Australian Government
Defence

PFAS INVESTIGATION AND MANAGEMENT PROGRAM

SERVICE
COURAGE
RESPECT
INTEGRITY
EXCELLENCE

RAAF Base Amberley

PFAS ONGOING MONITORING PLAN

March 2025

ACKNOWLEDGEMENT OF COUNTRY

Defence acknowledges the Traditional Custodians of Country throughout Australia. Defence recognises their continuing connection to traditional lands and waters and would like to pay respect to their Elders both past and present. Defence would also like to pay respect to the Aboriginal and Torres Strait Islander peoples who have contributed to the defence of Australia in times of peace and war.

CONTENTS

GLOSSARY

AFFF	Aqueous Film Forming Foam
AHD	Australian Height Datum
AS	Australian Standard
ASC NEPM	National Environment Protection (Assessment of Site Contamination) Measure, as amended 2013
Base	RAAF Base Amberley
CPSA	Confirmed Primary Source Area
COC	Chain of Custody
CSM	Conceptual Site Model
Defence	Department of Defence
DO	Dissolved Oxygen
DQI	Data Quality Indicators
DQO	Data Quality Objectives
DSI	Detailed Site Investigation
EC	Electrical Conductivity
DETSI	Department of Environment, Tourism, Science and Innovation
ERA	Ecological Risk Assessment
HHERA	Human Health and Ecological Risk Assessment
HHRA	Human Health Risk Assessment
LOR	Limit of Reporting
Management Area	The geographical area subject to Defence risk management actions. May include private or Defence owned detached properties beyond the boundaries of the Base.
NATA	National Association of Testing Authorities
Off-site	Off-Base (or other Defence property)
OMP	Ongoing Monitoring Plan
On-site	On-Base (or other Defence property)
PFAS	Per- and polyfluoroalkyl Substances
PFAS NEMP	PFAS National Environmental Management Plan
PFHxS	Perfluorohexane sulfonate
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PMAP	PFAS Management Area Plan
QA	Quality Assurance
QC	Quality Control
RAP	Remediation Action Plan

Risk management actions	Remediation and management actions to address potential risks to receptors from PFAS contamination
ROA	Remediation Options Assessment
SAQP	Sampling and Analysis Quality Plan
SFARP	So Far as Reasonably Practicable
Source	A source can be primary or secondary. Primary sources are areas where AFFF was used or stored. Secondary sources may be an accumulation of contamination in the environment, such as in soil, sediments, or surface water bodies.
SWL	Standing Water Level
TOC	Total Organic Carbon
TDS	Total Dissolved Solids

1 INTRODUCTION

1.1 Background

In March 2025 the Department of Defence (Defence) prepared a revised PFAS Management Area Plan (PMAP) for managing risks to human health and the environment from per- and poly-fluoroalkyl substances (PFAS) contamination associated with RAAF Base Amberley (the Base) and surrounding areas (the 2025 PMAP). An important requirement of the PMAP is to undertake ongoing monitoring of PFAS in the environment and to assess for changes in risks to human and ecological receptors from PFAS originating from the Base.

This Ongoing Monitoring Plan (OMP) replaces the September 2020 OMP (hereon referred to as the 2020 OMP).

1.2 Purpose

The OMP sets out requirements for collection of adequate data to identify and evaluate:

- Spatial, and temporal (including seasonal) variability of PFAS in the environment.
- Changes to sources, transport pathways and/or receptors, described as a conceptual site model (CSM) for the Base.
- Whether risks to human and ecological receptors require review.
- The influence that risk management activities at the Base, as outlined in the 2025 PMAP have had on PFAS in the environment.
- Whether the identified changes trigger an action and/or review.

The data collected may be used to inform where new risk management actions may be required, or to support a determination that remediation has been completed so far as reasonably practicable.

1.3 Supporting information

In developing this OMP, reference has been made to the *PFAS National Environmental Management Plan, Version 2.0* (PFAS NEMP Version 2.0 2020), the *National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013* (ASC NEPM) and Defence estate, environmental and PFAS-specific strategies and guidance, and other information as provided in the References section of this document.

1.4 Constraints and assumptions

This OMP has been prepared based on information available at the time of writing and relies on the findings of the Detailed Site Investigation (DSI), risk assessments, mass flux assessments, remediation activities, ongoing monitoring program data, and management of risks documented in the 2025 PMAP (see references in Appendix A). Defence recognises that there may still be gaps in information, and if required these will be progressively addressed while impacted areas are being managed.

This document has been developed based on the following assumptions:

- The current government issued guidelines, advisories and policies may change, and as a result may trigger a review of the OMP.

- The monitoring locations were based on the data collected to date and may be further refined as proposed management / remediation actions are implemented.
- Base infrastructure development and access constraints at the time of this report.
- Access to off-Base private properties will be granted, where required. It is noted that off-Base access has not been granted in some key locations.

2 SITE SETTING

2.1 Base description

RAAF Base Amberley is located in Amberley, Queensland, approximately seven kilometers west of Ipswich and 50 km southwest of Brisbane central business district, as shown in Figure 1 in Appendix C. The Base is approximately 2,030 ha in area and includes military facilities within the perimeter fence as well as several parcels of Defence owned land to the east and south of the Base (Appendix C, Figure 1).

2.2 Site and management area setting

The PFAS Management Area comprises RAAF Base Amberley and portions of the surrounding area, as shown on Figure 1 and Figure 2 in Appendix C. The area is the primary area throughout which risk management actions and ongoing monitoring has been completed to date.

The PFAS Management Area can be divided into the following zones:

- **The Base:** The Base is divided into 11 surface water catchment areas. The Base is currently an operating RAAF Base and is utilised for flying operations, bulk fuel storage, chemical and armaments storage, firefighting training, short-term accommodation and maintenance activities. Some land is also used for residential and recreational / open space uses**.**
- **Land adjacent to the Base and Bremer River**: This area comprises the Bremer River adjacent to the western, northern and eastern boundaries of the Base and extends as far downstream as Cribb Park. This area includes private properties adjacent to the stretch of river adjacent to the Base as far downstream as Woodend Road Reserve. Private properties within this area are used for agriculture and rural residential purposes. Bremer River is also used for recreational purposes including swimming and fishing, noting that Queensland Health has advised the public to not consume fish caught in the Bremer River adjacent to RAAF Base Amberley and downstream to Cribb Park (i.e. catch and release only).
- **Land adjacent to the Base and Warrill Creek**: This area comprises land adjacent to the southern boundary of the Base and Warrill Creek downstream to the confluence with the Bremer River. This area includes private properties adjacent to the Base along this stretch of the creek. Private properties that lie within this area are used for agriculture and rural residential purposes. Warrill Creek is also used for recreational purposes including swimming and fishing, noting that Queensland Health has advised the public to not consume fish caught in Warrill Creek adjacent to RAAF Base Amberley (i.e. catch and release only).

The surrounding land immediately adjacent to the Base is used for grazing, cropping, mining and small acreages/hobby farms. Surrounding land uses located further to the north, south and west of the Base is predominantly characterised by rural residential areas and several urban suburbs. East of the Base, land use changes from rural to low density residential land uses, industrial estates and landfill approaching the City of Ipswich. Residential development and parkland areas are present adjacent to the Bremer River, downstream of the Base.

It is understood that Berry's Lagoon (also known as Berry's Weir or the Bremer River fishway), located immediately north of the abattoir in Yamanto, is a popular local recreational area. Berry's Lagoon is approximately 2.2km downstream of the confluence of Bremer River and Warrill Creek. Kayaking, canoeing, fishing and swimming are popular recreational activities in the waterways east of the Base.

A summary of the environmental setting of the Management Area is as follows:

- The highest average temperatures are experienced in January, with a mean daily maximum temperature of 31.2 °C. The lowest temperatures typically occur in July, with a mean maximum temperature of 21.3 °C.
- Average annual rainfall for Amberley is 850.9mm per year. The highest rainfall rates typically occur during the month of February with a mean monthly rainfall of 123.2 mm, whilst the lowest mean rainfall occurs in the month of August with a mean monthly rainfall of 27.9 mm.
- The Base and Management Area is predominantly located in the floodplains of the Bremer River and Warrill Creek. In the central west of the Base, the topography rises above the floodplain to topographical highs of 50 m Australian Height Datum (AHD) in the south (south of Frog's Hollow Gully) and 60 m AHD in the west, at the Fire Fighting Training School. The central eastern portion of the Base is located below the 30 m AHD, within the flood plains, where the topography is very flat (with surface gradients of 0.003 to 0.005).
- The geology of the Base and Management Area comprises Quaternary flood plain and terrace alluvium (silt gravel and clay) in the eastern and lower elevations of the Base, Tertiary Fomation (claystone, siltstone, sandstone) in the central west of the Base at higher elevations and Jurassic Walloon Coal Measures (shale, siltstone, sandstone and coal seams) along the western boundary.
- The three main water-bearing units underlying the Base include the Quaternary Floodplain Alluvium, Tertiary Formation, and the Walloon Coal Measures. The Alluvium and Tertiary Formation are connected and are considered a single hydrogeological unit. The Walloon Coal Measures sit beneath the Alluvium and Tertiary formations in some areas of the Base (not laterally continuous). Groundwater at the Base is encountered at depths between 5.5 to 18 metres below ground level (mbgl).
- The Base and Management Area are located within the Bremer River sub-catchment and has historically been segregated into 11 surface water catchment areas which discharge to Bremer River or Warrill Creek at a number of discharge points. An extensive stormwater drainage system comprising open, lined, and unlined drains, covered lined drains, underground drainpipes and grated lined drains direct water from operational areas to discharge points off-Base.

3 EXTENT OF PFAS CONTAMINATION

This section provides an outline of the PFAS related source areas, transport pathways, receptors and risks. This information is described as a CSM, which was reviewed as part of the 2024 PMAP revision. For more detailed information informing the CSM, refer to the reports listed in Appendix A and the 2024 PMAP.

3.1 Source areas

Source areas can be primary or secondary. Primary sources are areas of PFAS contamination where aqueous film forming foam (AFFF) was used or stored, for example, a fire training area. Secondary source areas contain an accumulation of PFAS contamination in the environment, such as in soil, sediment, groundwater or surface water, which has migrated from a primary source area.

In the 2020 PMAP, a total of 32 Confirmed Primary Source Areas (CPSAs) were identified (Appendix B). Additional monitoring and investigations have subsequently been undertaken at the Base to improve understanding of these source areas and to inform the risk management requirements. These investigations identified three catchment areas (Catchment 3, 7 and 8) which include a number of PFAS source areas that represent approximately 87% of the PFAS mass which migrates from the Base. The 2025 PMAP provides an update on the current status of source areas.

