling. Start with the Defence Garrison Estate Management System (GEMS), then check the Defence PFAS webpage. Additional sampling should be justified as filling critical data gaps. Data in ESdat can be requested from Defence.

#### Beneficial reuse of PFAS contaminated materials
- Consider beneficial reuse options when managing PFAS contaminated materials. Refer to the DEQMS Waste Minimisation website for more information.
- Locations where contaminated material has been reused for beneficial purposes should be entered in GEMS as per the DCMM.
- Refer to the work objectives and apply this framework using all available data to inform professional judgement and undertake an assessment of risk for the beneficial reuse of material.

#### Directorate of PFAS Investigation and Remediation (DPFASR)
- DPFASR is currently delivering a range of services for the remediation, assessment and management of PFAS contamination across the Defence estate.
- Where PFAS Management Area Plans (PMAPs) are available, DPFASR should be engaged to ensure alignment and integration of the management actions identified within the PMAP and the works delivered on the base.
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1 INTRODUCTION

1.1 About this document

1.1.1 Purpose

The Defence PFAS Construction and Maintenance Framework has been developed to support decision makers in managing risks from material contaminated with per- and poly-fluoroalkyl substances (PFAS) in the context of construction and maintenance works on the Defence estate.

Specifically, guidance is provided on the management of PFAS contamination for:

- soil;
- water; and
- construction and demolition (C&D) waste.

The framework is not to be used for targeted PFAS investigations or managing wastes generated through pollution incidents, instead refer to the current version of Department of Defence Pollution Prevention Management Manual (PPMM) including Annex 1C Fire Fighting Foam Management.

The PPMM should be used for guidance when there is a risk that PFAS containing foam might pollute an otherwise clean environment. It should be used when managing hangar foam discharge, tank cleaning, foam changeover or spills.

The latest version of the Defence Contamination Management Manual (DCMM) should be used for guidance when the soil, water or other material is already contaminated and needs to be managed. Refer to DCMM Annex C - Planning to Minimise and Manage Stockpiling for guidance on stockpiling.

1.1.2 Goals

The goals of this guidance are:

- to provide options for the management of PFAS contaminated soil, water, construction/demolition waste and other materials such as vegetation, tanks and pipes, that will mitigate the risks associated with PFAS contamination at the works site, on the base, or in close proximity to the base;
- to guide decision-making for efficient and compliant solutions when managing PFAS contaminated materials in this context;
- to minimise the impact of risk-management of PFAS contamination on Defence capability;
- to ensure an integrated approach to PFAS risk management aligned with the PFAS Management Area Plans (PMAPs), Remedial Action Plans (RAPs) and works requirements; and
- to provide guidance that is consistent with the PFAS National Environmental Management Plan Version 2.0 (PFAS NEMP; HEPA, 2020).
1.2 Application

1.2.1 Who will use this framework?
This framework applies to:

- all Defence delivered infrastructure works:
  - Defence (including contractors) carrying out public works, including construction and maintenance works on the Defence estate; and
  - Defence Environmental staff responsible for environmental approvals associated with relevant works.

The framework must be provided as a compliance requirement for all managers, developers and deliverers of such works.

This framework should be used during the planning, design and delivery phases of projects. It should assist development of tender specifications, preparation of cost estimates and consideration of management options.

See section 2.3 for a list of roles and responsibilities.

1.2.2 When to use this framework
This framework applies to all Bases and other properties in the Defence estate.

Particular consideration should be given to works that may occur at properties:

- identified online at the Defence PFAS Investigation and Management Program website;
- listed on the Defence Garrison Estate Management System (GEMS) as having PFAS contamination;
- where previous environmental testing has identified PFAS contamination; or
- where there is known history of the use and/or storage of Class B firefighting foam, for either incidents or training, at or nearby the works site or a proposed reuse site.

The framework does NOT apply:

- to targeted PFAS contaminated land investigations, including management of investigation derived waste (IDW);
- to works occurring in an area on base where there is no evidence of actual or likely presence of PFAS contamination;
- where the total volume of soil being displaced at a works site is below 10 cubic metres (m³) and it is being reinstated back within the works site;
- where the volume of water being displaced from the environment is below 1000 Litres (L) and the water is returned to ground for infiltration within the works site within 48 hours;
- to construction and demolition waste except where it is associated with Class B foam infrastructure (e.g. training, storage or deluge systems) or where there is reason to believe that the material has

What does that word mean?
Appendix A contains a glossary of words and acronyms.
In this document, the word 'base' means the Defence property on which the works site is located. This is whether or not the Defence property is a designated 'base'.
been in direct contact with PFAS containing foam (incident response or other release);
• to operational maintenance and management of sewage treatment plants (STPs) or to sewage treatment, biosolids or wastewater discharge. It would apply to demolition of a STP; and
• to water generated from processes such as hangar foam tests, tank cleaning, spill management.

1.2.3 Other compliance requirements

The guidance in this framework should be applied in conjunction with:

• any existing property approvals or Environmental Clearance Certificates (ECCs);
• site management or BM, ADES, ESM, ESO requirements on base;
• State or Territory environmental regulations;
• Work Health and Safety Act 2011 (Commonwealth);
• Work Health and Safety Regulations 2011 (Commonwealth);
• consideration of any other co-contaminants identified at the works site;
• Defence guidance set out in section 1.7.2 as applicable; and
• PFAS Management Area Plan (see section 1.8) and DPFASR guidance on remedial actions relating to the property.
• PFAS NEMP Version 2.0, as amended from time to time (HEPA 2020).

When referencing the framework for management and reuse of very large volumes of material (thousands of cubic metres of soil or hundreds of thousands of litres of water), further risk assessment is required. The risks to the receiving environment from the total load (mass) of PFAS need to be assessed in such cases.

1.3 Background

PFAS are a large group of man-made chemicals which include perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), and perfluorooctanoic acid (PFOA). PFAS have been widely used around the world since the 1950s to make products that resist heat, stains, grease and water. These products include hydraulic fluid, stain resistant applications for furniture and carpets, packaged food containers, waterproof clothing, personal care products and cleaning products.

Due to their effectiveness in extinguishing liquid fuel fires, PFAS are an ingredient in AFFF used extensively worldwide by both civilian and military authorities from about the 1970s. Legacy formulations of AFFF contained long chain PFAS with longer carbon chain structures are considered more hazardous

1 PFAS with longer carbon chain structures are considered more hazardous
Committee (enHealth), published revised guidance statements advising that there is currently no consistent evidence that exposure to PFOS and PFOA has a substantial impact on human health. However, since these chemicals remain in humans and the environment for many years, it is recommended that as a precaution, human exposure to PFAS be minimised.

PFOS was listed in 2009 under the Stockholm Convention on Persistent Organic Pollutants (POPs), with PFOA listed in 2019 and PFHxS is currently under consideration for listing. These chemicals are considered to be highly persistent, can bioaccumulate, and are toxic to some aquatic organisms. PFAS are also highly mobile in aquatic environments, with limited remediation options.

1.4 What’s different about PFAS contamination?

1.4.1 The nature of PFAS

PFAS has many qualities that combine to present particular challenges in locating, containing and remediating PFAS contamination.

- Water is the primary method of PFAS contamination transferring from a source, such as a fire training area or fire-fighting foam incident site, to a receptor, such as a person, animal, plant, ecosystem, property or a water body;
- PFAS is reasonably soluble in water and can rapidly leach through soils or disperse in waterways, travelling long distances;
- PFAS can permeate some solid surfaces. This includes concrete and other porous building materials, such as some firefighting appliances and apparatus, storage tanks and fire training pads;
- PFAS does not permeate intact plastic containers or PVC piping;
- Key PFAS relevant to fire-fighting foam (including PFOS, PFHxS and PFOA) are very chemically and biologically stable and have a low vapour pressure, so they are resistant to breakdown and evaporation; and
- Some PFAS (including PFOS, PFHxS and PFOA) are environmentally persistent and bioaccumulative. This means that some plants and animals may take up PFAS through soil and water. It may then bioaccumulate and become a part of the food chain.

1.4.2 New knowledge and new remediation techniques

Developments in analytical methods have improved detection of PFAS over recent years, but there are still levels below which PFAS cannot be accurately quantified at commercial scale, although it may be present (known as the ‘limit of reporting’ or ‘LOR’).

As an emerging contaminant, the understanding of the behaviour and impacts of PFAS contamination on human health and the environment is still developing, such as what concentrations of contamination in water and soil give rise to concern, and when. In some cases, site-specific risk management measures may need to be developed to minimise human exposures and protect the environment. PFAS Estate Management is to be contacted at pfas.estatemanagement@defence.gov.au by projects seeking further advice.

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2 enHealth is a subcommittee of the Australian Health Protection Principal Committee, and is responsible for providing agreed environmental health policy advice. Its membership includes representatives from the Health portfolios of Australian and New Zealand governments.

3 enHealth Guidance Statements on per- and poly-fluoroalkyl substances (2019)
Remediation technologies are at various stages of research and development. They are currently more advanced in the treatment of water than for soil. Advice on the latest technology can be provided by DPFASR.

The science of PFAS impacts and technologies for managing PFAS is constantly evolving. As a result, this framework may be updated to meet changing national standards.

1.5 PFAS on the Defence estate

The majority of PFAS contamination on the Defence estate is the result of the historical use and storage of legacy firefighting foams, specifically Class B PFAS containing foams. These foams have been used for training purposes or incident control. In the Defence context, sources and reservoirs of PFAS contamination are generally associated with current or former fire training areas, accident scenes where PFAS containing foams were used and stored, and fire stations or areas where fire suppression systems were used or tested.

In 2004, on Defence bases, Defence commenced the process of transitioning from foams that contain PFAS and updated the way it uses, stores and trains with AFFF. Ansulite, a product that does not contain PFOS or PFOA as active ingredients (but contains some level of PFAS), was introduced and in its turn is being replaced by a product that does not contain any PFAS. To date, all Aircraft Rescue and Firefighting vehicles have transitioned to fluorine free foams. The transition of portable, handheld and mobile fire extinguishers will be completed by early 2022. The remaining sources of PFAS containing foam will be in our fixed fire suppression systems in certain hangars and bulk fuel areas.

The Defence National PFAS Investigation and Management Program is progressing at Defence properties across Australia as a result of the historical use and storage of legacy PFAS containing foam. For those sites that have concluded the investigations phase, Defence has prepared PFAS Management Area Plans (PMAPs). These are high level plans for managing elevated exposure risks identified as part of the site specific human health or ecological risk assessments.

Defence has undertaken an iterative, evidence-based approach to efficiently prioritise and investigate sites across the estate most likely to be significantly contaminated or that may potentially pose a risk to human health and the environment. All other properties are subject to routine contaminated site investigations, with PFAS considered as a contaminant of potential concern. Further work to address those areas with identified contamination will be considered for remediation and management actions. This information should be considered during all phases of project management for construction and remediation works.

1.6 PFAS contamination risks for works on the Defence estate

The risks associated with PFAS contamination in the context of works on the Defence estate arise because:

- PFAS contamination may be found in soils, water (e.g. groundwater, surface water), or construction and demolition waste;
- works can mobilise existing contamination through demolition, excavation, changed storm water flows, changes to groundwater flows, large-scale dewatering, dust suppression or stockpiling; and
- once mobilised, PFAS can rapidly leach through soils or disperse in groundwater and surface waterways resulting in exposure to humans and the environment.

