Appendix H

Sampling and Analysis Quality Plans

Prepared for
Department of Defence
ABN: 68 706 814 312

AECOM

Sampling and Analysis Quality Plan

Jervis Bay Range Facility & HMAS Creswell

30-Apr-2024
PFAS Ongoing Monitoring Program
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Sampling and Analysis Quality Plan

Jervis Bay Range Facility & HMAS Creswell

Client: Department of Defence

ABN: 68 706 814 312

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1.0 Introduction

1.1 Preamble

AECOM Australia Pty Ltd (AECOM) has prepared this Sampling and Analysis Quality Plan (SAQP) for the implementation of the per- and poly-fluoroalkyl substance (PFAS) Ongoing Monitoring Plan (OMP) program at Jervis Bay Range Facility (JBRF) and His Majesty's Australian Ship Creswell (HMAS Creswell) (collectively the 'Site') (Site IDs 0021 and 0020, respectively) and surrounding off-Site areas, including the extent within the Management Area and Monitoring Area (refer to **Figure 1** in **Appendix A**).

The SAQP supports the OMP presented in Attachment 1 of the *PFAS Management Area Plan* – December 2020 (Defence, 2020b) for the Site, here-in referred to as the OMP (Defence, 2020a).

The purpose of the ongoing monitoring program is to collect data that will enable Defence to maintain an up to date understanding of the distribution, concentration, transport (migration pathways and rates) and transformation of PFAS in the Management Area. The OMP (Defence, 2020a) aims to achieve the following:

- an evidence base for targeted and effective risk management of PFAS contamination to protect human health and environmental receptors
- an early indication that additional management of PFAS contamination may be warranted in areas not currently affected by PFAS.

The data will assist in the timely identification of risks and inform Defence's approach to the management of PFAS, including updates and revisions to the PFAS Management Area Plan (PMAP) (Defence, 2020b) throughout the initial three-year implementation period.

1.2 SAQP Objectives

The objectives of this SAQP are to outline the proposed:

- scope of works in detail
- sampling methodology to be adopted
- quality assurance and quality control (QA/QC) measures to be adopted
- data collection and management requirements for the project.

1.3 Scope of Works

To meet the objectives, the following scope of works are proposed as per the OMP (Defence, 2020a):

- monitor the nature and extent (spatial and temporal) of PFAS impact in groundwater, surface water, tank water and sediment pathways associated with site sources of PFAS derived from the historical use of aqueous film forming foam (AFFF)
- monitor the migration of PFAS in groundwater, surface water and sediment from the Site, utilising newly obtained and historical data
- provide confirmation of the current understanding of risk
- provide supporting data for assessment of management actions, where relevant.

1.4 Guidelines and Legislation

The SAQP has been developed with reference to the following guidelines and legislation:

- Australian and New Zealand Guidelines, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

- Department of Defence, 2018. *Contamination Management Manual – Annex L Data Management*. August 2018, Amended June 2021.
- Department of Defence, 2022. *PFAS Investigation and Management, Guidance Document E Standard PFAS Analytical Suite*. June 2022.
- Department of Health, 2017. *Health Based Guidance Values for PFAS for use in site investigations in Australia*. April 2017.
- FSANZ, 2017. *Supporting Document 1: Hazard assessment report – Perfluorooctane Sulfonate (PFOS), Perfluorooctanoic Acid (PFOA), Perfluorohexane Sulfonate (PFHxS).*
- Heads of EPAs Australia and New Zealand (HEPA) 2020. *PFAS National Environmental Management Plan 2.0*. January 2020.
- National Environment Protection Council (NEPC), 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013).*
- National Health and Medical Research Council (NHMRC), 2019. *Guidance on PFAS in Recreational Water.* August 2019.
- Standards Australia, 1998. AS/NZ 5667:1998 Water Quality – Sampling. Part 11: Guidance on sampling of groundwaters.

1.5 Previous investigations

The previous investigations carried out at the Site prior to the implementation of the OMP include the Detailed Site Investigation (DSI) (GHD, 2019a) and the Supplementary Detailed Site Investigation (GHD, 2020b), which supported the Human Health Risk Assessment (HHRA) (GHD, 2019b) and the Ecological Risk Assessment (ERA) (GHD, 2020a). These reports detailed the nature and extent of PFAS at the Site and its associated risks, to both human and ecological receptors from sources of PFAS contamination related to legacy use of AFFF at JBRF and to a lesser extent its legacy storage and use at HMAS Creswell.

The PMAP (Defence, 2020b) was subsequently developed and includes the overall purpose and requirements of the OMP.

To date, a total of five OMP Sampling Event Factual Reports (AECOM, 2022a, 2022b, 2023a, 2023b and 2023c) have been prepared following each sampling event.

2.0 Site Setting

2.1 Site Description

The Site is located on the Bherwerre Peninsula approximately 200 kilometres (km) south of Sydney. These areas are presented in **Figure F1** in **Appendix A**.