3.2 Transport pathways

PFAS can travel from a source to human or environmental receptors via transport pathways, such as surface water, groundwater and stormwater. The transport pathways identified at, and surrounding RAAF Base Amberley were summarised in the DSI (CH2M Hill, 2018) and are briefly described below.

The DSI (CH2M Hill, 2018) identified that PFAS derived from the Base was migrating into the surface waters of Warrill Creek and the Bremer River. The extent of PFAS within the Bremer River which is associated with the Base is defined by the downstream extents of the PFAS Management Area. On the basis of the 2023 mass flux assessment (Senversa, 2023b), surface water migration is considered to be the most important transport pathway for the movement of PFAS downstream of the Base (i.e. 99% of PFAS mass migrates from Base via surface water).

Leachate analysis conducted on sediment and soil samples recovered throughout the DSI (CH2M Hill, 2018) and during subsequent investigations (Senversa, 2023b) has demonstrated that the key analytes of interest, namely PFOS and PFHxS, were readily leached from the soil samples. The results confirm that, without management, impacted soil and sediment at the Base will present an ongoing source of contamination to the on-Base stormwater drainage system, groundwater beneath the Base and off-Base surface water of the Bremer River and Warrill Creek.

Stormwater collected from across the Base is discharged off-Base through the stormwater drainage network. The Base drainage network is comprised of a mixture of unlined drains, lined open drains, and underground pipes within eleven main surface water catchments. A total of approximately 24 discharge points are located west, north and east of the Base along the Bremer River and south along Warrill Creek. As noted previously, the 2023 mass flux study (Senversa, 2023b) identified that 99% of PFAS mass migrates from the Base via surface water with off-Base migration of PFAS for all surface water catchments. As previously noted, Catchments 3, 7 and 8 have been identified to be responsible for 87% of the PFAS discharge from the Base.

PFAS in soil, sediment and stormwater has the potential to migrate vertically into underlying groundwater. PFAS is present in groundwater throughout the Base, with the highest concentrations in groundwater correlating with CPSAs and unlined stormwater drainage lines. Discharge from groundwater to surface water is dependent on gaining or losing stream conditions, with previous studies indicating the Bremer River and Warrill Creek are both gaining and losing streams under different rainfall conditions. The 2023 mass flux study (Senversa, 2023b) identified less than 1% of PFAS migrates from Base via groundwater.

3.3 Receptors and risks

A total of 10 elevated or unacceptable risk scenarios were identified by the outcomes of the DSI and the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) process. Table 1 below details each risk scenario and provides a current summary of the status of each risk, noting no change to the risk profile has occurred between 2020 and 2024.

Table 1: Risk Listing and Consequence

ID	Risk	Description	Nature of Risk	Relevant Risk Group	Risk Timescale
1	Incidental direct contact with PFAS in soil and sediment	Soils within CPSA A and N contain elevated concentrations of PFAS which presents a risk to Base personnel and contractors who are involved in regular soil disturbance activities. Direct contact with soil and sediment on Base is mitigated by implementation of safe work practices and the Defence PFAS Construction and Maintenance Framework.	Human health	Risk Group 1 – CPSA A and N, located within the RAAF Base Amberley Management Area	Current
2	Human consumption of fish caught from local waterways	PFAS has been detected in fish and crustaceans collected from Warrill Creek and Bremer River. Current Queensland Health advice is not to consume fish caught in the Investigation Area due to presence of PFAS.	Human health	Risk Group 3 – Warrill Creek Risk Group 5 – Bremer River	Current (although precautionary advice in place)
3	Consumption of eggs by children	PFAS has been detected in soils on private properties and in water that has historically been used for irrigation. This exposure risk applies to properties where chickens have regular access to PFAS in soil or where water containing PFAS is used for irrigation.	Human health	Risk Group 4 – Properties adjacent to Warrill Creek	Current
4	Consumption of home- slaughtered beef meat	PFAS has been detected in soils on private properties and in water that has historically been used for irrigation. This exposure risk applies to properties where cattle have regular access to PFAS in soil / sediment / pasture, or where water containing PFAS is used for irrigation.	Human health	Risk Group 4 – Properties adjacent to Warrill Creek	Current
5	Consumption of home- slaughtered beef offal (liver and / or kidney)	PFAS has been detected in soils on private properties and in water that has historically been used for irrigation. This exposure risk applies to properties where cattle have regular access to PFAS in soil / sediment / pasture, or where water containing PFAS is used for irrigation.	Human health	Risk Group 4 – Properties adjacent to Warrill Creek	Current
6	Multiple exposure pathways	Multiple exposure pathways that relate to the cumulative risks associated with the consumption of fish, eggs and beef products as identified in Risk ID 3 - 6 above and the incidental direct contact with water and swimming in the Bremer River and Warrill Creek.	Human health	Risk Group 3 – Warrill Creek Risk Group 4 – Properties adjacent to Warrill Creek Risk Group 5 – Bremer River Risk Group 6 – Properties adjacent to Bremer River	Current

ID	Risk	Description	Nature of Risk	Relevant Risk Group	Risk Timescale
7	Direct toxicity to terrestrial ecosystems	Concentrations of PFOS in soils, sediments and some grass samples on-Base exceeded investigation criteria for ecological direct exposure (HEPA, 2020). As such, adverse effects on ecological receptors cannot be excluded.	Ecological risk	Risk Group 2 – CPSA A, C, G, W, X, DD, located within RAAF Base Amberley Management Area	Current
8	Bioaccumulation and effects on higher order consumers within terrestrial ecosystems	Concentrations of PFOS in soils, sediments and some grass samples on- and off-Base exceeded investigation criteria for ecological direct exposure (95% species protection) (HEPA, 2020). As such, adverse effects on ecological receptors cannot be excluded.	Ecological risk	Risk Group 2 – CPSA A, C, G, W, X, DD, located within RAAF Base Amberley Management Area	Current
9	Direct toxicity to aquatic ecosystems	Concentrations of PFOS in surface water exceeded investigation criteria for ecological direct exposure (HEPA, 2020). As such, adverse effects on ecological receptors cannot be excluded.	Ecological risk	Risk Group 3 – Warrill Creek Risk Group 5 – Bremer River	Current
10	Bioaccumulation and effects on higher order consumers within aquatic ecosystems	Concentrations of PFOS in surface water exceeded investigation criteria for ecological direct exposure (HEPA, 2020). As such, adverse effects on ecological receptors cannot be excluded.	Ecological risk	Risk Group 3 – Warrill Creek Risk Group 5 – Bremer River	Current

4 ONGOING MONITORING PLAN

This section sets out the data quality objectives, monitoring scope and assessment requirements. Changes made to the 2020 OMP are summarised in the following sections, and supporting rationale is provided in Appendix E.

4.1 Sampling, Analysis and Quality Plan

A Sampling and Analysis Quality Plan (SAQP) will be developed prior to implementation of the OMP. The SAQP will provide information on data quality assurance procedures and measures including data quality indicators (DQI), sampling methodologies and analytical methods. The SAQP will be updated as required.

4.2 Data Quality Objectives

The Data Quality Objective (DQO) process is an iterative planning approach used to define the type, quantity and quality of data that is needed to inform decisions relating to the environmental condition of a site. The seven-step DQO process:

- Clarifies the study objective.
- Defines the most appropriate collection of data as relevant to the study objective.
- Determines the conditions from which to collect data.
- Specifies tolerable limits on decision errors, which will be used as the basis for establishing the quantity and quality of data, needed to support the decision.

The DQOs for monitoring are presented in Table 2. They have been prepared in line with the DQO process outlined in the ASC NEPM (Schedule B2).

Table 2. Data Quality Objectives

Process	Description
Step 1: State the problem	Elevated concentrations of PFAS have been identified within environmental media, presenting potentially elevated risks to human health and the environment. Management response actions are being investigated and implemented to reduce PFAS mass migrating from the Base so far as reasonably practicable. On the basis of the above, ongoing monitoring is required to: • Assess the effectiveness of the response actions, and to enable informed risk management decisions to protect human health and the environment. • Refine the CSM to allow for an update of the human health and ecological risk assessment.
Step 2: Identify the decision/goal of the study	The overall goal of the study is to continue a systematic routine monitoring program assessing PFAS in groundwater and surface water in order to assess: • Spatial, and temporal (including seasonal) variability of PFAS in the environment. • Changes to sources, transport pathways and/or receptors, described as a CSM for the Base. • Whether risks to human and ecological receptors require review. • The influence that risk management activities at the Base, as outlined in the 2024 PMAP have had on PFAS in the environment.

Process	Description
	• Whether the identified changes trigger an action and/or review.
Step 3: Identify the information inputs	To allow assessment of the data against the study goal listed in Step 2 above, the following inputs will be considered: • PFAS results from previous environmental investigations, inclusive of PSIs, DSIs, HHRA, ERA and mass flux studies. • Meteorological data. • Data collected during implementation of this OMP. • Groundwater elevation data. • Surface water conditions at time of sampling of surface water. • Site status and land use scenarios and whether conditions and uses have changed. • Historical concentration trends. • Advances in laboratory analytical approaches and changes in regulatory requirements. Key inputs to the decisions also include field observations and measurements, sample collection, preservation, storage, transportation and documentation for each media of concern, analytical methods, and field and laboratory Quality Assurance/ Quality Control (QA/QC) data.
Step 4: Define the boundaries of the study	The spatial and temporal boundaries that apply for data collection are detailed below and will influence the decision-making process for ongoing monitoring: • The spatial boundary for data collection and decision-making is limited to the Management Area shown on Figure 1 in Appendix C. • The sampling completed as part of the OMP will be limited to groundwater and surface water at the frequencies defined in Section 4.3. • The monitoring will occur for a further three-year period after which a review will be completed to assess ongoing monitoring requirements. Notwithstanding, the PMAP and OMP will be reviewed annually and revised as necessary in conjunction with the Ongoing Monitoring Report.
Step 5: Develop the analytical approach/decision rules	Sample locations have been selected with the objective of monitoring PFAS trends (temporal and seasonal), providing early warning of changes in the migration of PFAS in surface water and groundwater. The decision rules can be defined as: • If the laboratory QA/QC data are within the acceptable ranges, the data will be considered suitable for use. • If PFAS concentrations are reported above the laboratory LOR, where it was previously <LOR, then further assessment of the data may be required. Specific triggers and response actions are detailed in Section 7. • If the PFAS is reported at a concentration that is above drinking water guideline in groundwater, then it will be considered that further assessment is required and / or notification (refer to Section 7). Note, specific triggers for action and review of monitoring data and monitoring locations are detailed in Section 7, including triggers for resampling where PFAS is detected for the first time, or is detected above relevant guidance values. The decision on the acceptance of the analytical data should be made on the basis of the Data Quality Indicators (DQIs) as follows: • **Precision**: A quantitative measure of the variability (or reproducibility) of data. • **Accuracy:** A quantitative measure of the closeness of reported data to the true value. • **Representativeness:** The confidence (expressed qualitatively) that data are representative of each medium present on the site.