1.7 Guidance values used in this framework

This framework is based on appropriate risk management of PFAS contaminated material on Defence properties undergoing construction and maintenance works where the nature and extent of required
management actions for PFAS contamination are not yet known. Where the investigation process for a Defence property has been completed, a PMAP will be published on the Defence PFAS webpage that describes PFAS management actions at the property. In these cases guidance in the PMAP may supersede this document (see section 1.8).

The guidance values provided in this framework are not intended to be used for remediation targets, health-based criteria or for regulatory purposes. Rather, the potential need for management of contaminated materials (e.g. remediation or reuse) is identified by an exceedance of guidance values stated in this framework, based on a site-specific assessment. The values should be used in conjunction with relevant, up to date guidance documents (see section 1.7.1).

The guidance values specified in this framework apply to PFOS, PFOA and PFHxS, as human health guidance values are available for these PFAS in Australia. Additionally, some ecological guidance values are available for PFOS and PFOA. As with other components of this framework, guidance values may be expected to be updated as the science, policy and remediation technologies are developed over time.

### 1.7.1 Source references

In developing categories for management of soils with differing PFAS concentrations, the following was referenced:

- PFAS National Environmental Management Plan (NEMP) 2.0, (HEPA 2020)

### 1.7.2 Relationship with other Defence environmental management guidance

Defence environmental management guidance includes, but is not limited to:

- Defence Contamination Management Manual (DCMM), 2019
- Defence Draft Guidance on Stabilisation and Reinstatement of PFAS Impacted Soils (refer to DPFASR for the most recent version)
- Defence Interim PFAS Remediation Action Plan Guidance. It should also be consulted where a RAP targets a number of contaminants, including PFAS (refer to DPFASR for the most recent version).

### 1.8 Integrating and aligning PFAS management across the estate

Since PFAS investigations commenced under the Defence National PFAS Investigation and Management Program, Defence has sought to develop a comprehensive evidence-based approach to managing the risks associated with PFAS contamination. This has resulted in a staged approach:

| 1 | Interim Response Management (IRM) Actions | During the investigation phase, some risks are identified that require the commencement of management actions before the conclusion of investigations. Providing drinking water to people whose drinking supply is contaminated by PFAS is an example. Other actions may also be commenced on some bases to address off-base migration or treatment of contaminated groundwater. |
2. **PFAS Management Area Plan (PMAP)**

A PMAP sets out a comprehensive plan for Defence to manage the elevated risks of PFAS contamination as identified in a completed DSI report and any risk assessment reports, on and from a Defence property. Any IRM actions underway are assessed for efficiency and effectiveness and incorporated as relevant into the PMAP.

3. **PMAP Implementation Plan (PMAP IP)**

A PMAP IP provides a high-level delivery program for PMAP recommendations, how they will be implemented and with approximate timeframes, costs and constraints. A PMAP IP is regularly reviewed and updated to reflect progress.

4. **Remedial Action Plan (RAP)**

A RAP details the preferred remediation strategy for the management of PFAS impacted soils and/or groundwater at a known source area in order to reduce the mass flux of PFAS migrating from the area. The remediation strategy is intended to provide the best balance between the removal/treatment of PFAS mass and cost/logistical constraints.

This means that for some sites, works and PFAS management actions may take place on overlapping or nearby areas. It is important for the works team to liaise with DPFASR to deliver integrated PFAS risk management actions that take advantage of opportunities to align timing and expenditure.

A PMAP is periodically reviewed. This allows changes in circumstances to be taken into account, including regulatory guidance on remediation principles or criteria, the availability of new technologies and the results of an ongoing monitoring plan that informs changes in the behaviour of a contamination plume, evidences progress in risk management or the effectiveness of specific management actions.
2 HOW TO USE THE GUIDANCE IN THIS FRAMEWORK

2.1 Check for updates

Risk management of PFAS contamination is rapidly evolving. To ensure the most recent version of this guidance is being used, check the publication on the DEQMS website.

A PFAS National Environmental Management Plan Version 2.0 (NEMP) has been published by the Heads of EPAs Australia and New Zealand (HEPA) (including State and Territory environmental regulators and the Commonwealth Department of Agriculture, Water and the Environment) to guide the management of PFAS across Australia. The PFAS NEMP is updated from time to time.

2.2 Is the base currently being investigated or managed by DPFASR for PFAS contamination?

Properties that are currently being investigated or managed by DPFASR are listed online at Defence PFAS Investigation and Management Program website. Where the works site is on a Defence property being investigated or managed by DPFASR, this means:

- sampling data, detailed site investigation (DSI) reports and risk assessment reports (Human Health and Ecological Risk Assessments [HHERA], Human Health Risk Assessment [HHRA], Ecological Risk Assessment [ERA]) are likely to be available for the base; and
- works should be aligned with any PFAS management actions (remediation, containment, stockpiling) that may be planned by DPFASR. This has the potential to save time and money for both the project/works and for DPFASR.

For properties where PFAS investigations are complete, DSI and risk assessment reports are publicly accessible from the above website.

2.3 Roles and responsibilities

The following roles and responsibilities apply in connection with implementation of this framework.

Table 1 Roles and responsibilities

<table>
<thead>
<tr>
<th>Roles</th>
<th>PFAS Management Responsibilities</th>
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<tbody>
<tr>
<td>Base Manager (BM)</td>
<td>• Coordinates the provision of base services.</td>
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<tr>
<td>Capital Facilities and Infrastructure (CFI)</td>
<td>• Delivers Defence construction projects. Ensures this Framework is being adopted and implemented for projects.</td>
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<tr>
<td>Commonwealth Department of Agriculture, Water and the Environment</td>
<td>• PFAS Taskforce, PFAS Inter-Departmental Committee, Intergovernmental Agreement on a National Framework for Responding to PFAS Contamination, EPBC Act referrals and approvals, PFAS NEMP coordination</td>
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<tr>
<td>Environment and Engineering Branch</td>
<td>• Defence Subject Matter Experts and policy owner for environment, engineering, heritage, contamination management, pollution prevention, energy, water and waste management within Defence.</td>
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<td>Environmental/Lead Consultant</td>
<td>• Contracted by Defence to deliver investigations, prepare technical advice (including RAPs) and provide oversight of PFAS management on a base</td>
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<tr>
<td>Role</td>
<td>Details</td>
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<td>Estate Maintenance and Operations Services (EMOS)</td>
<td>• Contracted to Defence to provide maintenance and operations support services to the Defence Estate.</td>
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<td>• Provides delivery of selected maintenance projects and Project Support Services.</td>
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<td>• Manages the Handover/Takeover process to ensure project data is received and uploaded to GEMS and conversely, provides data to projects through the project support process.</td>
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<td>• Delivers routine water quality monitoring at select sites and undertakes land management activities at sites.</td>
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<tr>
<td>Main/Lead/Principal/Head Contractor</td>
<td>• Contracted to Defence to undertake construction and maintenance works on the Defence estate.</td>
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<tr>
<td>National Program Services (NPS)</td>
<td>• Contracted to Defence to provide programming and management of the Estate Works Program.</td>
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<tr>
<td>Directorate of PFAS Investigation and Remediation (DPFASR)</td>
<td>• Project management of PFAS environmental investigations and remediation.</td>
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<td></td>
<td>• Provides policy advice and coordinates resolution of enquires within DPFASR.</td>
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<td>• Develops &amp; promotes PFAS guidance and management resources to E&amp;IG.</td>
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<td>• Provision of Defence and whole of government PFAS related policies.</td>
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<td>Project Delivery Services (PDS)</td>
<td>• Contracted to Defence (currently Augility and Aurecon) to provide project/contract management of the Estate Works Program.</td>
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<td>• Holds relevant project and contract documentation including environmental and waste disposal documentation.</td>
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<tr>
<td>Project Manager/Contract Administrator (PMCA)</td>
<td>• Contracted to Defence to provide project/contract management oversight of construction projects (program is part of the contract, such as meeting milestones).</td>
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<td></td>
<td>• Holds pertinent project and contract documentation including environmental management documentation.</td>
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<td>SDD Environment and Sustainability team including ADES, ESM, ESO</td>
<td>• Lead stakeholder when considering reuse of PFAS impacted materials on base.</td>
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<td>• Oversight of environmental and heritage issues for a specified base/s.</td>
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<td></td>
<td>• Review Construction Environmental Management Plan; approve Environmental Clearance Certificates.</td>
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<tr>
<td>Service Delivery Division and its contractors (SDD)</td>
<td>• Provides essential on-the-ground services and support to Defence personnel around Australia through the Base Services Contract (BSC).</td>
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<td>• Product Director SDD – approval delegate and contract manager for works delivered by SDD service providers through the BSC. Provides governance and compliance of the delivery of BSC works.</td>
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<td>State/Territory environmental regulator</td>
<td>• Approve licences for transportation of waste and storage/disposal of waste at licenced waste disposal facilities.</td>
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<td></td>
<td>• Consultation within State/Territory jurisdictions.</td>
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<tr>
<td>Technical Assessor/Site Auditor</td>
<td>• Review and validation of PFAS management and remedial actions.</td>
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</table>
2.4 Work, health and safety

All works undertaken on the Defence estate must comply with requirements in the Work Health and Safety Act (Cth) 2011 (WHS Act), the Work Health and Safety Regulations (Cth) 2011 and the Defence Work Health and Safety (WHS) Manual. The Commonwealth Regulator is Comcare. For construction and maintenance works on bases that have completed a PFAS risk assessment, management measures may have been identified to mitigate any risks to human health.

The Defence WHS manual provides safety policy and procedures with electronic links to corporate tools, services and expert advice to address the management of activities where people are exposed to hazards, as required by the WHS legislation as it applies to Defence.

In general, absorption of PFAS due to dermal exposure is considered to be negligible in comparison to the ingestion pathway. Additionally, PFAS compounds of primary concern are not sufficiently volatile, and thus exposure via inhalation is also not considered to be significant where normal precautions for prevention of exposure to dust are followed. The environmental concentrations typically detected on Defence sites are unlikely to pose WHS risks in a typical construction scenario. Therefore additional workplace precautions or PPE are not required beyond compliance with standard Work Health and Safety procedures for construction.

Water quality monitoring must be undertaken in accordance with the WHS requirements of the EMOS/PDS/NPS contractor which are aligned with Defence WHS requirements. For demolition works, standard WHS requirements should also be adopted. Similarly, WHS PFAS exposure risks within the identified Management Area are not within the scope of the PMAP. They are appropriately managed by the relevant contractor in accordance with applicable work, health and safety legislation.

2.5 Sampling data, recording and reporting

2.5.1 Sampling data

Data for the works site and other parts of the base may be available as a result of previous investigations. Check the following:

- Defence PFAS webpage for published PSI reports, DSI reports, PMAPs and human health and ecological risk assessments;
- GEMS EFM – CSR (the former Contaminated Sites Register) for records of PFAS contamination on the project/works site (see section 2.5.2);
- ESdat Database (see section 2.5.3);
- DPFASR for information on investigations not yet concluded; and
- ADES/ESM/ESO for the site/base for information on investigations not yet concluded or other planned and current works programs

Where this information is available, use or supplement it (as required) with site-specific sampling to provide sufficient information on which to base decisions under this Framework.