JBRF is host to an operational airfield with two runways (approximately north to south and east to west directions) and associated buildings and infrastructure, including the Royal Australian Navy School of Survivability and Ship Safety (RAN SSSS). HMAS Creswell is a naval training facility. It provides accommodation, waterfront services and other support, including assistance to military activities conducted in the East Australian exercise area. It also hosts operational facilities including offices, accommodation, a fire station, sewage treatment plant and port facilities.

The PMAP (Defence, 2020a) and OMP (Defence, 2020b) define the extent of the 'Management Area' as well as 'Monitoring Area', for areas surrounding the Site.

The 'Management Area' refers to on-Site areas of HMAS Creswell and JBRF, Areas of Environmental Concern (AECs, listed below), and surrounding areas of the Wreck Bay community lands and Booderee National Park with surface water, groundwater and soil containing PFAS, within the Mary Creek sub-catchment, Flat Rock Creek sub-catchment, Captains Lagoon sub-catchment and Summercloud Creek sub-catchment.

These areas are included within the Management Area as they were identified in the DSI (GHD, 2019a), HHRA (GHD, 2019b) and the ERA (GHD, 2020a) to contain actual or potential pathways for PFAS to move from site, for example via surface water flows and groundwater. The Management Area excludes portions of the Monitoring Area that were not found to be impacted by PFAS or were not found to present an elevated risk of PFAS exposure to receptors such as Telegraph Creek, the marine waters of Jervis Bay and Wreck Bay, Lake Windermere and Lake McKenzie.

The 'Monitoring Area' is located to the west of JBRF and the Management Area, and has been established based on the sensitivity of the surrounding lakes and waterbodies (including Lake McKenzie and Lake Windermere), given they provide potable water for the Jervis Bay Territory (JBT). Ongoing monitoring in this area will enable the assessment of risks to drinking water.

The AECs identified in the DSI (GHD, 2019a) are as follows:

- AEC A: CSR_ACT_000108 - RAN SSSS
- AEC B: CSR_ACT_000109 - JBRF area southwest of RAN SSSS within the headwaters of Mary Creek
- AEC C: JBRF former fire-fighting training area (FFTA), now the site of the parachute training school
- AEC E: CSR_ACT_000106 - HMAS Creswell former golf course, irrigated using treated effluent
- AEC F: CSR_ACT_000101 - HMAS Creswell fire station
- AEC G: CSR_ACT_000118 and CSR_ACT_000115 - HMAS Creswell Sewage Treatment Plant.

The Management and Monitoring Areas are presented in **Figure F1** in **Appendix A**.

2.1.1 Regional Meteorology

The Bureau of Meteorology (BoM) Jervis Bay Point Perpendicular Lighthouse (station number 068034) located 10 km north of the Site, recorded data between 1899 and 2004 presenting a record of approximately 105 years, for which the temperature and rainfall data is summarised below:

- Mean monthly maximum temperatures have varied from 15.1°C in July to 23.9°C in February.
- Mean rainfall at the Site is 1,247.8 mm per annum. The lowest recorded annual rainfall was 585.9 mm in 1940 and the highest annual rainfall was 2,493.6 mm in 1961. The highest monthly rainfall generally occurs between March and July (averaging >100 mm per month), with the lowest rainfall in August to December (averaging 84 mm per month).

The BoM Jervis Bay Airfield AWS (station number 068264) located at the JBRF has recorded data since 2018. The temperature and rainfall data for recent monitoring events is summarised below:

- Mean monthly maximum temperatures recorded during each sampling event were as follows:
  - 20.8 °C in October 2021
  - 21.4 °C in April 2022
  - 20.1°C in October 2022
  - 21.2°C in April 2023
  - 22.4°C in October 2023.
- Total rainfall recorded during each sampling event was as follows:
  - 110.8 mm in October 2021
  - 319.2 mm in April 2022
  - 276.8mm in October 2022
  - 375.4 mm in April 2023
  - 83.8 mm in October 2023.

2.1.2 Topography and Geology

The Site and Management Area are situated on the southern peninsula of Jervis Bay.

JBRF is located on the crest of the plateau at an elevation of approximately 50 m AHD, at the top of the catchment area.

HMAS Creswell is located on the headland between Hyams Beach and Captains Beach at an elevation of approximately 30 m AHD on the foreshore of Jervis Bay.

The geology of the Site and Management Area comprises the following geological units:

- Quaternary Holocene sediments, comprising grey, white and yellow/ light brown sand
- Quaternary Pleistocene sediments, comprising pale grey leached quartz sand veneering yellow brown feldspathic sand with podzolic soil profiles
- Tertiary ferruginous quartz gravel
- Tertiary white kaolinitic clay and weathered Permian dolerite
- Late Permian porphyritic dolerite dykes and sills
- Early Permian Snapper Point Formation (known locally as the Jervis Bay Sandstone), comprising quartz pebbly sandstone and minor conglomerate, which is exposed in sections of JBRF and around the upper catchment of Mary Creek.

2.1.3 Hydrogeology

The hydrogeology of the Management Area consists of the following:

- An ‘upper aquifer’ which is unconfined and located in the Pleistocene and Holocene sediments and the upper weathered and highly fractured portion of the Permian sandstone bedrock. It is not expected that the upper aquifer is hydraulically connected to Lake McKenzie and Lake Windermere and parts of this aquifer near the coastal areas are tidally influenced
- A ‘lower aquifer’, located in the bedrock of the Permian sandstone formation.