Process	Description
	• **Completeness**: A measure of the amount of useable data from a data collection activity. • **Comparability**: The confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event.
Step 6: Specify performance or acceptance criteria	Specific limits for the OMP have been adopted in accordance with the appropriate guidance made or endorsed by state and national regulations, appropriate indicators of data quality, and standard procedures for field sampling and handling. This step also includes the following acceptable limits on decision making errors: • A decision can be made based on a 95% confidence limit in any given data set. A limit on the decision error will be 5% that a conclusive statement may be a false positive or false negative. • A decision error in the context of the decision rule presented above would lead to either underestimation or overestimation of the risk level associated with a particular sampling area. • Sampling errors may occur when the sampling program does not adequately detect the variability of a contaminant from point to point across the site. To address this, alternate locations may be sampled, or additional sampling events may be conducted. • There may be limitations in the data if aspects of the OMP cannot be implemented, such as: o Surface water locations may be dry at the time of sampling. o Groundwater sampling locations are damaged or destroyed and therefore cannot be sampled. o Access to some sampling locations could be restricted due to operational activities or inaccessible due to weather. • Measurement errors can occur during sample collection, handling, preparation, analysis and data reduction. To address this the following measures are proposed: o Collection of sufficient sample mass to facilitate analysis reported to standard laboratory detections limits. Collection of insufficient sample mass may result in raised detection limits. o Field staff to follow a standard procedure when collecting samples, including decontamination of tools, and use of appropriate sample containers and preservation methods. o Laboratories to follow a standard procedure when preparing samples for analysis and undertaking analysis. o Laboratories to report QA/QC data for comparison with the DQIs established for the SAQP.
Step 7: Develop the plan for obtaining data	The scope and methodology for the assessment to gather data is defined within this OMP document. The SAQP to be developed specific to implementing this OMP will define the manner in which data will be collected to achieve the study goals defined above.

4.3 Proposed monitoring intervals

4.3.1 Groundwater monitoring

The groundwater monitoring programs detailed in this OMP will be completed on an annual basis, targeting an **autumn** monitoring event conducted during March / April to capture post-wet season conditions. Post wet season conditions are to be targeted as PFAS in soils immediately above the saturated zone (also known as the capillary fringe and vadose zone) can be mobilised as groundwater levels rise, which commonly occurs during and immediately following the wet season.

Annual monitoring is considered to be appropriate on the basis of the following:

- Groundwater migration rates are relatively slow and it is anticipated that groundwater concentrations will not change significantly over a 12 month period, consistent with historical trends.
- Conceptually the October (post dry season) event is designed to capture lower rainfall conditions and lower standing water levels, whereas the April (post wet season) event is designed to capture higher rainfall conditions and higher standing water levels. A comparison of average April vs October concentrations in wells containing the highest PFAS concentrations predominantly shows a lack of statistically significant seasonal influence.
- The 2023 mass flux study (Senversa, 2023b) demonstrates that groundwater is a secondary concern with respect to off-Base PFAS migration (i.e. 1% via groundwater, 99% via stormwater). As such, future remediation work will focus upon reducing PFAS concentrations in surface water and there may be relatively short term changes in PFAS concentrations in surface water (i.e. which warrants biannual monitoring). In contrast, PFAS concentrations in groundwater are not expected to change significantly in the short term and biannual monitoring is not critical.

4.3.2 Surface water monitoring

The surface water monitoring program detailed in this OMP will be completed on a biannual basis, consistent with the frequency nominated in the 2020 OMP. This includes:

- An **autumn** monitoring event conducted during March / April to capture post-wet season conditions.
- A **spring** monitoring event conducted during September / October to capture post dry-season conditions.

Biannual monitoring is considered appropriate to assess the seasonal variation in contamination concentrations. Monitoring completed to date has demonstrated seasonal variability in contamination concentrations in surface water.

During the dry season, opportunities to collect surface water samples can be limited on-Base as drains are likely to be dry. During the OMP dry season monitoring event, if there is rainfall, then opportunistic sampling of surface water should be taken from the Base drains.

4.3.3 Sediment Monitoring

No routine sediment monitoring is to be completed as part of the OMP on the following basis:

- There is no current Commonwealth sediment criteria for which to assess the biannual sediment data against.
- There is poor correlation between co-located sediment and surface water data. This is consistent with what may reasonably be expected as sediment samples represent PFAS contamination within a very localised area (<50mm sample diameter) whereas surface water samples represent PFAS contamination across a much larger area (i.e. runoff from various Base areas and in contact with sediment over hundreds of m^2).
- Based on current Commonwealth guidance, the primary use of sediment data is to inform bioconcentration modelling (e.g. to predict PFAS concentration in benthic invertebrates). Targeted event based sediment sampling can be completed to inform future modelling as required.

4.4 Monitoring locations

4.4.1 Groundwater monitoring locations

Groundwater monitoring will be undertaken on selected monitoring wells based on the following rationale:

- Monitor spatial and temporal variations in PFAS concentrations in groundwater concentrations up, down and cross gradient of source areas.
- Assess if PFAS concentrations in groundwater within and downgradient of the source areas change in response to management measures over time.
- Continue to monitor groundwater wells with existing temporal datasets to assist with better understanding of temporal patterns in PFAS concentrations.

A summary of the monitoring locations and the proximity to the PFAS sources has been presented in Table 3 below. The sample location co-ordinates and well construction details are provided in Appendix D and locations shown on Figure 3.

The groundwater monitoring locations are in accordance with the 2020 PMAP, with the exception of new monitoring wells installed to replace damaged wells (see Appendix D).

Table 3: Groundwater monitoring locations

Approximate Target Source Area	Monitoring well ID	Screened Aquifer	Rationale
CPSA A Former Topside Aviation FTA and current FTA Fire Pad	MW002	Walloon Coal Measures	Downgradient of Temporary Storage Facility (TSF)
	MW033	Walloon Coal Measures	Downgradient of Temporary Storage Facility (TSF)
	MW535	Alluvium	Downgradient of Catchment 9
	MW536	Alluvium	Downgradient of Catchment 9
	MW539	Alluvium	Downgradient of Fire Training Area
CPSA B Hangar 410 and Former Landfill	MW047	Tertiary Formation	Downgradient of CPSA B
CPSA C Frogs Hollow Former Fire Training School Location	MW037	Alluvium	Within CPSA C
CPSA D Sewage Treatment Plant	MW021	Alluvium	Within CPSA
	MW032	Alluvium	Downgradient of CPSA D
CPSA E Historical Containment Pond	MW048	Alluvium	Within CPSA E
CPSA G Former FTA and Operational Testing Area	MW050	Alluvium	Downgradient of CPSA G
CPSA J Former FTA and Operational Testing Area	MW005	Alluvium	Downgradient of CPSA J
CPSA M	MW006	Alluvium	Adjacent to CPSA L

Approximate Target Source Area	Monitoring well ID	Screened Aquifer	Rationale
Former Fuel Farm 1 and Triple Interceptor Pit – CPSA N Fire Station	MW023	Alluvium	Downgradient of CPSA L at main discharge point for Catchment 3
	MW028	Alluvium	Downgradient of CPSA L
	MW029	Alluvium	Downgradient of CPSA L
	MW036	Alluvium	Downgradient of CPSA L
	MW309	Tertiary Formation	Upgradient of CPSA N
CPSA P Potential location of 1978 Skyhawk incident	MW538	Alluvium	Downgradient of CPSA P
CPSA V AFFF Wastewater Holding Tank	MW046	Tertiary Formation	Within CPSA V
CPSA W Fire Fighting Training School	MW026	Tertiary Formation	Upgradient of CPSA W (local area background well)
	MW030	Walloon Coal Measures	Downgradient of CPSA W (adjacent to drainage line)
	MW031	Tertiary Formation	Downgradient of CPSA W (adjacent to drainage line)
	MW042	Walloon Coal Measures	Downgradient boundary of CPSA W
	MW043	Walloon Coal Measures	Downgradient boundary of CPSA W
CPSA X Former Structural and Open Pit FTA	MW041	Walloon Coal Measures	Within CPSA X
CPSA Y Former Secondary FTA	MW537	Tertiary Formation	Adjacent to CPSA Y
CPSA Z Fuel underground storage tank (UST) with AFFF listing	MW020	Tertiary Formation	Within CPSA Z
CPSA AA Triple Interceptor Pits at Engine Test Cell Facilities 1 and 2	MW007	Alluvium	Downgradient of CPSA AA
CPSA BB Areas used for irrigation-former grassed runways	MW012	Tertiary Formation	Downgradient of CPSA Z
CPSACC Former Landfill	MW022	Alluvium	Downgradient of CPSA CC
CPSA DD HS748 Former FTA on Disused Runway	MW049	Alluvium	Downgradient of CPSA DD
Off-Base Warrill Creek These locations are down-gradient of multiple source areas.	MW054S	Alluvium	Downgradient of CPSA G (across Warrill Creek)
	MW054D	Walloon Coal Measures	Downgradient of CPSA G (across Warrill Creek)

Approximate Target Source Area	Monitoring well ID	Screened Aquifer	Rationale
	MW057S	Alluvium	Downgradient of CPSA H and CPSA J (across Warrill Creek)
	MW057I	Tertiary Formation	Downgradient of CPSA H and CPSA J (across Warrill Creek)
On-Base Bremer River These locations are down-gradient of multiple source areas.	MW024	Alluvium	Downgradient of CPSA AA and CPSA P
	MW025	Alluvium	Base boundary well downgradient of CPSA A
	MW034	Alluvium	Base boundary well downgradient of CPSA A
	MW035	Alluvium	Base boundary well downgradient of CPSA AA
	MW044	Alluvium	Base boundary well downgradient of CPSA AA and CPSA P
	MW055S	Alluvium	Base boundary well downgradient of CPSA AA and CPSA P
	MW055D	Walloon Coal Measures	Base boundary well downgradient of CPSA AA and CPSA P
Off-Base Bremer River These locations are down-gradient of multiple source areas	MW056S	Alluvium	Downgradient of Bremer River and Warrill Creek confluence
	MW056I	Tertiary Formation	Downgradient of Bremer River and Warrill Creek confluence

4.4.2 Surface water monitoring locations

Surface water monitoring will be undertaken at select locations based on the following rationale:

- Monitor spatial and temporal variations of PFAS concentrations at i) PFAS sources, ii) intermediate locations between sources and discharge points, and iii) the discharge point for each surface water catchment in consideration of the Base stormwater network (e.g. underground pipework and unlined drains).
- Monitor spatial and temporal variations of PFAS concentrations in the receiving environment (e.g. Bremer River and Warrill Creek).
- Assess if PFAS concentrations in surface water within and downgradient of the source areas change in response to management measures over time.
- Continue to monitor surface water at locations with existing temporal datasets to assist with better understanding of temporal patterns in PFAS concentrations.