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Potential contamination must be considered early in the design stage to help identify options for soil and water management and allocation of resources. In some cases, early planning can identify suitable beneficial reuse options for PFAS contaminated materials, or identify changes in design to minimise spoil that would otherwise be generated. For example, off-base transport and disposal of contaminated material must comply with regulatory requirements of the relevant State/Territory. National hazardous waste coding (e.g. M270), may be required. There may also be a requirement for sampling other potential contaminants of concern based on a review of site history, and in particular, additional analyses will be required if material is to be disposed of offsite.

Defence has tolerance to accept a certain level of risk and uncertainty to meet its objectives for each project or program. Risks associated with managing PFAS contamination should be balanced with other project risks. Evidence-based decision making, through use of available data and site specific information, will help optimise the risk management.

Avoid oversampling and over-testing by careful planning, consultation and assessment of current data, site characteristics and whether material is intended for reuse on base, stockpiling (generally a temporary measure) or disposal. When scoping projects/works during the procurement phase, ensure that the level of sampling and testing for PFAS contamination is fully justified and conforms to the requirements of this Framework.

Consultation on the appropriate level and type of sampling for works is available:

- directly between the base (ADES/ESM/ESO) and contractors;
- with EMOS contractors;
- with SMEs during project procurement, planning and delivery;
- during the stages of Design Review; or
- directly from DPFASR.

2.5.2 Defence Contaminated Sites Records

Contamination on Defence properties is recorded in the Garrison Estate Management System, Environmental Factor Management - Contaminated Sites Records (GEMS EFM-CSR). Contamination on the works site is to be registered in GEMS EFM-CSR. For further information please refer to the Defence Contamination Management Manual.

2.5.3 Environmental Data Management Software (ESdat) Database

Environmental Data Management Software (ESdat) is a specialist environmental database system used to compile a broad range of environmental data including chemistry results and sampling information. Laboratory analytical results for environmental samples including PFAS and other contaminants is to be entered into ESdat in accordance with the Defence Contamination Management Manual (Annex L). Consultants/contractors can request datasets from PFAS environmental testing, and other potential contaminants, to inform desktop analysis. Consultants and contractors should contact the Directorate of Contamination Assessment Remediation and Management (DCARM) at ncrp@defence.gov.au and DPFASR at pfas.estatemanagement@defence.gov.au to discuss access to ESdat data. Refer to the Defence Contamination Management Manual, Annex L for the sampling naming conventions, data management requirements and data compliance requirements.
2.6 Risk management principles for PFAS contamination

The following risk management principles apply to this guidance.

Under this framework, management actions include:

- On-work site management;
- Off-work site, on-base management; and
- Off-base management.

The following preference hierarchy applies to options for PFAS management actions:

a) On-work site management of the contamination so that the risks are reduced to an acceptable level.

b) Where work site management is not practicable, other locations on base for the beneficial re-use of the material may be considered so that the risks are reduced to an acceptable level and other risks are not created.

c) Where on-base management is not appropriate, off-base management of the contamination in order that the risks are reduced to an acceptable level may be required.

A PFAS management action:

- may only be pursued where the predicted impact of the action does not increase the risk or lead to unacceptable risk of PFAS contamination affecting human exposure or the environment;
- should be proportionate to risks;
- should seek to conform and align with the actions identified within site-specific PMAPs;
- should be adapted for local conditions;
- should be efficient and compliant with the NEMP; and
- should apply the Defence Risk Management Framework, (includes operational considerations).

Source / Pathway / Receptor linkages: categories of risk management for contamination

A risk may occur when a source of contamination (such as soil contaminated with PFAS) is linked to a receptor (such as a person or wildlife or matter of national environmental significance [MNES]) via an exposure pathway.

Response to a risk may involve one or more of the following three principal components:

- **source** management by removal, destruction, treatment, disposal and/or other methods leading to the source no longer being present.

- **pathway** management by capping, containing, stabilisation, diversion, point of use treatment and/or other methods where the source remains in place but pathways are managed.

- **receptor** management by relocation, institutional controls, behaviour management and/or other methods focussed on the receptor.

Figure 1 (page 16) contains a schematic diagram of contamination sources, pathways and receptors, known as a Conceptual Site Model (CSM).
2.6.1 Assessment of risk – beneficial reuse

Beneficial reuse of PFAS contaminated materials is best practice, where practicable. Beneficial reuse of materials avoids the need for stockpiling which can save costs associated with ongoing stockpile management and monitoring. While beneficial reuse of materials helps to achieve Defence’s sustainability goals, reuse must not lead to an unacceptable risk to human health and/or the environment or an increase in risk at or near the proposed reuse site. When assessing whether to reuse PFAS contaminated materials generated on a base, it is critical to:

- consider the concentration and total load of PFAS in the materials, especially where large volumes are involved (see Chapters 3, 4 and 5);
- consider whether the additional PFAS load at the proposed site changes the risk at or from the proposed reuse site;
- consider the characteristics of the reuse site, in particular:
  - pre-existing PFAS impacts at the proposed site;
  - site drainage: where does surface water flow or accumulate? Where do stormwater channels drain? In which direction does any groundwater flow? How high is the water table?;
  - proximity to the Defence property boundary: What is the risk of any contaminated water, resulting from the reuse, migrating from the Defence site?;
- consider the risks to sensitive receptors, including direct and indirect receptors, which may be on- and off-Base;
- consider cumulative effects of discharging or irrigating with PFAS contaminated water over time or from multiple projects;
- consider multiple lines of evidence;
- consider future land use – Estate Base Plans;
- understand that beneficial reuse does not include stockpiling;
- consult with the ADES, ESM, BM for any additional considerations.

In many cases, the works team will already be aware of base boundaries and drainage networks. In other cases, this information may already be available in the form of a conceptual site model (CSM). A CSM is a description or image of the characteristics and processes at a site that impact on how contamination at the site can move or change, and where it can end up, such as in drinking water or seafood.

Check GEMS EFM-CSR in the first instance. If the site has been the subject of a PFAS DSI, the CSM will be available in the DSI report on the Defence PFAS webpage. Related health and ecological assessments may also provide useful information.

Depending on the complexity of the site, an assessment may be required by the works team or by an experienced environmental consultant.

2.6.2 Role of remediation in the Framework

The extent to which remediation will be required for any specific area of identified PFAS contamination on specific bases is in the process of being determined for many Defence properties and is described in the corresponding PFAS PMAPs. Remediation principles, criteria and available technologies for PFAS are still evolving so approaches to remediation may also change over time.
Where remediation of areas of elevated PFAS contamination can be efficiently implemented as part of infrastructure works, planning and development of any remediation options should be undertaken in consultation with DPFASR.

In some cases, soil stabilisation may be appropriate to reduce risks due to PFAS leaching to either surface water or groundwater. Soil stabilisation is the addition of an amendment such as activated carbon or a proprietary product to reduce PFAS mobility. Soil stabilisation requires a monitoring strategy to ensure long term reduction in risks has been achieved, and should only be used when identified and managed through a Remedial Action Plan (RAP) prepared by suitably qualified consultants. See Section 3.6.2 and refer to the draft Guidance on Stabilisation and Reinstatement of PFAS Impacted Soils (refer to DPASR for the most recent version).

2.6.3 Adaptation to local conditions

Management options addressed within the framework should be site-specific and consider local conditions. These may include:

a) Environment and land-use characteristics
   - Local weather, hydrological and soil characteristics.
   - Presence of receptors that may reasonably be affected by the contamination.

b) Technological and financial parameters
   - Availability of best-practice management systems, treatments and technologies.
   - Availability of treatment/storage management options to manage waste streams.
   - Degree of confidence in available treatment techniques.
   - Longevity and sustainability of the solution.
   - Need for ongoing operations, management, maintenance or monitoring.
   - Cost-efficiency.

c) Impacts of proposed action
   - Potential for cross-contamination (new contamination resulting from the action), and remobilisation (actions that may trigger movement of PFAS, usually from a previously stable condition).
   - Evaluation of proposed reuse sites that may create new potential pathways to human health or sensitive environmental receptors (additional management options that prevent or mitigate new pathways may be required).
   - Potential human exposure based on land use.
   - Potential impacts on environmental values, both on- and off-base, such as surface water and groundwater quality, aquatic species, and matters of national environmental significance.
   - Community impacts (including the impact of any truck movements associated with off-base management, through the local community and on local infrastructure).
   - Consideration or guidance by the jurisdictional regulator, where relevant.
   - Conflicting redevelopment projects and their footprints.
2.7 Expert advice

If environmental consultants have been engaged for a project, they may be able to use their experience and expertise to make recommendations that deviate from the specific requirements of this framework. Deviating from the framework may be justified where it will deliver additional efficiencies through improved mitigation of environmental risks or cost savings. In such case, any deviation needs to:

- comply with relevant national and jurisdictional guidelines, including the PFAS NEMP Version 2.0 (HEPA);
- provide assessments that are data-driven and evidence-based;
- provide recommendations that allow for efficient and effective management options;
- generally follow the principles within this framework, documenting any deviation;
- apply an appropriate risk tolerance; and
- where the deviation is not minor, and a site is subject to a PMAP IP, is agreed to by DPFASM.

Consultation with base environmental management staff and DPFASM may be required depending on the degree of risk in the project.
Figure 1 Conceptual Site Model – Contamination Risks from PFAS (Defence Contamination Management Manual, GHD 2017)

**Sources**
1. PFAS impact groundwater
2. PFAS impacted groundwater in storage containers
3. PFAS impacted soils and concrete

**Pathways**
A. Surface water drainage over land via pipes or channels
B. Migration through unsaturated zone
C. Groundwater migration
D. Ingestion/dermal contact with contaminated soil or water

**Receptors**
1. Intrusive maintenance workers
2. Onsite Defence personnel
3. Offsite residents
4. Groundwater use
5. Surface water collection – potential stock/irrigation use
6. Ecological receptors
7. Groundwater
8. Human consumption of biota
9. Sediments
3 STATEN

Manage soil (natural soil and fill materials in the form of rocks, excavation stone, and dried sediment) on a work site in accordance with this Chapter.

3.1 Planning for risk management of PFAS contamination in soil

3.1.1 Consulting with other Defence decision-makers

Guidance on roles, responsibilities and stakeholders involved in decision-making for soil management is provided in section 2.3. Consulting with stakeholders during the planning stage of works should assist with:

- Identifying viable areas for beneficial reuse of soil;
- Identifying the potential impact on Defence capability and base redevelopment;
- Minimising volume of waste soil requiring management;
- Identifying opportunities for beneficial reuse in the works;
- Identifying beneficial reuse opportunities in other works (e.g. backfill material);
- Identifying material that is suitable for off-base beneficial reuse or disposal;
- Avoiding works delays;
- Avoiding or minimising stockpiling (generally a temporary measure);
- Avoiding double-handling of waste material;
- Budgeting and cost-benefit analysis of soil management options;
- Identifying sampling and analysis requirements for soil characterisation, beneficial reuse or disposal; and
- Overlaying available data with project footprint to inform decision-making.

3.1.2 Soil sampling

The requirement for soil sampling should be carefully considered during the project planning phase. If PFAS has been identified at the project site through previous investigations (see section 2.2) or a site history review indicates legacy activities that may have caused contamination, further sampling and analysis may be required.

However, testing may not be required if a desktop review confirms that PFAS contamination on the base is considered unlikely. Refer to section 2.5 for sources of soil data potentially relevant to the works site.