A summary of the monitoring locations and the proximity to the PFAS sources has been presented in Table 4 below. The sample location co-ordinates are provided in Appendix D and locations shown on Figure 4.

The monitoring locations are consistent with the 2020 PMAP, with the addition of a number of new discharge point monitoring locations (see Appendix D). The additional locations have been included to ensure representative data is collected from the surface water catchments located across the Base, on the basis that surface water/stormwater runoff from the Base represents the primary PFAS transport pathway (Senversa 2023b).

Table 4: Surface water sample locations

Catchment	Monitoring Location	Source Area	Rationale
NA	SW025	-	Bremer River background, west of Catchment 1 and upstream of DP1
NA	SW043	-	Warrill Creek background, south of Catchment 7 and upstream of DP24
Catchment 1	SW033	CPSA W	On-Base, source area
	SW021	CPSA W	On-Base, downstream of source area
	SW049	CPSA W, CPSA A	On-Base, dam downstream of source areas
	SW656	CPSA W, CPSA A	DP1, downstream of southern portion of Catchment 1 which receives runoff from CPSA W
Catchment 1 (Receiving Environment)	SW039	CPSA A	Bremer River, downstream background reference site (SW025)
	SW091	-	Bremer River, downstream of DP1
	SW090	-	Bremer River, downstream of DP2
	SW089	-	Bremer River, downstream of DP3
	SW052	-	Bremer River, adjacent to DP4
	SW088	-	Bremer River, downstream of DP4
Catchment 2	-	-	-
Catchment 2 (Receiving Environment)	SW005	CPSA DD	Warill Creek, adjacent to DP20
	SW657	CPSA DD	Warrill Creek, adjacent to DP18
Catchment 3	SW080	CPSA M, CPSA N, CPSA Z, CPSA BB, CPSA O	On-Base, downstream source areas
	SW079	CPSA M, CPSA N, CPSA Z, CPSA BB, CPSA O	On-Base, downstream source areas (downstream SW080)
	SW041	CPSA M, CPSA N, CPSA Z, CPSA BB, CPSA O	On-Base, downstream source areas (downstream SW079)
Catchment 3 (Receiving Environment)	**SW658**	CPSA M, CPSA N, CPSA Z, CPSA BB, CPSA O	On-Base, downstream source areas prior to discharge into Bremer River (downstream SW041)
	SW098	-	Bremer River, downstream DP7 (downstream SW096)
	SW659	CPSA J	Warrill Creek, at DP13
	SW100	CPSA J	Warrill Creek, downstream DP12
	SW660	CPSA J	Warrill Creek, at DP10
	SW099	-	Warrill Creek, downstream DP10

Catchment	Monitoring Location	Source Area	Rationale
	SW026	-	Confluence of Bremer River and Warrill Creek, downstream of SW099 and SW098
Catchment 4	-	-	-
Catchment 4 (Receiving Environment)	**SW023**	-	Warrill Creek, at DP21
Catchment 5	-	-	-
Catchment 5 (Receiving Environment)	**SW022**	CPSA B	Warrill Creek, at DP22
Catchment 6	SW048	CPSA B	On-Base, adjacent source area
Catchment 6 (Receiving Environment)	SW004	-	Warrill Creek, Adjacent to discharge points DP22 (Catchment 6) and DP23 (Catchment 5)
Catchment 7	SW028	CPSA C	On-Base, source area.
	SW008	CPSA D	On-Base, source area (STP discharge)
	SW530	CPSA C / CPSA D	On-Base, downstream source area (adjacent to DP24
Catchment 7 (Receiving Environment)	SW009	CPSA C / CPSA D	Warrill Creek, upstream of DP24.
Catchment 8	SW037	-	On-Base, upstream source area
	SW059	CPSA A	On-Base, downstream source area
	SW011	CPSA S	On-Base, downstream of source area
	SW030	CPSA V	On-Base, downstream of source area
	SW002	CPSA A	On-Base, downstream source area (downstream SW059 and SW030).
	SW027	CPSA Q	On-Base, adjacent to source area
	SW076	CPSA U	On-Base, adjacent to source area
	SW003	CPSA A	On-Base, downstream of source area (downstream SW002)
	SW661	-	On-Base DP5
Catchment 8 (Receiving Environment)	SW047	-	Bremer River, adjacent DP5
	SW094	-	Bremer River, downstream DP5
Catchment 9	SW038	CPSAA	On-Base, source area
	SW053	CPSA Q	On-Base, downstream source area
	SW056	CPSA U	On-Base, adjacent source area
	SW036	-	Bremer River, downstream DP5 (downstream SW094)

Catchment	Monitoring Location	Source Area	Rationale
Catchment 9 (Receiving Environment)	SW050	-	Bremer River, adjacent to DP6
Catchment 10	SW067	CPSA J	On-Base, source area
	SW064	CPSA F	On-Base, downstream source area
Catchment 10 (Receiving Environment)	SW016	CPSA CC	Warill Creek, source area, downstream of DP17
	SW015	CPSA CC	Warrill Creek, downstream source area, downstream DP16
	SW032	CPSA FF	Warrill Creek, downstream source area, downstream of DP15
	SW034	CPSA H	Warrill Creek, source area, downstream of DP15
	SW018	CPSA H	Warrill Creek, source area, downstream of DP14
	SW020	CPSA H/I	Warrill Creek, downstream source area, downstream of DP14
Catchment 11	**SW662**	-	On-Base, adjacent to DP7
Catchment 11 (Receiving Environment)	SW051		Bremer River, downstream of DP7
	SW096	-	Bremer River, downstream of DP7
NA	SW045		Downstream of Bremer River and Warrill Creek confluence
NA	SW040		Approximately 2km downstream of SW/SD45, north of abattoir

Note: **Bold** indicates new OMP surface water sample location. 'NA' – not applicable.

Off-site monitoring locations will require the agreement of the landholder/leaseholder, refer to Section 8.

4.5 Sample analysis

Samples will be analysed by a NATA accredited laboratory for a suite of PFAS as outlined in Appendix F, using NATA accredited methods.

Laboratory levels of reporting (LORs) must be selected to achieve the OMP objectives (Section 1) and the DQO's. The rationale for selecting LORs below the standard LOR must be provided.

Quality control and quality assurance measures will be outlined within the SAQP.

In addition to PFAS, field measurement of water quality parameters such as pH, electrical conductivity, redox potential, dissolved oxygen, temperature, total dissolved solids, salinity, and turbidity (where feasible) will be undertaken on all surface and groundwater samples.

5 OTHER ASPECTS

To achieve the OMP objectives (Section 1), inform the CSM and allow assessment of the site risk profile, a review of other aspects has been undertaken, including (but not limited to) water use surveys, registered bore searches, change in land zoning, changes in land use on/off Base, development works, remediation works, etc.

The aspects review requirements are addressed in Table 5.

Table 5. Other aspects review

Aspect	Review requirements
Information sources	The OMP has considered other sources of information, such as: • Data obtained from works associated with PMAP implementation, namely remediation actions. • Changes which may result from the specific or cumulative impact of remediation or containment actions, changes to the stormwater network, and changes to hydrogeology. • Investigations associated with estate planning or works. • Other remediation works (non-PFAS) which may also result in changes to existing transportation trends, changes to hydrogeology.
Development works or changes in on-Base land use	The OMP has considered development works and/or changes in on-Base land use that may have the potential to impact the nature and/or extent of PFAS, such as a significant change of land use in a remediated source area or alteration of the stormwater network. These changes require review of the OMP to assess whether changes to monitoring will be required (noting actions may include reintroducing monitoring of existing wells on or off-Base, installing new monitoring wells, adding new surface water monitoring locations, or altering the frequency of monitoring).
Development works or changes in off-Base land use	The OMP has considered development works and/or changes in off-Base land use that may have the potential to impact the nature and/or extent of PFAS, such as a change of stormwater management within the Management Area.
Significant weather events	Significant weather events could include prolonged wet weather or long dry periods, where rainfall is significantly greater or lower than the monthly averages for the area. Review of these aspects has included consideration of: • Potential for variability on PFAS concentrations. • Potential for surface water or groundwater interaction with source areas could become a significant contributor.
Water use surveys	The OMP has considered data collected through the completion of water use surveys to identify any changes in water use or land use activities which may impact the respective risk profiles.
Changes in nationally endorsed PFAS Screening Criteria	The OMP has considered changes to the current human health and ecological screening criteria for PFAS as presented in the PFAS NEMP Version 2.0 (2020).

6 PFAS SCREENING CRITERIA

The adopted screening criteria references the PFAS NEMP Version 2.0 (2020), Defence estate and environmental strategies, and Defence PFAS-specific strategies and guidance. At the time of preparing this OMP, a number of guidance documents were available in Australia and referred to, including:

- PFAS NEMP Version 2.0 (2020).
- Department of Health (DoH), April 2017. Health Based Guidance Values for PFAS for use in site investigations in Australia. This document is based on the works undertaken by FSANZ in 2017 (FSANZ, 2017).
- National Health and Medical Research Council's (NHMRC), 2011. *Australian Drinking Water Guidelines* (ADWG), Version 3.8 updated September 2022 (ADWG).
- National Health and Medical Research Council (NHMRC), 2019. Guidance on Per and Polyfluoroalkyl Substances (PFAS) in Recreational Water. August 2019 (NHMRC, 2019).
- National Environment Protection (Assessment of Site Contamination) Measure 1999, Schedule B1, as amended in 2013 (ASC NEPM).

The adopted PFAS screening criteria to assess the data collected as part of the monitoring are presented in Table 6 and Table 7.

Table 6 PFAS Water Criteria Summary – Human Health

Media	Exposure scenario	Compound	Criteria	Comment / Reference
Groundwater	Drinking water	PFOS+ PFHxS	0.07 µg/L	The values presented in the PFAS NEMP Version 2.0 (2020) are from DoH 2017, which published final health-based guidance values for PFAS for use in site investigations in Australia. DoH utilised the TDI for PFOS and PFOA from FSANZ (2017) and the methodology described in Chapter 6.3.3 of ADWG to determine drinking water values. For PFHxS, DoH 2017 noted that *'FSANZ concluded that there was not enough toxicological and epidemiological information to justify establishing a tolerable daily intake. However, as a precaution, and for the purposes of site investigations, the PFOS tolerable daily intake should apply to PFHxS. In practice, this means that the level of PFHxS exposure should be added to the level of PFOS exposure; and this combined level be compared to the tolerable daily intake for PFOS'.*
		PFOA	0.56 µg/L	

Media	Exposure scenario	Compound	Criteria	Comment / Reference
Surface water	Recreational use	PFOS+ PFHxS	2 µg/L	The values presented in the PFAS NEMP Version 2.0 (2020) are from NHMRC (2019) and are based on applying the TDIs for PFOS and PFOA using an ingestion rate of 30 L per year (based on an ingestion rate of 0.2 L of water per event and an event frequency of 150 events / year).
		PFOA	10 µg/L	

Table 7 PFAS Water Criteria Summary – Ecological

Media	Exposure scenario	Compound	Criteria	Comment / Reference
Water – Surface Water and Groundwater	Freshwater (95% species protection)	PFOS+ PFHxS	0.13 µg/L	The values are from the PFAS NEMP Version 2.0 (2020) which endorsed the Australian and New Zealand Guidelines for Fresh and Marine Water Quality – technical draft default guideline values. It is understood that these guidelines are currently being reviewed and may be subject to future revision.
		PFOA	220 µg/L	
	Freshwater (99% species protection))	PFOS+ PFHxS	0.00023 µg/L	
		PFOA	19 µg/L	

7 TRIGGERS FOR ACTION AND REVIEW

A critical step in establishing an effective monitoring program is to identify performance measures against which the environmental impact of PFAS can be assessed. Once these have been established, an action plan is necessary to describe the measures taken if pre-defined compliance levels are exceeded.

Performance measures designed to monitor the environmental impacts to groundwater and surface water have been assigned on the basis of the following definitions:

- **Assessment criteria:** a water quality standard that is identified as being appropriate to a contaminant in a water body in order to assess the overall impact on water quality.
- **Trigger level**: a specific assessment criterion applied to a contaminant to assess whether there have been possible adverse trends in environmental monitoring data. A trigger level is used as a tool to alert stakeholders and Regulators of these changes. The trigger levels and responses are described in Table 8.

Table 8 Trigger levels and responses

Trigger	Response
First time detection of PFOS, PFOS+PFHxS or PFOA in groundwater / surface water	**On-Base** • Request the analytical laboratory to reanalyse the sample to verify the detection. • Review risk profile for identified potential receptors including confirmation of exposure pathways. • Consider increasing frequency of monitoring. **Off-Base** • Request the analytical laboratory to reanalyse the sample to verify the detection. • Review risk profile for identified potential receptors including confirmation of exposure pathways. • Increasing frequency of monitoring (if required). • Notify relevant stakeholders (if required).
First time exceedance for PFOS+PFHxS or PFOA in groundwater above the drinking water guideline.	**On-Base** • Confirm groundwater in vicinity is not being utilised for drinking water purposes. • Re-sample to verify the exceedance. • Review concentration trends. • Notify relevant stakeholders (if required). **Off-Base** • Re-sample to verify the exceedance. • Review concentration trends. • Review risk profile for identified potential receptors including confirmation of exposure pathways. • Review potential for off-Base sources of PFAS to have contributed to identified impacts. • Issue Water Use Surveys to any licensed extractive groundwater users in vicinity of plume expansion (if not previously completed). • Notify relevant stakeholders (if required).

Trigger	Response
New maximum concentration for PFOS, PFOS+PFHxS or PFOA in surface water or groundwater which is less than an order of magnitude greater than the previous maximum.	**On-Base** • Review concentration trends. • Request the analytical laboratory to reanalyse the sample to verify the detection. • Review risk profile for identified potential receptors including confirmation of exposure pathways. **Off-Base** • Request the analytical laboratory to reanalyse the sample to verify the detection. • If initial result verified, re-sample to verify the exceedance. • Compare concentrations to HHRA assumptions to determine if review of risk profile is warranted. • Review concentration trends. • Review potential for off-Base sources of PFAS to have contributed to identified impacts. • Issue Water Use Surveys to any licensed extractive groundwater users in vicinity of plume expansion (if not previously completed) (if required). • Notify relevant stakeholders (if required).
New maximum concentration for PFOS, PFOS+PFHxS or PFOA in surface water or groundwater which is greater than an order of magnitude greater than the previous maximum.	• Re-sample within two weeks of receiving the results. • Review recent activities in vicinity of sampling location/s within two weeks. • Review risk profile, including confirmation of any potential exposure pathways. • Review management measures and amend (if required). • Notify relevant stakeholders (if required).
New minimum concentration for PFOS, PFOS+PFHxS or PFOA in surface water or groundwater.	**On-Base and Off-Base** • Review concentration trends. • Review risk profile for identified potential receptors including confirmation of exposure pathways. • Review requirement for ongoing monitoring.
First time exceedance of human health recreational guidelines for PFOS+PFHxS or PFOA in surface water off Base (Bremer River, Warrill Creek).	• Request the analytical laboratory to reanalyse the sample to verify the exceedance. • Resample location within four weeks of confirmation to verify detection (if water still present). • Review concentration trends. • Review risk profile, including confirmation of any potential exposure pathways. • Review management measures and amend if required. • Notify relevant stakeholders (if required).
Complete source pathway and receptor linkage identified based on Water Use Survey / change in land use.	• Review risk profile, including concentrations and exposure pathways. • Notify relevant stakeholders (if required). • Conduct further assessment and/or management (if required)
Statistically significant increasing trends for Sum of PFAS (assessed using statistical analysis such as Mann Kendall trend assessment)	• Further assessment of the data to determine whether updates to the CSM and/or risk profile are required. • Conduct further assessment and/or management, if required.

Trigger	Response
Statistically significant decreasing trends for Sum of PFAS trends (assessed using statistical analysis such as Mann Kendall trend assessment)	• Assess whether risks have been reduced, potential amendment to sampling program. • Review whether reduction is related to risk management actions implemented by Defence.
No triggers or acceptable levels are exceeded.	• Recommend the following actions during the next OMP Review: o Decrease frequency of monitoring. o Cease monitoring and / or monitor nearby locations.
Change in Commonwealth tolerable daily intake recommendations and/or tier 1 screening criteria.	• Review OMP within four weeks. • Revise OMP (if appropriate). • Revise human health risk assessment (if appropriate). • Revise ecological risk assessment (if appropriate). • Review the risk register (as appropriate). • Notify relevant stakeholders (if required).

8 REPORTING REQUIREMENTS

8.1 Reporting

After each monitoring event, information, field and laboratory data will be documented in a Sampling Event Report.

At the end of a specified monitoring period (typically 12 months but may vary) the whole data set (including the current and historic data) will be reviewed, and an interpretive Ongoing Monitoring Report prepared.

The Ongoing Monitoring Report will report on the objectives of the OMP, which are to identify and evaluate:

- Spatial, and temporal (including seasonal) variability of PFAS in the environment.
- Changes to sources, transport pathways or receptors, described as a CSM for the Base
- Changes in risks to human and environmental receptors.
- the influence that risk management activities at the Base, as outlined in the 2024 PMAP have had on PFAS in the environment.
- Whether the identified changes trigger a prescribed action and/or review (Section 7).

8.2 Stakeholder engagement

Engagement with a range of stakeholders, such as Department of Environment, Tourism, Science, and Innovation (DETSI), Councils, other agencies, and the community will be undertaken. A stakeholder engagement plan will be prepared and/or updated to manage the engagement process.

Where off-Base monitoring is undertaken a separate letter will be provided to the stakeholder presenting the results of the monitoring event.

The OMP will be published on the Defence website, along with the current PMAP and Ongoing Monitoring Report.

APPENDIX A REFERENCES

PMAP and OMP

Defence. (2020). PFAS Area Management Plan, RAAF Base Amberley, Australian Department of Defence, Revision 0.

Defence. (2025). PFAS Area Management Plan, RAAF Base Amberley, Australian Department of Defence, Revision 1.

PFAS Investigation and Remediation Reports

Aurecon. (2013). Amberley Base Engineering Assessment Program Stage 2 Final Report, Rev2.

CH2M Hill. (2018). RAAF Base Amberley PFAS Investigation—Detailed Site Investigation (No. 2). CH2M Australia Pty Ltd.

CH2M Hill. (2019). RAAF Base Amberley PFAS Investigation – Terrestrial Ecology Technical Report, Revision 2.

CH2M Hill. (2020a). RAAF Base Amberley PFAS Investigation—Factual Report for Additional Sewage Treatment Plant (STP) Investigation, Revision 2.

CH2M Hill. (2020b). RAAF Base Amberley, Human Health Risk Assessment for Leichhardt Residential Area, Revision 3.

CH2M Hill. (2020c). RAAF Base Amberley Seasonal Monitoring Event, Post Dry Season 2019—Addendum Report, Revision 2.

CH2M Hill. (2020d). RAAF Base Amberley Seasonal Monitoring Event Report, Revision 4.

EnRiskS. (2019). Human Health Risk Assessment for the RAAF Base Amberley PFAS Investigation. Prepared for: CH2M Hill Australia Pty Ltd and the Australian Government Department of Defence. Environmental Risk Sciences Pty Ltd.

EnRiskS. (2020). Screening Level Ecological Risk Assessment for the RAAF Base Amberley Investigation, Revision F (CH2M/18/AMBR002).

Senversa. (2022a). SP2 – Temporary Stockpile Storage Facility Investigation Factual Report, RAAF Base Amberley, August 2022, Revision C.

Senversa. (2022b). SP2 – Topography, Sewer, Surface Water and Sediment Investigation Factual Report, Revision B.

Senversa. (2023a). SP2 – Washdown and Lysimetry Investigation Factual Report, Revision D.

Senversa. (2023b). SP3 – PFAS Mass Flux Interpretive Report, RAAF Base Amberley, Revision D.