3.1.3 Managing very small volumes of contaminated soil

When the total volume of soil being managed for the project/works is less than 10 m\(^3\), it will usually be appropriate and acceptable to reinstate the soil at the work site without testing. This is because responses to PFAS contamination should be proportionate to the risk where disturbing small volumes of soil is unlikely to have a material or measurable impact on the overall contamination on a base. There are significant cost, time and practicability limitations on testing in every scenario.
Areas of significant contamination, such as former Fire Training Areas and other primary source areas, have been extensively investigated and identified across the Defence estate. If work is being conducted within these areas as identified, the volume threshold would not apply.

When the works are adjacent to a water course, or an area potentially connected with groundwater, or are in a hardstand area, consultation should be undertaken with the ESM on appropriate management options.

Where there is no reason to believe that soil is contaminated and it is not proposed to be disposed off-base, testing for PFAS is not required.

Examples where Section 3.1.3 is likely to be applied includes footpath repairs, installing signposts or erosion repairs. It does not apply where the total volume of contaminated soil being managed is greater than 10 m³.

3.1.4 Managing very large volumes of contaminated soil

Where very large volumes of soil are to be excavated and relocated on- or off-base, considering PFAS concentrations only, and comparing with the soil categories in this chapter, may not be sufficient to inform the overall environmental risks. This is because the total amount of PFAS in the soil may be significant, just because of the scale of the project, despite the concentrations being low.

For projects where the volume of soil to be managed is > 1,500 m³, additional risk assessment is required to demonstrate that any risks from the additional PFAS load at the receiving location are acceptable. This risk assessment should be done by a suitably qualified environmental expert. This assessment is to include the possibility of PFAS being mobilised from the soil at the receiving site and linkages to potential receptors. DPFASR is to be consulted during the assessment of reuse options and the design process for reusing material. Validation of earthworks should occur as part of HOTO to ensure earthwork operators follow design specifications for layering, capping, compaction and any other reuse specifications.

3.1.5 Management of sludge and slurry

Many works will generate soil sludge or slurry from construction and maintenance projects. De-water the sludge or slurry and manage the separated sediment in accordance with this Chapter. Manage the separated water in accordance with Chapter 4. Alternative solutions are available such as skips with retractable covers where water can be evaporated off leaving only the remaining sludge to be managed.

Non-destructive digging (NDD) technologies such as hydro-vac will mobilise PFAS from soils to water. For larger projects in PFAS-contaminated areas, the planning phase should consider the value proposition of NDD compared with dry methods.

3.2 Soil waste management hierarchy

This section provides the waste soil management hierarchy for soils that cannot be managed in accordance with standard processes due to the presence of PFAS contamination:

1. Avoid excavating PFAS contaminated soils where possible
2. Limit how much PFAS contaminated soil is excavated to the minimum required
3. Reuse excavated PFAS contaminated soil where possible, in order of preference:
   - on-work site;
   - off-work site, on-base; and
   - off-base.
4. Dispose of PFAS contaminated soils off-base where possible; and

5. Stockpile PFAS contaminated soils on-base temporarily in accordance with the DCMM Annex C.

3.2.1 Treatment technologies

There is currently no Australian framework specifically for remediating or treating PFAS contaminated soil. The PFAS NEMP (HEPA, 2020), Appendix C: Treatment Technologies Potentially Available in Australia provides a list of technologies but does not take into consideration commercial viability or current feasibility.

Several treatment technologies are in the research and development phase with minimal commercially available technologies currently suitable for remediation of PFAS in soils. Defence is working with other Commonwealth agencies, States and Territories to fund research programs to identify viable solutions. When suitable treatment options become available, this guidance will be updated.

3.2.2 On-works site management

Reinstatement on the works site has the potential to give Defence the best environmental outcomes and most efficient solution when managing PFAS contaminated soil.

Where reuse is proposed in areas where there are likely exposure pathways to potentially sensitive receptors – ‘high-sensitivity’ locations (see section 3.2.53), the proposal should be subject to an assessment of environmental risk, including the potential for bioaccumulation of PFAS in the receiving environment.

Dilution of PFAS contaminated soil is not an acceptable waste management strategy for creation of suitable reuse material. In this context, the total mass, or ‘load’ of PFAS being added to the receiving environment is also important, rather than their transient concentrations alone.

3.2.3 Off-works site, on-base management

Reuse of soil off the works site but on-base may be considered where:

- the volume of soil available to be reused cannot be utilised on the works site;
- the reuse is considered to be beneficial;
- the engineering properties of the soil make it unsuitable for reuse on the works site; or
- reuse on the receiving site will achieve a better environmental outcome than reuse on the works site.

These are only acceptable scenarios where reuse does not add to or increase the concentration, load or flux of contaminants at the off-works site, such as leads to an unacceptable environmental risk.

The receiving site should be selected following an assessment of risk, including the consideration of a conceptual site model for that site.

When Category 2, 3 and 4 soils (see section 3.5) emplacement is to existing contaminated areas with appropriate mitigation actions (on or off-works site), they are not to be treated as a new contaminated site record within GEMS. However, an existing CSR may need to be updated to include the additional contaminant load and risk analysis.

The location of the reuse site with the required information is to be entered into GEMS by the project at handover/takeover of the project. This could be as an amendment to the CSR through the data load tool or the provision of a spatial data layer with the geographic extent of the reuse area attached to the site information to inform future planning.
Beneficial reuse is defined in the PFAS NEMP Version 2.0. Examples include where there is an existing need for soil for purposes such as landscaping, construction works, roadworks, etc. Putting contaminated soil in a location without such existing need, is considered to be waste disposal. Waste disposal is not supported on the Defence Estate, except under exceptional circumstances, and is subject to approval by the BSM/ESM with supporting documentation. Other characteristics of the soil may preclude beneficial reuse. Consultation and planning for reuse needs to occur in the early planning phases of the project to ensure budget allocation and prevent project delays.

3.2.4 Off-base management

Off-base management includes treatment and/or disposal at a licensed waste facility, either within the State or Territory or interstate.

Acceptance criteria and management options for PFAS contaminated soils vary between the States and Territories. The waste classification and management guidance from the relevant state/territory environmental regulator must be followed. The degree of guidance varies between jurisdictions and in some cases a request will be considered by the approving agency on a case by case basis. Even if regulatory approval is granted, not all landfill operators will accept PFAS contaminated waste.

Subject to State and Territory requirements (including transportation from or through different states/territories), the option may exist for waste to be disposed of at a waste disposal facility within a different state/territory.

3.2.5 Storage on-base

On-base storage is the least preferred option for managing excess contaminated soils.

The DCMM Annex C contains the guiding policy on stockpiling requirements including timeframes for resolving the end-point for the excess material. The ongoing management requirements including financial considerations need to be assessed when deciding on storage options for the long-term. Projects must cost ongoing maintenance and monitoring for the life of the stockpile and budget accordingly.

Suitability of location, material for storage and land availability should be determined through site-specific assessment, noting that stockpiling is a temporary measure while awaiting determination of the appropriate management action. Ongoing management of stockpiles, including monitoring, will need to be factored into overall project costs. The Directorate of Estate and Land Management (DELM) must be consulted if a project is considering leaving a stockpile on site for the long-term.

If there is significant variability in contaminant concentrations, then the material should be appropriately segregated and managed according to the concentrations of PFAS as categorised in Section 3.5.

3.3 Reuse in high-sensitivity areas

Reuse of PFAS contaminated soils in the following scenarios should normally be avoided. If the listed scenarios are considered, then they must be assessed to demonstrate that the environmental and human health risks are acceptable. Reuse in high sensitivity areas is to be approved by the ESM following consultation with DPFASR and other relevant stakeholders. This assessment of direct and indirect risk is required if the soil (including Category 4) is to be applied or used:

- on land used for agricultural or aquaculture purposes;
- as fill in residential developments;
- as compost, fertilisers or soil conditioners;
as fill or burial within 2.0 metres of the seasonal maximum groundwater level;

- as fill or burial or reuse in locations potentially affected by reasonably foreseeable future rises in groundwater or near stormwater drains;

- within 200 metres of a wetland area or surface water body (e.g. river, pond);

- in areas prone to flooding and with reactive soils; and

- where contaminated soil, sediment or water can enter areas of national environmental significance protected under the EPBC Act 1999, and areas of environmental significance as identified by the relevant State/Territory.

Reuse at some bases is highly constrained due to flooding, proximity to water or elevated groundwater. In these cases reuse options may consider coordination with future planned remediation activities, such as through infrastructure work, PFAS Management Area Plans or other base works where treatment or management of soil may be required.

### 3.4 Soil sampling and characterisation

Soils to be disturbed by works are to be sampled in accordance with this section, unless:

- the soil has previously been sampled for PFAS; or

- preliminary investigation or desktop analysis has determined that it is not likely for PFAS contamination to be present at the work site or base.

The ESM/ESO should be satisfied that sufficient data are available to apply this management guidance.

In-situ sampling is preferred, to inform availability of management options and potentially avoid mixing areas of low and high PFAS contamination, and thereby increasing management costs. Where this is not feasible, ex-situ sampling for classification of excavated materials will be required.

Samples are to be collected by a suitably qualified and experienced environmental professional.

#### 3.4.1 Approaches to Sampling

Due to the nature of legacy PFAS containing foam use in training and incident response, and the known characteristics of PFAS fate and transport, the impact of PFAS contamination is generally less localised and more widespread than for other contaminants. Australian Standard AS 4482.1 (2005) provides guidance on the number of samples per area needed to detect a hot spot of a given diameter on a contaminated site with sufficient confidence.

State and territory guidance is also available on the minimum number of samples per volume needed to characterise excavated material. These approaches are suitable for sampling at a site not previously assessed. However, where sampling has already been conducted, it may be possible to use a site specific conceptual site model (CSM) to develop an estimated characterisation for soils to be disturbed. In these cases, significantly fewer samples would need to be collected in order to confirm the characterisation. Sampling plans to fill any data gaps prior to the development of management options for excess soils should ensure that the density of sampling is appropriate.

The NSW EPA Sampling Design Guidelines for Contaminated Sites (published in 1995 and currently under review) provides a methodology for adjusting the number of samples required for different hot spot detection diameters and may be applied by projects in some circumstances to justify reducing the number of samples to a more appropriate level.
3.4.2 Soil sampling - disposal off base

Sampling requirements for the purposes of off-site landfill disposal should be undertaken in accordance with the PFAS NEMP Version 2.0 (HEPA, 2020) and specific State and Territory guidance, and may require other contaminants of concern to be analysed. Engagement with the State and Territory regulator will be required.

3.4.3 Soil sampling - reuse on base

Any reuse on base must be for a beneficial purpose and agreed following consultation with the base ADES/ESM and other relevant stakeholders (see 2.3 and 3.1.1). The PFAS NEMP Version 2.0 (HEPA, 2020) provides further guidance on what is considered beneficial and what constitutes an appropriate assessment of risk.

To evaluate on-base reuse/management options, samples are to be analysed for the following:

a) PFAS analysis that includes the standard laboratory suite as per Appendix B with standard laboratory reporting limits, typically 0.005 mg/kg (5 µg/kg).

b) Other identified contaminants of potential concern based on identification through a preliminary conceptual site model. This may include reference documentation such as desktop studies, PSI or DSI if available. Assessment of soil reuse is based on land use criteria identified in the NEPM and not waste disposal criteria.

For on-base reuse of non-stabilised soils, comparison of leachability between the soil to be moved and the receiving location, using standard laboratory leaching procedures, serves no clear purpose. It is more important to consider the total load of PFAS that may be available to leach at the new location and consider whether that load would meaningfully change the risk profile at that location.