Aurecon. (2023). Regional Contamination Investigation Program, Phase 2 North Region 2021-2024, RAAF Base Amberley (0861) Stage 2 Detailed Site Investigation: Report, Revision 0.

Ongoing Monitoring Reports

AECOM. (2020). Annual Interpretive Report, 2020, PFAS OMP – RAAF Base Amberley.

AECOM. (2021). Annual Interpretive Report, 2021, PFAS OMP – RAAF Base Amberley.

AECOM. (2024). Ongoing Monitoring Report (March 2021 to May 2023), PFAS OMP – RAAF Base Amberley, Revision 7.

Guidance Documents

ANZG. (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia, 2018.

Defence. (2021). Defence PFAS Construction and Maintenance Framework, Guidance for managing risk of PFAS contamination for works on Defence estate, Version 3.0, dated August 2021.

Defence. (2023). PMAP and OMP Revision Process, PFAS Investigation and Management Program, Australian Government Department of Defence, Revision 0, dated 27 October 2023.

DoH. (2017). Health Based Guidance Values for PFAS for use in site investigations in Australia, Department of Health, April 2017.

FSANZ. (2017). Hazard Assessment Report: Perfluorooctane sulfonate (PFOS), Perfluorooctanoic acid (PFOA) and Perfluorohexane sulfonate (PFHxS), Food Standards Australia New Zealand, April 2017.

HEPA. (2020). PFAS National Environmental Management Plan, Version 2.0 – January 2020, National Chemicals Working Group of the Heads of EPAs Australia and New Zealand, January 202

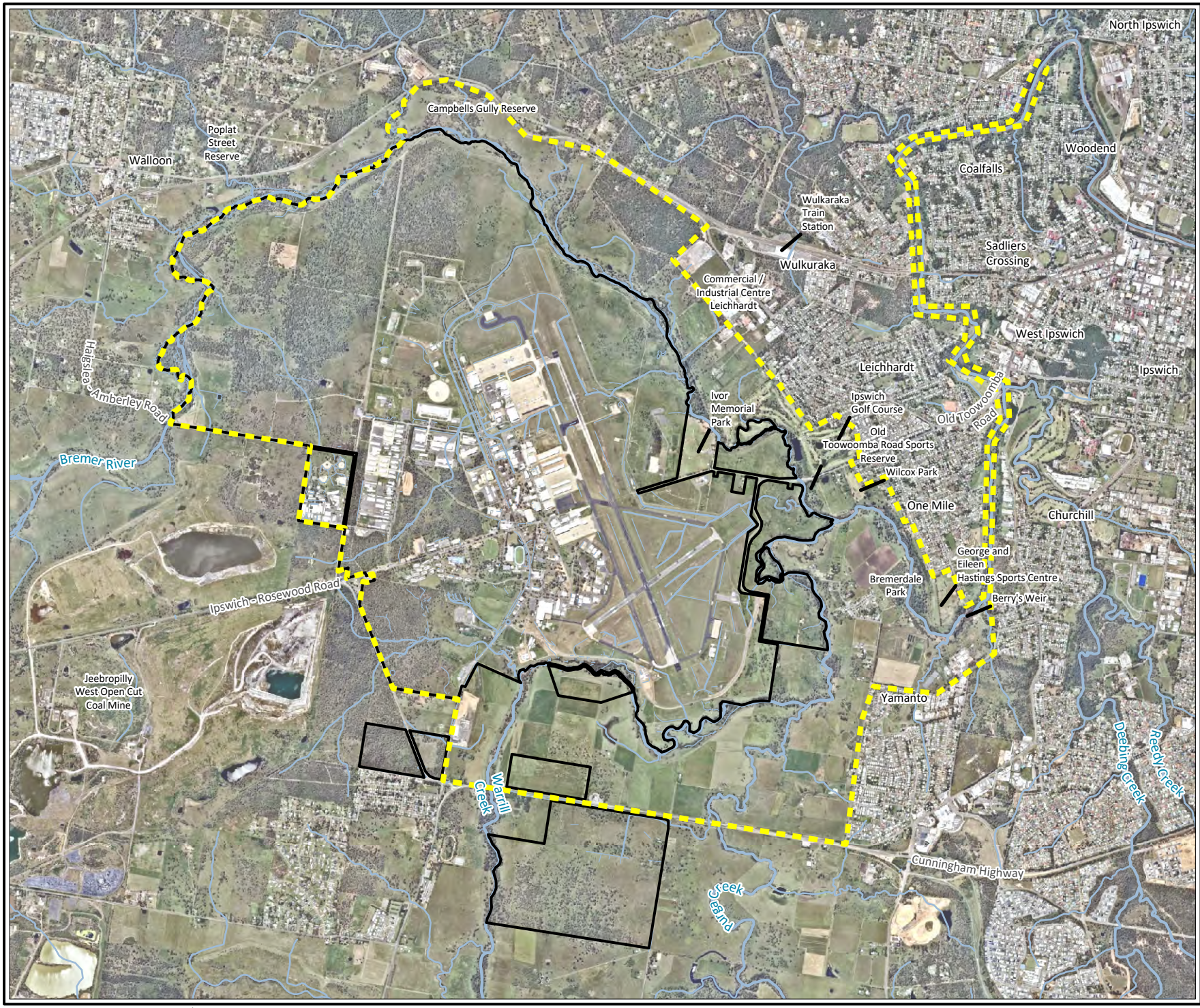
National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended in 2013. (NEPM 2013)

APPENDIX B CONFIRMED PRIMARY SOURCE AREAS

Source Areas	CPSA	Description
Primary Source Areas	CPSA A	Former Topside Aviation Fire Training Area (FTA) and current FTA Pad
	CPSA B	Hangar 410 (Building 410) and Former Landfill
	CPSA C	Frogs Hollow Former Fire Training School Location
	CPSA D	Sewage Treatment Plant (STP)
	CPSA E	Historic Containment Pond
	CPSA F	Potential former FTA and Landfill
	CPSA G	Former FTA and Operations Testing Area
	CPSA H	Potential Former FTA and Landfill
	CPSA I	Potential Former FTA and Landfill
	CPSA J	Former FTA and Operations Testing Area
	CPSA L	Potential Former Fire Training and Operations Testing Area
	CPSA M	Former Fuel Farm 1 and Triple Interceptor Pit
	CPSA N	Fire Station, FTA training
	CPSA O	Potential location of F1-11 2006 incident
	CPSA P	Potential location of 1978 Skyhawk incident
	CPSA Q	1 Squadron Hangar and 6 Squadron Hangar
	CPSA R	K Store- potential AFFF storage
	CPSA S	AFFF Store / Truck Washdown at Fuel Farm 2/2A
	CPSA T	Potential Location of Aircraft F-4E Incident
	CPSA U	38 Squadron Hangar
	CPSA V	AFFF Wastewater Holding Tank1
	CPSA W	Fire Fighting Training School
	CPSA X	Former Structural and Open Pit FTA
	CPSA Y	Former Secondary FTA
	CPSA Z	Fuel UST with AFFF listing

Source Areas	CPSA	Description
	CPSA CC	Former Landfill
	CPSA BB	Areas used for irrigation – former grassed runways
	CPSA DD	HS748 Former FTA on Disused Runway
	CPSA FF	Buried PFAS impacted stockpile from CPSA A
Secondary Source Areas	CPSA AA	Triple interceptor pits at engine test cell facilities 1 and 2, which receive wastewaters from a variety of on-Base facilities.
	CPSA EE	Former sports ovals – potentially irrigated with PFAS contaminated wastewater.

APPENDIX C FIGURES



Legend

- Watercourse
- PFAS Management Area Plan Boundary
- Approximate RAAF Base Amberley Boundary

JBS&G

Job No: 66133	
Client: Department of Defence	
Version: v1	Date: 04-Dec-2024
Scale 1:48,000	

0 500 1,000
metres

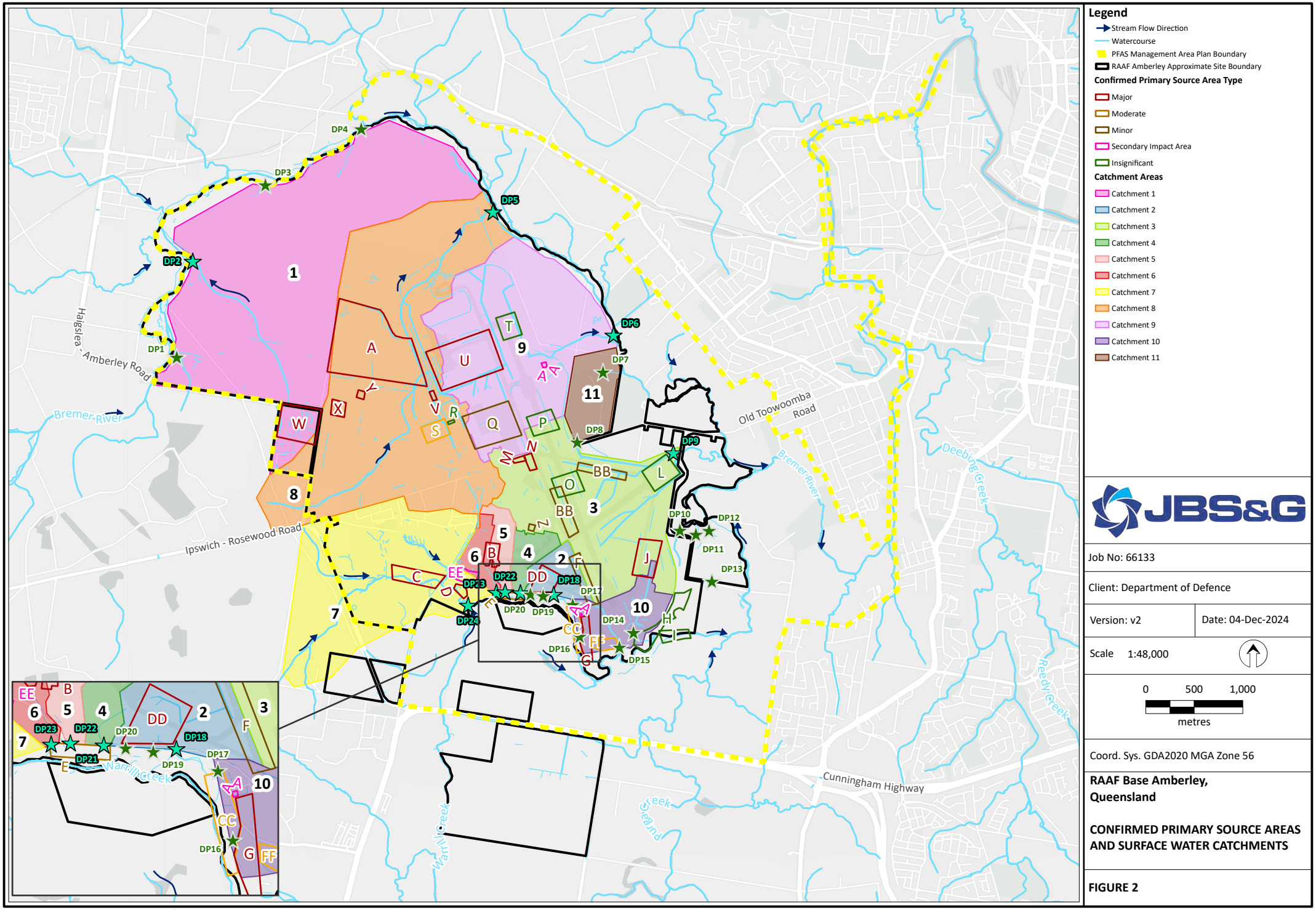
Coord. Sys. GDA2020 MGA Zone 56

RAAF Base Amberley, Queensland

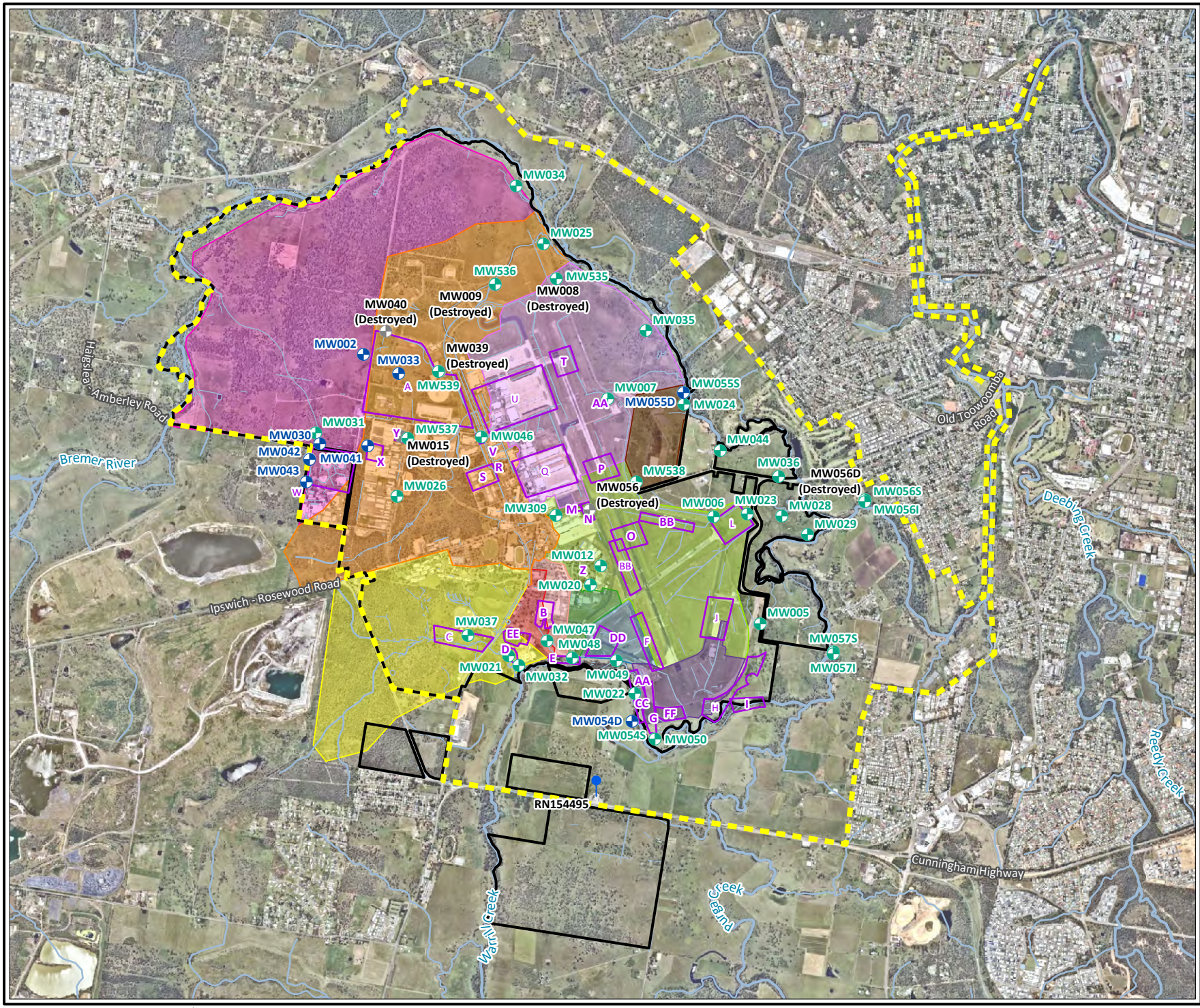
SITE LOCATION AND MANAGEMENT AREA

FIGURE 1

Name: 66133_RAAF_Amberley_OMP24Review_v2/ 66133_01_SiteLoc
Reference: www.nearmap.com - Imagery Date: 02/03/2024



Name: 66133_RAAF_Amberley_OMP24Review_v2/ 66133_02_CPSAsAndCatchments



Legend

- Registered Groundwater Bore
- Tertiary Formation / Alluvium
- Walloon Coal Measures
- Destroyed
- Watercourse
- PFAS Management Area Plan Boundary
- Confirmed Primary Source Area
- RAAF Amberley Approximate Site Boundary

Catchment Areas

- Catchment 1
- Catchment 2
- Catchment 3
- Catchment 4
- Catchment 5
- Catchment 6
- Catchment 7
- Catchment 8
- Catchment 9
- Catchment 10
- Catchment 11

JBS&G

Job No: 66133

Client: Department of Defence

Version: v1 | Date: 04-Dec-2024

Scale 1:48,000

0 500 1,000
metres

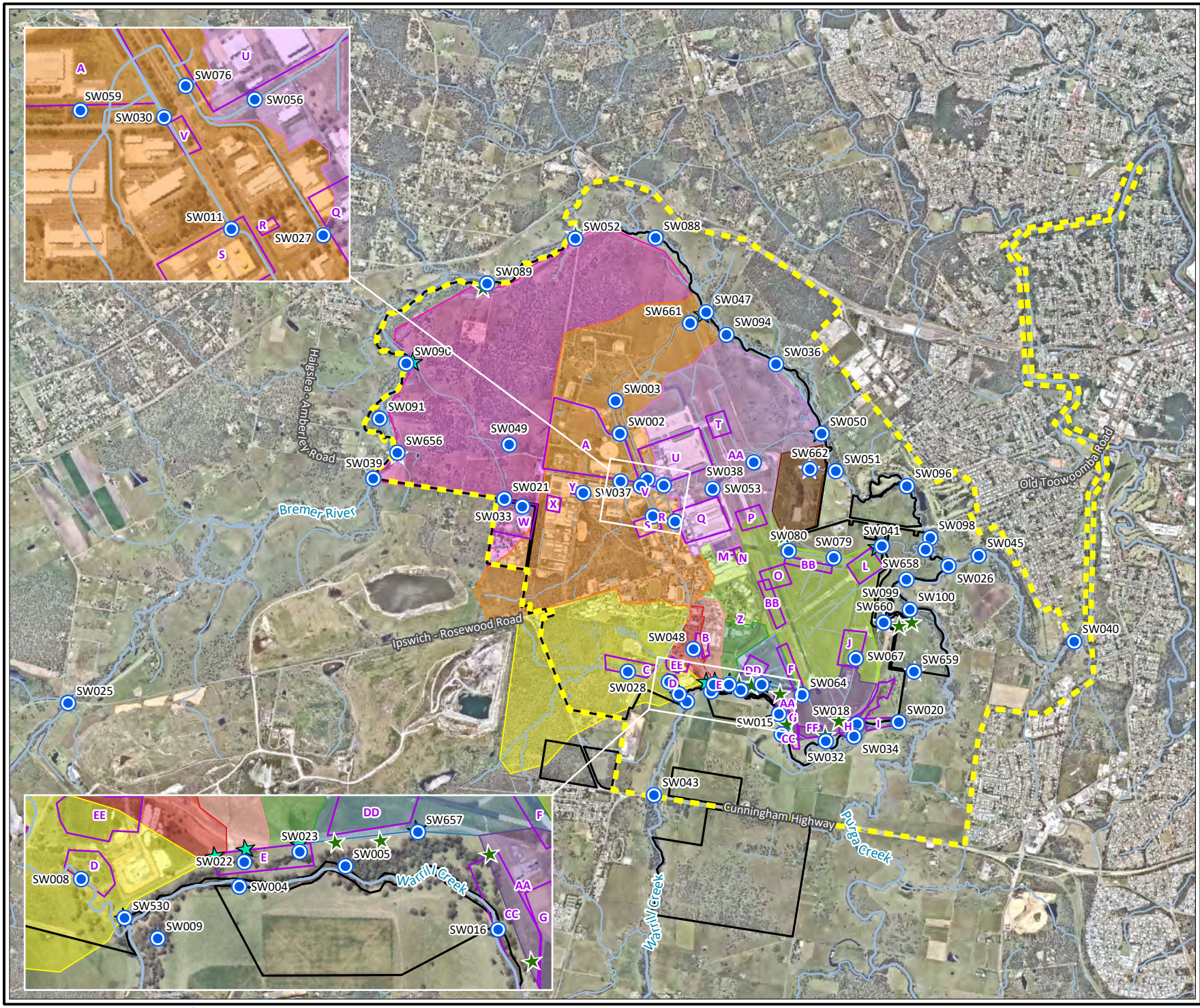
Coord. Sys. GDA2020 MGA Zone 56

RAAF Base Amberley, Queensland

GROUNDWATER MONITORING WELL LOCATIONS

FIGURE 3

Name: 66133_RAAF_Amberley_OMP24Review_v2/ 66133_03_GWLocs
Reference: www.nearmap.com - Imagery Date: 03/06/2024



Legend

- Surface Water Sample Location
- Watercourse
- PFAS Management Area Plan Boundary
- Confirmed Primary Source Area
- RAAF Amberley Approximate Site Boundary