3.5 Soil categorisation

Soils disturbed during construction or maintenance work will fall into one of four categories for PFAS concentrations in soil, where Category 1 is the highest concern (refer to Table 2). Other contaminants of potential concern should be considered separately. The soil categories in Table 2 should not form part of a RAP. Soil below LOR is classed as non-detect.
### Table 2 Soil Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Management Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 1</strong></td>
<td>Excavated soils with PFOS + PFHxS concentrations of 20 mg/kg or more.</td>
<td>Unacceptable risk $\Rightarrow$ offsite (destroy or landfill) or onsite (options identified through a RAP)</td>
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<tr>
<td></td>
<td></td>
<td>Category 1 soil must be managed to address the risk. Options may include off-base disposal to an appropriately licenced facility or on-site management guided by a RAP. Soil at concentrations $&gt; 50$ mg/kg should be sent for destruction at a licenced facility. DPFASR can provide advice.</td>
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<tr>
<td></td>
<td></td>
<td>If the excavated soil is required to be temporarily stockpiled for later treatment, refer to DCMM Annex C.</td>
</tr>
<tr>
<td><strong>Category 2</strong></td>
<td>Excavated soils with PFOS + PFHxS concentrations less than 20 mg/kg but greater than 1 mg/kg.</td>
<td>High risk $\Rightarrow$ treat and/or contain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Category 2 soil can be reused within the works site provided that exposure to receptors is minimised. This should consider both direct exposure at the site and the potential for PFAS transport due to leaching. If reuse is not appropriate on the works site, then an assessment of risk should be undertaken by a suitably qualified person(s) to evaluate the following options: off-base disposal to an appropriately licensed landfill, or on-base encapsulation, containment and/or treatment. If treatment is required, this needs to be guided by a RAP.</td>
</tr>
<tr>
<td><strong>Category 3</strong></td>
<td>Excavated soils with PFOS + PFHxS concentrations less than 1 mg/kg but greater than 0.01 mg/kg.</td>
<td>Moderate risk $\Rightarrow$ reuse with assessment and mitigation</td>
</tr>
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<td></td>
<td></td>
<td>Category 3 soil can be reused within the works site with no additional mitigation procedures or on-base (subject to Base approvals) if the risk to human health or the environment, as determined by a suitably qualified person(s), is not increased or otherwise results in unacceptable risk. Some mitigation may be required if potential pathways exist and there are potential high sensitivity receptors. The overall load of PFAS in the total volume of soil should also be considered when assessing the risk.</td>
</tr>
<tr>
<td><strong>Category 4</strong></td>
<td>Excavated soils with PFOS + PFHxS concentrations less than 0.01 mg/kg.</td>
<td>Acceptable risk $\Rightarrow$ reuse on site or on base without assessment or mitigation unless:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- a previous site assessment suggests otherwise</td>
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<td></td>
<td></td>
<td>- soil volumes $&gt; 1,500$ m$^3$ (see section 3.1.4).</td>
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<tr>
<td></td>
<td></td>
<td>- reuse is in a high-sensitivity area (see section 3.3)</td>
</tr>
<tr>
<td><strong>Non-detect at standard LOR</strong></td>
<td>Excavated soils with PFOS + PFHxS concentrations less than the laboratory LOR.</td>
<td>Acceptable risk $\Rightarrow$ reuse on site or on base without further assessment or mitigation. If offsite disposal is needed, re-analysis at a lower LOR might be required by the jurisdiction or waste receiver.</td>
</tr>
</tbody>
</table>

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1 Human health criterion for direct soil contact for industrial land use, PFAS NEMP
2 Human health criterion for direct soil contact for public open space, PFAS NEMP
3 Interim soil – ecological indirect exposure for all land uses, PFAS NEMP
Even if soils are identified as Category 4 or non-detect, if no reuse can be found on-Base, and offsite disposal or reuse are proposed as options, further management may be needed. For example, the jurisdiction authority (e.g. EPA) or the receiver (landfill or resource recovery centre) may still require the soil to be analysed at a lower LOR prior to agreeing to receive the soil.

Extensive testing for PFAS on the Defence estate has not identified PFOA as a limiting factor for decision making. Categorisation of soil is usually determined by PFOS and PFHxS concentrations, as relevant guidelines for PFOA are significantly higher than PFOS and the frequency and levels of PFOA detected are less than combined PFHxS and PFOS.

3.6 Soil management actions

The following soil management actions are outlined in accordance with the soil categories detailed in Section 3.5. These actions only apply to soils that cannot be managed as per standard practice due to the presence of PFAS contamination.

3.6.1 Category 1 soil management

Category 1 soils are to be excavated and treated or temporarily placed in a lined and covered stockpile on-Base at a location authorised by a Defence environmental officer (ADES/ESM/ESO) following consultation with work teams (see section 2.3). Management actions are provided in Table 3.

DPFASR is to be notified when Category 1 soils are encountered. The PMAP for the Base may have identified a preferred management approach for the contamination. Where practicable double-handling should be avoided through aligning the excavation with the treatment.

Table 3 Category 1 soil management actions

<table>
<thead>
<tr>
<th>Category 1</th>
<th>Management actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil - Human Health –Property Users Commercial / Industrial Setting</td>
<td>Soils with PFOS + PFHxS of 20 mg/kg or more must be excavated and treated or temporarily stockpiled for later treatment with like materials according to Defence policy. The design of the stockpile cell must be impermeable and prevent leaching.</td>
</tr>
<tr>
<td>PFOS + PFHxS &gt; 20 mg/kg</td>
<td></td>
</tr>
<tr>
<td>PFOS, PFOA, or PFHxS &gt;50 mg/kg</td>
<td>The reuse of PFAS contaminated material above the Stockholm Convention low content limit of 50 mg/kg will not be considered.</td>
</tr>
</tbody>
</table>

3.6.2 Category 2 soil management

Category 2 soils may be reused within the works site with appropriate mitigation strategies (Table 4), provided that reuse does not:

- increase the cumulative risk profile at the site i.e. increasing risk from additions of contaminated material over time; each volume assessed on its own might be acceptable but cumulatively they may not be. Increasing total mass of PFAS at a site might become an unacceptable risk
- create new pathways to sensitive environmental receptors (including impacted soil runoff into waterways and migration of leached PFAS into surface waterways or groundwater).
The reuse location should be authorised by a Defence environmental officer (ADES/ESM/ESO) following consultation with work teams (see Section 2.3).

If the works site is unable to feasibly reuse this material (e.g. excess to work needs, geotechnical unsuitability), it may be disposed off-Base, reused elsewhere on-Base with risk mitigation, or managed as per Category 1 soils. If stabilisation is the method chosen to mitigate risk, this must be implemented according to a Remediation Action Plan (RAP). The Defence draft Guidance on Stabilisation and Reinstatement of PFAS Impacted Soils Policy provides details of Defence requirements including how to choose acceptable amendment products, testing for appropriate addition rates and monitoring to ensure long-term performance. Stabilised soils should not be placed in an environmentally dynamic area (such as flood prone areas).

Stabilisation may require ongoing monitoring to demonstrate long-term effectiveness and the cost of this, and the mechanism for this, need to be considered. Without a stabilisation option, reuse would likely be limited to very small volumes that can be accommodated under buildings or sealed roads.

On-Base reuse may require risk mitigation measures such as capping or stabilisation and will be dependent upon the site setting. These measures should be selected following consideration of a Conceptual Site Model (CSM) to identify both receptors and exposure pathways and with the authorisation of a Defence environmental officer (ADES/ESM/ESO) following consultation with work teams. Reuse must not increase the level of environmental risk posed by PFAS impacted materials in their current pre-work state or at the proposed reuse location.

Where soil stabilisation is used to mitigate risks, testing of the reduction of leachability is an important part of validating performance. Similarly, leachability testing (ASLP or TCLP) may be needed to support off-site disposal to landfill. For on-base reuse of non-stabilised soils, comparison of leachability between the soil to be moved and the receiving location, using standard laboratory leaching procedures, serves no clear purpose. It is more important to consider the total load of PFAS that may be available to leach at the new location and consider whether that load would meaningfully change the risk profile at that location.

Table 4 Category 2 soil management actions

<table>
<thead>
<tr>
<th>Category 2</th>
<th>Management actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOS + PFHxS 1.0 mg/kg to &lt; 20 mg/kg</td>
<td>Exceedance of the Category 2 trigger level does not preclude reuse of these materials on the site. Re-use would require careful assessment of risk. Reuse elsewhere on base will likely require mitigation strategies or any other additional measures to prevent new exposure pathways or an increase in risk to environmental or human health. Off-base disposal is permitted subject to the requirements of the jurisdictional regulator. Pre-treatment may be required.</td>
</tr>
</tbody>
</table>

3.6.3 Category 3 soil management

Category 3 soils can be reused on the works site without further treatment or management or on-Base at locations authorised by a Defence environmental officer (ADES, ESM, ESO) following consultation with work teams (see section 2.3) and an assessment of risk.

The assessment of risk should be undertaken to confirm that there is no increased risk, or unacceptable risk, to human health or sensitive environmental receptors as a result of the re-use. The assessment should have
regard to the total mass loading at the re-use location and the likely mass flux arising from the re-use. This will require a practical and evidence-based approach and may include a review of existing conditions, development of a conceptual site model and an evaluation of the change in relative risk.

In general, the concentration of PFAS in the re-use materials should be lower than those at the proposed re-use location, unless management measures have been assessed and can control risk to the environment. For example:

Reuse of Category 3 material in a Category 4 area – managed by use of capping layers, compaction, impermeable membranes or clay liners. Capping may be under a bitumen sealed road, runway, apron, car park or designed within a platform, pad or mound and separated from lower concentration material with an impermeable marker layer.

If the volume of soil to be moved is relatively small compared to volume of contaminated soil at the receiving site, an assessment of the change in risk based on the change in mass load of PFAS, and how this may impact on receptors, may be sufficient. In other words, a comparison of total and leachable concentrations is likely to be of little benefit in this situation. Expert judgement may be required to determine when this assumption is appropriate.

Table 5 Category 3 soil management actions

<table>
<thead>
<tr>
<th>Category 3</th>
<th>Management actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOS + PFHxS 0.01 to &lt; 1.0 mg/kg</td>
<td>No additional mitigation is required for work-site re-use. An assessment of risk should be conducted prior to re-use elsewhere on base. If it cannot be determined whether the risk profile of the receiving area will be impacted by the reuse, the management actions for soils will be the same as for Category 2 (see section 3.6.2). Off-Base disposal is permitted subject to the requirements of the jurisdictional regulator.</td>
</tr>
</tbody>
</table>

3.6.4 Category 4 soil management

Soils with PFOS + PFHxS less than 0.01 mg/kg are available for reuse on the works site or on-Base, without further treatment or management, unless other considerations indicate that additional management and risk assessment may be required, such as where sensitive environmental receptors are present (e.g. protected marine areas; wetlands) or the scale of soil volumes involved (>1,500m³) create a potential risk.

For example, if soil is to be moved to an area near the boundary of the base where wetlands are present, further consideration of the change of risk is appropriate. Additional risk assessment may be required in order to consider:

- The likelihood of runoff and the sensitivity of the potential receiving environment

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8 This soil is considered protective of indirect exposure to secondary consumers, as the most sensitive exposure pathway for any land management actions.
- Total PFAS load compared to load at the proposed reuse site, where large volumes of soil are to be moved
- Transfer of risk from one area of base to another
- Leaching into surface drainage and off-base transport pathways.

Agreement must be made with the ESM, BM or their representative on the works team prior to reusing soil on parts of the base other than the work site.

### Table 6 Category 4 soil management actions

<table>
<thead>
<tr>
<th>Category 4</th>
<th>Management actions</th>
</tr>
</thead>
</table>
| PFOS + PFHxS LOR < 0.01 mg/kg | Available for reuse on the works site or on-Base, without further assessment or mitigation unless:  
  - soil volumes >1,500m³ where total PFAS load may require further assessment and potential mitigation  
  - in a high-sensitivity area  
  - previous site assessment suggests otherwise.  

Reuse will be subject to Defence approval, such as agreement with the BM or their representative on the works team, or where other considerations indicate that additional management may be required, such as where sensitive environmental receptors are present.  

Off-Base disposal is permitted subject to the requirements of the jurisdictional regulator.

### 3.6.5 Non-Detect (below standard LOR)

For soil reuse/re-emplacement on Defence land, using a standard limit of reporting is in most circumstances appropriate for PFAS analyses (see Section 3.4.3). Soil with PFAS concentrations below the standard limit of reporting is considered to be non-detect and can be used on base without further risk assessment or mitigation.

If the soil is to be taken off-Base, there may still be additional requirements for sampling and analysis. The strong preference for such material should be reuse via resource recovery, rather than disposal to landfill, consistent with sustainability objectives. However, the receiving entity and/or the relevant EPA may require that PFAS is analysed at trace or ultra-trace limit of reporting in order to support the possible reuse options. Advice should be sought from the receiving entity as to what requirements are needed to support acceptance of the material. Ideally this consultation should occur at a suitable stage in project design to avoid a hold up during the works implementation stage.

If disposal to landfill is necessary (for example other contaminants of potential concern rule out the possibility of reuse), the standard LOR for PFAS should be used.
4 WATER

Manage environmental water on a work site in accordance with this Chapter.

This guidance applies to water generated or encountered during construction works or dewatering actions (e.g. from a trench), including runoff, surface water drainage, groundwater and stormwater.

It does not apply to waste water from hangar foam suppression testing, cleaning of storage tanks and trucks, waste treatment plants, or any other process or industrial waste water. For such cases, refer to the Defence Pollution Prevention Management Manual.

4.1 Planning for risk management of PFAS contamination in water

4.1.1 Water management principles

Water is the primary pathway for PFAS contamination from its source to people and other receptors. This means that managing contaminated water during works is critical to ensuring that exposure risks (new or increased) are not realised.

The following principles apply to the management of all water on or from works:

- the choice of management action should not pollute the environment;
- the assessment of risk should account for potential bioaccumulation of PFAS in the receiving environment;
- the assessment should account for cumulative increases in PFAS where large volumes (>100,000 L) are discharged or used for irrigation of soil (including repeat discharge of smaller volumes in the same catchment);
- in ecologically sensitive areas, a local catchment assessment may be required to demonstrate that the overall PFAS load within the catchment will not be materially increased;
- the choice of management action must comply with applicable State or Territory legislation with any required licences or permits to be obtained. For example, for water leaving the base, regulators may require management actions that substantively decrease PFAS concentrations or loads to the receiving environment; and
- if there is a reasonable expectation that water may contain PFAS, it should not be used in concrete batching.

A conceptual site model, along with site specific hydrology and hydrogeology needs to be considered when determining the impact of water reuse within the work site, the Base or the broader environment. The assessment should include:

- an understanding of potential migration pathways;
- an understanding of environmental values which may be impacted by change in surface water and groundwater quality;
- presence of sensitive on and off-site receptors;
- seasonal fluctuations in surface and groundwater;
- site drainage;
- evaporation and infiltration rates;
• aquifer/groundwater characteristics; and
• surface water / groundwater interactions.

4.1.2 Prevention of stormwater contamination

Stormwater is surface water that originates from precipitation (rain, hail or snow). Stormwater can take up PFAS from contaminated materials such as soil, concrete and asphalt.

To avoid this, stormwater should be diverted around site excavations, to the extent possible, and managed in line with relevant stormwater practices for the Base. This will limit the volume of water required to be managed for the works.

Dewatering should consider the potential risk of surface water flows taking up PFAS from contaminated surface soils and drainage channels.

4.1.3 Managing very small volumes of contaminated water

When the total volume of water being managed for the works is <1000 L, water should be infiltrated near to the work site or in consultation with the ESM/ESO to another adjacent area. This exemption only applies when the water is removed from and returned to the environment in the same location and at the same time. If this is not the case, the environmental impact of infiltrating the water is required to be assessed by a suitably qualified professional.

4.2 Sampling and analysis

Where water samples are to be collected and analysed for PFAS, the below guidance should be followed.

It is important to obtain samples that represent PFAS concentrations in the water from which they are collected. Conventional sample handling and processing practices can generally be applied for PFAS in water samples, with particular care to be taken to avoid cross contamination. Samples are to be collected by a suitably qualified and experienced environmental professional. Laboratory analysis should be conducted according to the NEPM (2013) and the PFAS NEMP Version 2.0 (HEPA 2020). The standard laboratory suite for PFAS analysis is provided in Appendix B.

Some considerations include:

• selecting appropriate sampling equipment;
• obtaining a representative sample or samples; and
• appropriate labelling, preserving, storing and transporting of samples for analysis.

4.2.1 Project coordination

Sampling of monitoring wells and some surface water locations will typically be coordinated by other programs such as:

• Ongoing Monitoring Program (OMP) or Remedial Action Plans (RAP) under the PMAPs;
• the Regional Contamination Investigation Program (RCIP) delivered through the Directorate of Contamination Assessment, Remediation and Management (DCARM);
• the Routine Investigation Close-Out (RICO) monitoring at sites handed over to DPFASR from RCIP;
• the Water Quality Monitoring Program (WQMP) delivered by the Directorate of Estate and Land Management (DELM).
Data from these programs can be used to inform project planning decisions regarding water management. This includes confirmation of other monitoring activities being undertaken, to avoid duplication of effort and other issues, such as an impact on data integrity (e.g. if a well has been accessed and purged recently by another program).

Where there may be a need for on-base water treatment, consult first with the base and DELM to assess whether there is already a water treatment plant (WTP) on base that might be used. Where possible, coordinate scoping requirements to avoid duplication of capital and operating costs and reduce any program delays. Understanding the impacts of extraction, discharge or reinjection of water is critical to the management of aquifers and other water bodies.

4.2.2 Requests to use established Water Treatment Plants (WTPs)

Treating water

Where projects need to treat environmental water with PFAS as the primary contaminant, there is the option to use the PFAS Water Treatment Plants at RAAF bases Williamtown, Edinburgh, and Tindal, and Army Aviation Centre Oakey. Opportunities should also be considered at other bases where water treatment opportunities might be available. Proponents should follow the below relevant procedure in DEQMS and submit a request form to DPFASR.

Guidance for Requests to Use DPFASR Water Treatment Plants

Request form to use DPFASR Water Treatment Plant

Using treated water

Where projects require construction water for dust suppression, wetting down etc, there is the option to use PFAS treated water from WTPs at RAAF bases Williamtown, Edinburgh, and Tindal, and Army Aviation Centre Oakey. Proponents should follow the relevant procedure in DEQMS and submit a request form to DPFASR.

Process for Provision of WTP Treated PFAS Water to Projects

Request Form to use WTP Treated PFAS Water

4.2.3 Other PFAS compounds

Sometimes there are cases where PFOS, PFOA and PFHxS concentrations in water being assessed for reuse are below LOR but other PFAS compounds in the Standard Laboratory Suite (Appendix B) such as PFBA, 6:2 FTS, 8:2 FTS, PFPeA, PFHxA are reported.

The PFAS NEMP Version 2.0 (HEPA, 2020) advises that management decisions can be made with PFOS, PFHxS, and PFOA in relation to the guideline values9. Other PFAS contaminants may affect the certainty with which management decisions can be made. If high concentrations of other PFAS are present, then a more conservative assessment may be warranted and consultation should be undertaken with DPFASR.

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9 Published literature could inform management decisions, or State/Territory specific policies.
4.3 Water management

Water management decisions should consider beneficial reuse options and whether discharge of water may change the risk to the environment or human health. This includes any potential measurable difference to PFAS concentrations in the receiving environment, including surface water, groundwater, soils or biota if discharge was to occur through release of non-treated water or water treated to a certain concentration level. Depending on site specific circumstances, regulators may also require treatment prior to discharge.

Discharge of extracted water may be carried out, subject to State or Territory regulations, in order of preference within the risk assessment process:

a) Irrigation or infiltration on-works site.

b) Irrigation or infiltration off-works site but on-base.

c) Discharge to creeks or storm water drains (on-base or off-base).

Irrigation refers to the controlled supply of water growing plants and can include maintenance of playing fields or watering of other vegetation (gardens, bushes, trees).

Infiltration refers to the process by which water on the ground surface enters the soil. Usually this is achieved by putting water in a trench or turkey nest and allowing water to infiltrate the soil passively over time.

Spraying water for dust suppression can be also considered an activity for controlled infiltration. If the application rate exceeds the infiltration rate, runoff will usually occur unless there is some physical barrier. Ongoing dust suppression can also results in PFAS accumulating in soil which may then be source of PFAS to stormwater.

All discharges of water that may impact on soils, surface water or groundwater require a risk-based assessment that considers:

- concentration of PFAS contamination;
- volume of water to be returned to the environment;
- existing soil and/or groundwater conditions or aquifer properties;
- profile (type, concentration) of other contaminants in the water to be discharged relative to the existing soil/groundwater conditions;
- potential sensitive receptors including aquatic ecosystems and direct contact through recreational water use; and
- regulatory requirements.

Where the assessment of risk concludes that there is an unacceptable risk, water may need to be treated to acceptable levels prior to beneficial reuse, discharge or disposal. Depending on the level of treatment, some of the risks noted about may also need to be considered for the treated water.

4.3.1 Irrigation and Infiltration

Irrigation and infiltration should be located within the work area or as close as practicable to the extraction location, although irrigation may in some circumstances take place on the wider base (sports field maintenance, garden irrigation). Such discharges must be agreed with the ADES/ESM/ESO in advance.

Conduct irrigation in a controlled manner to prevent:

- contamination of non-contaminated areas;
cumulative increases in PFAS contamination resulting in secondary source areas;

- irrigation or dust suppression run-off beyond the applied area;

- the creation of hydraulic gradients that could result in migration of impacted groundwater into surface water bodies; and

- run-off of irrigation water back to its origin or otherwise creating a water ‘loop’ that may mobilise additional PFAS contamination from soils, unless the loop is part of a treatment system.

Irrigation and infiltration of large volumes of water should be confirmed by an environmental consultant in consultation with a Defence environmental officer once the dewatering volumes and site conditions have been assessed. Projects with extensive lengths of trenching should assess water management as a whole and not divide the project into smaller work areas in order to apply lower volume criteria.

Suitable storage capacity must be provided to allow controlled irrigation, including consideration of precipitation affecting volumes if stored in an open manner, such as holding dams or evaporation ponds. Management measures depend on the volume of extracted water to be irrigated, as provided in Table 7. Refer to the work objectives and application of this framework and source all available data to use professional judgement in making an assessment of risk.

Decision paths for water discharge are provided in Flowchart 1.