Discharge Point

- Major Discharge Point
- Minor Discharge Point

Catchment Areas

- Catchment 1
- Catchment 2
- Catchment 3
- Catchment 4
- Catchment 5
- Catchment 6
- Catchment 7
- Catchment 8
- Catchment 9
- Catchment 10
- Catchment 11

JBS&G

Job No: 66133

Client: Department of Defence

Version: v1 | Date: 19-Mar-2025

Scale 1:55,000

0 500 1,000
metres

Coord. Sys. GDA2020 MGA Zone 56

RAAF Base Amberley, Queensland

SURFACE WATER SAMPLE LOCATIONS

FIGURE 4

Name: 66133_RAAF_Amberley_OMP24Review_v2/ 66133_04_SWLocs
Reference: www.nearmap.com - Imagery Date: 03/06/2024

APPENDIX D SAMPLE LOCATION INFORMATION

APPENDIX E OMP REVIEW

Table 9: OMP monitoring location and review frequency

Location	Does the location inform the nature of PFAS at the site	Does the location inform the extent of PFAS at the site	Does the location inform the risk profile at the site	Does the sampling frequency inform the risk profile	OMP Review Outcome	Reason
Groundwater						
MW008, MW009, MW015, MW039, MW040	*Yes*	*Yes*	*Yes*	*Yes*	*Remove from OMP and incorporate replacement wells (see below).*	*The monitoring wells were damaged and not suitable for ongoing monitoring. The wells have since been decommissioned, with new replacement monitoring wells installed (see below).*
MW535	*Yes*	*Yes*	*Yes*	*No*	*Add to OMP, reduce sampling frequency*	*Replacement well for MW008, which was decommissioned due to damage. MW008 was located downgradient of CPSA A and monitored extent of plume.*
MW536	*Yes*	*Yes*	*Yes*	*No*	*Add to OMP, reduce sampling frequency*	*Replacement well for MW009, which was decommissioned due to damage. MW009 was located downgradient of CPSA A and adjacent to major drainage line within Catchment 8.*

Location	Does the location inform the nature of PFAS at the site	Does the location inform the extent of PFAS at the site	Does the location inform the risk profile at the site	Does the sampling frequency inform the risk profile	OMP Review Outcome	Reason
MW537	*Yes*	*Yes*	*Yes*	*No*	*Add to OMP, reduce sampling frequency*	*Replacement well for MW015, which was decommissioned due to damage. MW015 was located within PFAS source area CPSA Y.*
MW539	*Yes*	*Yes*	*Yes*	*No*	*Add to OMP, reduce sampling frequency*	*Replacement well for MW039, which was decommissioned due to damage. MW039 was located cross-gradient of CPSA A and monitored extent of plume.*
MW002, MW033, MW047, MW037, MW021, MW032, MW048, MW050, MW005, MW006, MW023, MW028, MW029, MW036, MW309, MW046, MW026, MW030, MW031, MW042, MW043, MW041, MW020, MW007, MW012, MW022, MW049, MW054S, MW054D, MW057S, MW057I, MW024, MW025, MW034,	*Yes*	*Yes*	*Yes*	*No*	*Reduce sampling frequency*	*Ongoing groundwater monitoring on biannual basis is not warranted on the basis following:* • *the 2023 mass flux study (Senversa, 2023b) demonstrates that groundwater is a secondary concern with respect to off-Base PFAS migration (i.e. 1% via groundwater, 99% via stormwater).* • *implementation of the 2024 PMAP will be focused upon remediation of source areas which*

Location	Does the location inform the nature of PFAS at the site	Does the location inform the extent of PFAS at the site	Does the location inform the risk profile at the site	Does the sampling frequency inform the risk profile	OMP Review Outcome	Reason
MW035, MW044, MW055S, MW055D, MW056S, MW056I						*significantly influence PFAS concentrations in surface water.* • *the groundwater migration rates are slow and as such biannual monitoring is not warranted.*
Surface Water						
SW656	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*Discharge point DP1 is located to the west of PFAS source area CPSA W. The location is proposed to be added to maintain a consistent surface water monitoring network (source, intermediate and discharge point). Upstream Bremer River sample location SW039 has reported transient detections of PFAS historically.*
SW657	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*There are no surface water monitoring locations within Catchment 2, which includes CPSA DD. A sample location at discharge point DP18 will provide information concerning*

Location	Does the location inform the nature of PFAS at the site	Does the location inform the extent of PFAS at the site	Does the location inform the risk profile at the site	Does the sampling frequency inform the risk profile	OMP Review Outcome	Reason
						the potential migration of PFAS for this catchment.
SW658	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*Elevated concentrations of PFAS above recreational crtieria are reported at SW041, located approximately 500m upstream of the discharge to the Bremer River. The location is proposed to be added to maintain a consistent surface water monitoring network (source, intermediate and discharge point).*
SW659	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*Discharge point DP13 is located to the east of Catchment 3. The location is proposed to be added to maintain a consistent surface water monitoring network (source, intermediate and discharge point). The sample location SW020 is approximately 1km upstream and has reported variable concentrations of PFAS.*
SW660	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*Discharge point DP10 is located to the east of Catchment 3. The location is*

Location	Does the location inform the nature of PFAS at the site	Does the location inform the extent of PFAS at the site	Does the location inform the risk profile at the site	Does the sampling frequency inform the risk profile	OMP Review Outcome	Reason
						proposed to be added to maintain a consistent surface water monitoring network (source, intermediate and discharge point). The sample location SW100 is approximately 300m upstream and has reported variable concentrations of PFAS.
SW023	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*There are no surface water monitoring locations within Catchment 4. A sample location at discharge point DP21 will provide information concerning the potential migration of PFAS for this catchment.*
SW022	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*There are no surface water monitoring locations within Catchment 5, including CPSA B. A sample location at discharge point DP22 will provide information concerning the potential migration of PFAS for this catchment.*
SW530	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*Discharge point DP24 is located downstream of sample location SW008 collected at*

Location	Does the location inform the nature of PFAS at the site	Does the location inform the extent of PFAS at the site	Does the location inform the risk profile at the site	Does the sampling frequency inform the risk profile	OMP Review Outcome	Reason
						the Sewage Treatment Plant. The location is proposed to be added to maintain a consistent surface water monitoring network (source, intermediate and discharge point). The sample location SW008 is approximately 200m upstream and has reported variable concentrations of PFAS exceeding recreational criteria.
SW661	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*Elevated concentrations of PFAS have been reported at SW003. The location is proposed to be added downstream of SW003 at the catchment 8 discharge point DP5, to maintain a consistent surface water monitoring network (source, intermediate and discharge point).*
SW032	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*Elevated concentrations of PFAS above recreational crtieria are reported at SW064, located adjacent to CPSA FF. The location is proposed to be added downstream of SW064 at the discharge point to maintain a consistent surface*

Location	Does the location inform the nature of PFAS at the site	Does the location inform the extent of PFAS at the site	Does the location inform the risk profile at the site	Does the sampling frequency inform the risk profile	OMP Review Outcome	Reason
						water monitoring network (source, intermediate and discharge point).
SW096	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*There is approximately 1.5km between SW051 and SW098. The proposed sample location is intended to improve the understanding of PFAS discharging from the area immediately north of Catchment 3.*
SW662	*Yes*	*Yes*	*Yes*	*Yes*	*Add location to OMP*	*There are no surface water monitoring locations within Catchment 11. A sample location at discharge point DP7 will provide information concerning the potential migration of PFAS for this catchment.*
Sediment						

Location	Does the location inform the nature of PFAS at the site	Does the location inform the extent of PFAS at the site	Does the location inform the risk profile at the site	Does the sampling frequency inform the risk profile	OMP Review Outcome	Reason
SD002, SD003, SD008, SD011, SD021, SD027, SD028, SD030, SD033, SD037, SD038, SD041, SD048, SD049, SD053, SD056, SD059, SD064, SD067, SD076, SD079, SD080, SD004, SD005, SD009, SD015, SD016, SD018, SD020, SD026, SD034, SD043, SD099, SD100, SD025, SD036, SD039, SD040, SD045, SD047, SD050, SD051, SD052, SD088, SD089, SD090, SD091, SD094, SD098	*No*	*No*	*Yes*	*No*	*Remove from OMP*	*Monitoring of sediment samples from drainage lines does not inform ongoing PMAP implementation on the basis of:* *a) For on-Base areas, samples represent a combination of soil (not permanently inundated areas) and sediment (permanently inundated areas), which creates a data comparability issue.* *b) There is a poor relationship between soil / sediment data and adjacent PFAS source areas as well as surface water data (i.e. soil / sediment data highly variable).* *c) There is a lack of Commonwealth sediment Criteria (where applicable for permanently inundated areas).*

APPENDIX F PFAS ANALYTICAL SUITE

Target analytes	
Perfluoroalkane sulfonic acids	
PFBS	Perfluorobutane sulfonic acid
PFPeS	Perfluoropentane sulfonic acid
PFHxS	Perfluorohexane sulfonic acid
PFHpS	Perfluoroheptane sulfonic acid
PFOS	Perfluorooctane sulfonic acid
PFDS	Perfluorodecane sulfonic acid
Perfluoroalkyl carboxylic acids	
PFBA	Perfluorobutanoic acid
PFPeA	Perfluoropentanoic acid
PFHxA	Perfluorohexanoic acid
PFHpA	Perfluoroheptanoic acid
PFOA	Perfluorooctanoic acid
PFNA	Perfluorononanoic acid
PFDA	Perfluorodecanoic acid
PFUnDA	Perfluoroundecanoic acid
PFDoDA	Perfluorododecanoic acid
PFTrDA	Perfluorotridecanoic acid
PFTeDA	Perfluorotetradecanoic acid
Perfluoroalkyl sulfonamides	
FOSA	Perfluorooctane sulfonamide
MeFOSA	N-Methyl perfluorooctane sulfonamide
EtFOSA	N-Ethyl perfluorooctane sulfonamide
MeFOSE	N-Methyl perfluorooctane sulfonamidoethanol
EtFOSE	N-Ethyl perfluorooctane sulfonamidoethanol
MeFOSAA	N-Methyl perfluorooctane sulfonamidoacetic acid
EtFOSAA	N-Ethyl perfluorooctane sulfonamidoacetic acid
(n:2) Fluorotelomer sulfonic acids	
4:2 FTS	4:2 Fluorotelomer sulfonic acid
6:2 FTS	6:2 Fluorotelomer sulfonic acid
8:2 FTS	8:2 Fluorotelomer sulfonic acid
10:2 FTS	10:2 Fluorotelomer sulfonic acid