### Table 7 Management of Extracted Water

<table>
<thead>
<tr>
<th>Total volume</th>
<th>Irrigation and Infiltration Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 – 100,000 L</td>
<td>If the PFAS contamination levels of the discharged water are less than or equal to contamination levels in the groundwater and there is no change to the risk profile or cumulative environmental impact caused by discharge, and no unacceptable risk, then no treatment is required and water can be used for irrigation and infiltration.</td>
</tr>
<tr>
<td>&gt; 100,000 L</td>
<td>The proposed discharge by irrigation/infiltration should not result in an increased ecological risk, as determined through consultation and assessment of risk by a suitably qualified environmental consultant. This must include an assessment of groundwater-surface water interactions. Where drinking water is known to be a beneficial use for groundwater in the vicinity of the base, an environmental consultant should confirm whether there is a pathway to the drinking water source and assess the risk to sensitive receptors. Treatment of water may be required to mitigate the risks.</td>
</tr>
</tbody>
</table>

#### 4.3.2 Treatment criteria - discharge on-base

If environmental water from a project is to be treated using an existing DPFASR water treatment plant, the treatment criteria or targets contracted for that plant will apply.

If discharge of water on base is likely to result in water transport off base (e.g. via creeks or drains) the considerations for off-base discharge apply (Section 4.3.3).

#### 4.3.3 Treatment criteria – discharge off-base

This section applies in the context of treated water taken from the environment to another area arising from construction and maintenance projects only. Discharge via creeks or stormwater drains may only take place:
in consultation with DPFASR
where PFAS concentrations are less than the NEMP screening criteria; and
in accordance with relevant state/territory laws and local water authorities including holding any required licences and permits.

Discharge of contaminated water via creeks or stormwater drains is likely to directly result in an exposure pathway to potential human health or ecological receptors. Therefore, conservatism in decision-making should apply. If treatment is required, water discharged to drainage or surface water should be treated to the NEMP screening criteria or in accordance with a negotiated agreement with the jurisdictional regulator.
Flowchart 1 - Treatment options for irrigation and infiltration

Is the proposed discharge at the on-work site?

Yes

< 1,000 L

What is the discharge volume?

> 100,000 L

1,000 L - 100,000 L

Are discharge contamination levels lower or higher than groundwater levels?

Lower

No

Engage environmental consultant to assess risk. Is there an unacceptable risk?

Yes

No treatment required

Treat to consultant’s proposed level for allowable risk, including attenuation

Water discharge to be conducted in a controlled manner.
5 CONSTRUCTION AND DEMOLITION WASTE

5.1 Construction and Demolition waste – management principles

For the purposes of this guidance, Construction and Demolition (C&D) waste refers to materials of the built or natural environment that is neither ‘soil’ (see Chapter 3) nor ‘water’ (see Chapter 4). It includes materials that are commonly recycled such as concrete, bricks, asphalt, tiles and metals and materials that are commonly reused or reprocessed such as green waste, trees and boulders.

Currently in Australia there is insufficient regulatory guidance on management options for PFAS contaminated C&D waste. This chapter has been prepared in the interim to bridge this gap in regulatory guidance.

This chapter is subject to and must be read in the context of all other Defence guidance and policy on C&D waste and nothing in this chapter provides authority to deviate from standard Defence policy. This includes but is not limited to:

- Defence Pollution Prevention Management Manual
- Defence Contamination Management Manual

5.2 Lessons from previous investigations

The extent to which construction materials, plant and equipment may become contaminated will depend on several factors including:

- **Contact** with PFAS impacted soil or water, for example a building slab located in a PFAS contaminated area is more likely to be PFAS impacted than the building walls sitting on the slab. Similarly, pipes carrying PFAS contaminated water may become PFAS impacted, even if the pipes themselves run through an otherwise PFAS free location.

- **The type of material** and its porosity will influence the ability and rate at which PFAS contamination in surrounding soil or water can absorb into the material. For example, asphalt and concrete are known to more easily absorb PFAS than steel.

- **Exposure concentration**, the higher the concentration of PFAS in surrounding soil or water, the higher the potential concentration of PFAS absorbed into the construction materials, particularly if exposure has occurred over a long period of time.

- **Exposure duration**, the longer the construction materials, plant and equipment have been in contact with PFAS contaminated soil or water the more PFAS can be absorbed.

Defence has commissioned a significant amount of testing for PFAS in the natural and built environment. Table 8 summarises important context for this chapter.
### 5.3 Whether to conduct sampling of C&D waste

#### 5.3.1 Sampling requirements

Refer to Flowchart 2 for determination of sampling requirements of C&D waste. Where sampling of C&D waste is required:

- the PFAS suite must include the standard laboratory suite as per Appendix B with standard laboratory reporting limits (typically 0.005 mg/kg, 5 µg/kg), subject to matrix interference; and
- the analysis must include other identified contaminants of potential concern.

Samples should be taken from both the material estimated to be the most highly contaminated, and material likely to be representative of the bulk of the area to be removed in order to determine a conservative estimate of the concentration of PFAS within the material.

If there is significant variability of contamination levels, material with differing levels should be segregated and managed according to the contamination levels. This will allow more efficient management of waste by avoiding contaminating large volumes of low contaminated waste by mixing with smaller volumes of highly contaminated waste.

There is no need to test vegetation, including trees, shrubs or grasses for PFAS unless the material has been removed from a primary source area such as a fire training ground.

<table>
<thead>
<tr>
<th>LIKELY to be contaminated by PFAS – warrants sampling and analysis for PFAS</th>
<th>NOT likely to be contaminated by PFAS – does not warrant sampling and analysis for PFAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Building materials in direct contact with PFAS concentrate; the application of PFAS containing foams; operating structures in trade waste treatment plants, or sewage treatment plants.</td>
<td>• Building materials (excluding pipes) in contact with concentrations of PFAS &lt; 1 mg/kg in soils or &lt; 10 µg/L in waters.</td>
</tr>
<tr>
<td>• Porous building materials in contact with elevated concentrations of PFAS. Typical building materials that are considered porous include: masonry, concrete and timber.</td>
<td>• Non-porous construction materials unless identified in one of the categories under “Likely to be contaminated by PFAS”. Such materials typically include metal and plastic objects (e.g. steel/plastic fencing, pipes, and sheet piles), plant and equipment (e.g. water tanks, plastic or metal pipes, pumps, water carts, mobile plant and equipment).</td>
</tr>
<tr>
<td>• Fire training mock ups.</td>
<td>• Vegetation in areas not directly adjacent to source areas such as fire training grounds or that did not receive regular applications of PFAS containing foam.</td>
</tr>
<tr>
<td>• Vegetation on or immediately adjacent to primary source areas such as fire training grounds.</td>
<td>• Other tanks and pipes.</td>
</tr>
<tr>
<td>• Tanks and pipes used for PFAS concentrate, fire training wastewater, trade waste or sewage treatment plants.</td>
<td>• Other concrete or asphalt roads and pavements.</td>
</tr>
<tr>
<td>• Concrete or asphalt pavement used for PFAS training.</td>
<td>• Car parks.</td>
</tr>
<tr>
<td>• Areas where PFAS containing foam was used for incident response.</td>
<td></td>
</tr>
</tbody>
</table>
Non-porous materials such as metal should only be tested where they have been used in areas of high PFAS contamination, such as a ship-board mock-up used for emergency training exercises. In such cases, swab testing can be used according to instructions from the laboratory to indicate surface contamination that may indicate cleaning is needed prior to disposal, or disposal as hazardous waste.

5.3.2 Disposal to commercial landfill

If the C&D waste is to be disposed to a commercial landfill, it must be classified in accordance with standard practice and the waste regulations for the relevant jurisdiction. If this process does not require testing for PFAS and the source of the C&D waste is listed in the right hand column of Table 8 above, then the C&D waste should not be tested for PFAS.

Cleared vegetation from non-primary source areas should have any soil knocked from the roots prior to disposal.

Where landfill disposal is to be considered, Toxicity Characteristics Leach Procedure (TCLP), Australian Standard Leaching Procedure (ASLP) or Total Oxidisable Precursor Assay (TOPA) tests may be required by the State or Territory regulator. Confirm the specific requirements with the landfill operator and the regulator.

5.4 Beneficial reuse of C&D waste

Beneficial reuse of C&D waste is best practice, where practicable. Beneficial reuse of materials avoids the need for stockpiling or disposal which can save costs associated with ongoing stockpile management and monitoring. While beneficial reuse of materials helps to achieve Defence’s sustainability goals, C&D waste should only be reused on the Defence estate in accordance with relevant guidelines and policies.

Analysis and beneficial reuse of C&D waste should ensure that the receiving environment has the same or higher risk profile and new potential pathways to sensitive environmental receptors are not created. Reuse should not increase the level of environmental risk posed by PFAS impacted materials in their current pre-work state.

Mulched vegetation, including trees, should if possible be reused on base for garden cover. Mulch generated from primary source areas should be reused in consultation with the ESM. It should not be disposed of to landfill or to a recycling facility. There is not enough scientific literature or regulatory guidance available to provide definitive criteria for management options on C&D waste. The soil criteria should not be used in the absence of guidance values.
Flowchart 2 – Sampling considerations for C&D waste

- Is there potential for the material to be contaminated by PFAS?
  - No
  - Yes

- Is there satisfactory existing data for proposed action?
  - Yes
  - No

- Is reuse proposed in a sensitive area? Section 3.2.5
  - Yes
  - No

- Is disposal or recycling proposed where testing is required?
  - Yes
  - No

- Is there uncertainty about risk?
  - No
  - Yes

- No testing required
  Document reasons for decision.

- Environmental testing required
  Sampling should be representative for proposed action.
## APPENDIX A: GLOSSARY

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADES</td>
<td>Assistant Director Environment and Sustainability</td>
</tr>
<tr>
<td>AFFF</td>
<td>Aqueous film forming foam</td>
</tr>
<tr>
<td>ASLP</td>
<td>Australian Standard Leaching Procedure</td>
</tr>
<tr>
<td>Attenuation</td>
<td>For PFAS in soil or groundwater, attenuations refers to dilution and adsorption but degradation is not relevant (Ref Flowchart 1).</td>
</tr>
<tr>
<td>Base</td>
<td>In this document, a reference to ‘base’ also includes a reference to other properties on the Defence estate.</td>
</tr>
<tr>
<td>BM</td>
<td>Base Manager</td>
</tr>
<tr>
<td>BSC</td>
<td>Base Services Contract</td>
</tr>
<tr>
<td>C&amp;D waste</td>
<td>Materials that are not defined as soil or water. Includes concrete, bricks, asphalt, and metals. It does not include rocks and excavation stone</td>
</tr>
<tr>
<td>CFI</td>
<td>Defence Capital Facilities and Infrastructure Branch</td>
</tr>
<tr>
<td>CSM</td>
<td>A Conceptual Site Model identifies the source of the contaminants, where they are currently found (source), any transport pathways including biological or geochemical transformations, and where they eventually end up (receptors). This information is used to identify the potential risks to human health and ecosystems</td>
</tr>
<tr>
<td>Cumulative Environmental Impact</td>
<td>Cumulative environmental impacts result from different actions that would not normally be accounted for collectively but may, when considered together, cause risk to the environment through accumulation. Risk management actions should account for cumulative exposure that may heighten potential impact to the receiving environment.</td>
</tr>
<tr>
<td>DCARM</td>
<td>Directorate of Contamination Assessment, Remediation and Management</td>
</tr>
<tr>
<td>DCMM</td>
<td>Defence Contamination Management Manual</td>
</tr>
<tr>
<td>DELM</td>
<td>Directorate of Estate and Land Management</td>
</tr>
<tr>
<td>DPFASR</td>
<td>Directorate of PFAS Investigation and Remediation</td>
</tr>
<tr>
<td>EMOS</td>
<td>Estate Maintenance and Operational Services</td>
</tr>
<tr>
<td>ESM</td>
<td>Defence Environment and Sustainability Manager</td>
</tr>
<tr>
<td>ESO</td>
<td>Defence Environment and Sustainability Officer</td>
</tr>
<tr>
<td>GEMS EFM-CSR</td>
<td>Garrison Estate Management System, Environmental Factor Management - Contaminated Sites Records</td>
</tr>
<tr>
<td>DSI</td>
<td>Detailed site investigation</td>
</tr>
<tr>
<td>ECC</td>
<td>Environmental Clearance Certificate</td>
</tr>
<tr>
<td>EE</td>
<td>Defence Environment and Engineering Branch</td>
</tr>
<tr>
<td>ERA</td>
<td>Ecological Risk Assessment</td>
</tr>
<tr>
<td><strong>EPA</strong></td>
<td>Environment Protection Authority – generally a state/territory environmental regulator</td>
</tr>
<tr>
<td><strong>EPBC Act</strong></td>
<td>Environment Protection and Biodiversity Conservation Act, 1999</td>
</tr>
<tr>
<td><strong>Exposure pathway</strong></td>
<td>The means by which hazardous substances move through the environment from a source to a point of contact with a receptor (such as a person)</td>
</tr>
<tr>
<td><strong>FSANZ</strong></td>
<td>Food Standards Australia New Zealand</td>
</tr>
<tr>
<td><strong>HBGV</strong></td>
<td>Health Based Guidance Values</td>
</tr>
<tr>
<td><strong>HEPA</strong></td>
<td>Heads of EPAs Australia and New Zealand</td>
</tr>
<tr>
<td><strong>HHERA</strong></td>
<td>Human Health and Ecological Risk Assessment</td>
</tr>
<tr>
<td><strong>HHRA</strong></td>
<td>Human Health Risk Assessment</td>
</tr>
<tr>
<td><strong>HOTO</strong></td>
<td>Handover/Takeover</td>
</tr>
<tr>
<td><strong>Infiltration</strong></td>
<td>The process by which water on the ground surface enters the soil</td>
</tr>
<tr>
<td><strong>IRM</strong></td>
<td>Interim Response Management</td>
</tr>
<tr>
<td><strong>LOR</strong></td>
<td>Limit of reporting</td>
</tr>
<tr>
<td><strong>NEMP</strong></td>
<td>PFAS National Environmental Management Plan Version 2.0, Heads of EPA Australia and New Zealand 2020</td>
</tr>
<tr>
<td><strong>NEPM</strong></td>
<td>National Environment Protection (Assessment of Site Contamination) Measure 1999 (Amended 2013)</td>
</tr>
<tr>
<td><strong>OMP</strong></td>
<td>Ongoing Monitoring Plan (for PFAS, under the PMAP)</td>
</tr>
<tr>
<td><strong>PDS</strong></td>
<td>Project Delivery Services</td>
</tr>
<tr>
<td><strong>PFAS</strong></td>
<td>Per- and Poly-fluoroalkyl Substances. The principal compounds, and those being managed by this Framework, are PFOS, PFOA and PFHxS</td>
</tr>
<tr>
<td><strong>PFHxS</strong></td>
<td>Perfluorohexane sulfonate</td>
</tr>
<tr>
<td><strong>PFOA</strong></td>
<td>Perfluorooctanoic acid</td>
</tr>
<tr>
<td><strong>PFOS</strong></td>
<td>Perfluorooctane sulfonate</td>
</tr>
<tr>
<td><strong>PMAP</strong></td>
<td>PFAS Management Area Plan</td>
</tr>
<tr>
<td><strong>PMCA</strong></td>
<td>Project Management Contract Administrator</td>
</tr>
<tr>
<td><strong>PPMM</strong></td>
<td>Pollution Prevention Management Manual</td>
</tr>
<tr>
<td><strong>PSI</strong></td>
<td>Preliminary Site Investigation</td>
</tr>
<tr>
<td><strong>RAP</strong></td>
<td>Remediation Action Plan</td>
</tr>
<tr>
<td><strong>RCIP</strong></td>
<td>Regional Contamination Investigation Program</td>
</tr>
<tr>
<td><strong>RICO</strong></td>
<td>Routine Investigation Close-Out</td>
</tr>
<tr>
<td><strong>Receptor</strong></td>
<td>Who or what can be affected by pollution</td>
</tr>
<tr>
<td><strong>Sensitive receptor</strong></td>
<td>People or other organisms that can be adversely impacted by exposure to pollution or contamination because of increased sensitivity or increased exposure</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SDD</td>
<td>Defence Service Delivery Division</td>
</tr>
<tr>
<td>SME</td>
<td>Subject Matter Expert</td>
</tr>
<tr>
<td>Source</td>
<td>A source can be primary or secondary. Primary sources are generally areas where AFFF was used or stored, secondary sources may be an accumulation of contamination in the environment that causes secondary effects.</td>
</tr>
<tr>
<td>TCLP</td>
<td>Toxicity Characteristic Leaching Procedure</td>
</tr>
<tr>
<td>TOP Assay</td>
<td>Total Oxidisable Precursor Assay</td>
</tr>
<tr>
<td>Works site</td>
<td>The defined area for carrying out specific works.</td>
</tr>
<tr>
<td>WQMP</td>
<td>Water Quality Monitoring Plan</td>
</tr>
<tr>
<td>WTP</td>
<td>Water treatment plant</td>
</tr>
</tbody>
</table>
## APPENDIX B: STANDARD LABORATORY SUITE

**CORRECT AS AT JUNE 2021**

<table>
<thead>
<tr>
<th>Group</th>
<th>Acronym</th>
<th>Chemical Compound</th>
<th>CAS No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perfluoralkane Sulfonic Acids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PFBS</td>
<td></td>
<td>Perfluorobutane sulfonic acid</td>
<td>375-73-5</td>
</tr>
<tr>
<td>PFPeS</td>
<td></td>
<td>Perfluoropentane sulfonic acid</td>
<td>2706-91-4</td>
</tr>
<tr>
<td>PFHxS</td>
<td></td>
<td>Perfluorohexane sulfonic acid</td>
<td>355-46-4</td>
</tr>
<tr>
<td>PFHpS</td>
<td></td>
<td>Perfluoroheptane sulfonic acid</td>
<td>375-92-8</td>
</tr>
<tr>
<td>PFOS</td>
<td></td>
<td>Perfluorooctane sulfonic acid</td>
<td>1763-23-1</td>
</tr>
<tr>
<td>PFDS</td>
<td></td>
<td>Perfluorodecane sulfonic acid</td>
<td>335-77-3</td>
</tr>
<tr>
<td><strong>Perfluoralkane Carboxylic Acids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PFBA</td>
<td></td>
<td>Perfluorobutanoic acid</td>
<td>375-22-4</td>
</tr>
<tr>
<td>PFPeA</td>
<td></td>
<td>Perfluoropentanoic acid</td>
<td>2706-90-3</td>
</tr>
<tr>
<td>PFHxA</td>
<td></td>
<td>Perfluorohexanoic acid</td>
<td>307-24-4</td>
</tr>
<tr>
<td>PFHpA</td>
<td></td>
<td>Perfluoroheptanoic acid</td>
<td>375-85-9</td>
</tr>
<tr>
<td>PFOA</td>
<td></td>
<td>Perfluorooctanoic acid</td>
<td>335-67-1</td>
</tr>
<tr>
<td>PFNA</td>
<td></td>
<td>Perfluorononanoic acid</td>
<td>375-95-1</td>
</tr>
<tr>
<td>PFDA</td>
<td></td>
<td>Perfluorodecanoic acid</td>
<td>335-76-2</td>
</tr>
<tr>
<td>PFUnDA</td>
<td></td>
<td>Perfluoroundecanoic acid</td>
<td>2058-94-8</td>
</tr>
<tr>
<td>PFDoDA</td>
<td></td>
<td>Perfluorododecanoic acid</td>
<td>307-55-1</td>
</tr>
<tr>
<td>PFTrDA</td>
<td></td>
<td>Perfluorotridecanoic acid</td>
<td>72629-94-8</td>
</tr>
<tr>
<td>PFTeDA</td>
<td></td>
<td>Perfluorotetradecanoic acid</td>
<td>376-06-7</td>
</tr>
<tr>
<td><strong>Perfluoroalkyl Sulfonamides</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOSA</td>
<td></td>
<td>Perfluorooctane sulfonamide</td>
<td>754-91-6</td>
</tr>
<tr>
<td>MeFOSA</td>
<td></td>
<td>N-Methyl perfluorooctane sulfonamide</td>
<td>31506-32-8</td>
</tr>
<tr>
<td>EtFOSA</td>
<td></td>
<td>N-Ethyl perfluorooctane sulfonamide</td>
<td>4151-50-2</td>
</tr>
<tr>
<td>MeFOSE</td>
<td></td>
<td>N-methyl perfluorooctane sulfonamidoethanol</td>
<td>24448-09-7</td>
</tr>
<tr>
<td>EtFOSE</td>
<td></td>
<td>N-Ethyl perfluorooctane sulfonamidoethanol</td>
<td>1691-99-2</td>
</tr>
<tr>
<td>MeFOSAA</td>
<td></td>
<td>N-methyl perfluorooctane sulfonamidoacetic acid</td>
<td>2355-31-9</td>
</tr>
<tr>
<td>EtFOSAA</td>
<td></td>
<td>N-ethyl perfluorooctane sulfonamidoacetic acid</td>
<td>2991-50-6</td>
</tr>
<tr>
<td><strong>(n-2) Fluorotelomer Sulfonic Acids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:2 FTS</td>
<td></td>
<td>4:2 Fluorotelomer sulfonic acid</td>
<td>757124-72-4</td>
</tr>
<tr>
<td>6:2 FTS</td>
<td></td>
<td>6:2 Fluorotelomer sulfonic acid</td>
<td>27619-97-2</td>
</tr>
<tr>
<td>8:2 FTS</td>
<td></td>
<td>8:2 Fluorotelomer sulfonic acid</td>
<td>39108-34-4</td>
</tr>
<tr>
<td>10:2 FTS</td>
<td></td>
<td>10:2 Fluorotelomer sulfonic acid</td>
<td>120226-60-0</td>
</tr>
</tbody>
</table>
The standard PFAS Suite is based on consideration of:


- Table B15 of US DoD/DoE QSM 5.2.

- Current capabilities of analytical laboratories in Australia.

The laboratory is required to use NATA accredited methods based on NEPM, US EPA, Table B15 of US Department of Defence/Department of Energy (US DoD/DoE) Quality Systems Manual 5.2 (QSM) and American Society for Testing and Materials (ASTM) methods as appropriate.

The laboratory shall undertake all PFAS analysis in accordance with Table B15 of US DoD/DoE QSM 5.2. Where the laboratory is currently using a method not in accordance with Table B15 of US DoD/DoE QSM 5.2 it should specify the methodology used, variation from Table B15 of US DoD/DoE QSM 5.2 and capacity to modify current methods in accordance with Table B15 of US DoD/DoE QSM 5.2.