The upper and lower aquifers are hydraulically connected, however hydraulic conductivities vary with the lower hydraulic conductivity of the lower aquifer relative to the upper aquifer, inferring groundwater flow will occur preferentially within the upper aquifer.

Groundwater elevation for both aquifers is generally consistent with the topography of the Management Area, with the groundwater elevations highest in the vicinity of RAN SSSS. Groundwater flow from this area in the shallow aquifer is generally radial to the north, west and south from this high point.

There are no licensed groundwater wells within the Management Area and no evidence that groundwater is abstracted for potable or other use (Defence, 2020a).

2.1.4 Vegetation

JBRF and HMAS Creswell are surrounded by Booderee National Park (BNP). At HMAS Creswell, 55.4% of the property has been described as being occupied by open forest and woodland. At JBRF, 45.7% of the property has been described as being occupied by dry heath scrubland (Defence, 2020a). The remaining habitats include wet heath/sedgeland, ponds, wetlands and maintained areas.

2.1.5 Surface Water Drainage

JBRF drains northwards via creeks such as Flat Rock Creek, Telegraph Creek and Captains Lagoon into Jervis Bay.

JBRF also drains southwards via Mary Creek into Wreck Bay. Summercloud Creek, located to the east of Mary Creek, and noted to receive minimal runoff from JBRF, drains to Summercloud Bay, while an unnamed creek to the west of Mary Creek drains into Wreck Bay.

The catchments associated with Lake Windermere and Lake McKenzie are situated to the west of JBRF and HMAS Creswell. Lake Windermere is separate from the Site via a north to south trending ridgeline. Lake McKenzie, which includes a series of unnamed pools used by the Wreck Bay community, is anticipated to receive runoff from the area of JBRF to the south of the east to west runway.

The northernmost portion of HMAS Creswell has a catchment originating in the general vicinity of the fire station and it is inferred that overland flows discharge to Jervis Bay to the west of Captains Lagoon and infiltrate into the highly permeable sandy soils along the coast of Jervis Bay.

2.1.6 Current Surrounding Land Use

The current land uses of the surrounding off-Site areas include the following:

- North: Jervis Bay (including Jervis Bay Marine Park, beyond which is Hyams Beach (and village) and Vincentia residential areas.
- South: Wreck Bay community lands and Wreck Bay Village residential area. This area belongs to the Wreck Bay community, home to Indigenous people with connection to country, and is referred to as the ‘403 lands’.
- East: Jervis Bay Village (a residential community with a primary school, Police Station, local store and the Jervis Bay Territory Administration offices) and BNP (including Green Patch and Iluka camping grounds), beyond this is the Pacific Ocean.
- West: Bushland of BNP, including Lake Windermere and Lake McKenzie potable water supplies, Caves Beach, Bherwerre Barrier. Beyond this is the estuary of St George’s Basin.

2.2 Conceptual Site Model

The Conceptual Site Model (CSM) is presented in the PMAP which summarises the linkages between sources, exposure pathways and receptors, which was based on the assessments of risk exposure pathways presented in the DSI (GHD, 2019a), HHRA (GHD, 2019b) and the ERA (GHD, 2020a).

The CSM identified AECs A, C, G and F as the key source areas potentially requiring management to mitigate PFAS release to the environment. The following pathways were considered complete and were also identified as presenting an elevated risk:

Wreck Bay Village community members who may be exposed to PFAS via the following:

- Direct ingestion of freshwater at Mary Creek
- Recreational use of Mary Creek
- Consuming aquatic invertebrates from Mary Creek and consuming terrestrial mammalian offal.

Recreational users of BNP who may be exposed to PFAS via the following:

- Consuming aquatic biota (invertebrates and finfish) from Captains Lagoon and Flat Rock Creek.

Ecological receptors who may be exposed to PFAS via the following:

- Lower and higher order species exposed to PFAS in sediment, surface water and aquatic biota in the Mary Creek, Flat Rock Creek and Captains Lagoon catchments
- Higher order carnivorous terrestrial birds that may prey on species within the JBRF boundary.

3.0 Data Quality Objectives

3.1 DQO Process

The amended National Environmental Protection Measure (NEPM, Schedule B [2]) Guideline on Site Characterisation (2013) specifies that the nature and quality of the data produced in an investigation will be determined by the Data Quality Objectives (DQOs). As referenced by the NEPM, the DQO process is detailed in the United States Environmental Protection Agency (US EPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4: EPA/240/B-06/001), February 2006.*

The US EPA defines the process as *'a strategic planning approach based on the Scientific Method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect'.*

The process of establishing appropriate DQOs is defined according to the following seven steps:

Table 1 The seven steps in defining DQOs

Step	Data Quality Objective Step
1	**State the problem** – Define the problem that necessitates the study; identify the planning team, examine budget, schedule.
2	**Identify the goal of the study** – State how environmental data will be used in meeting objectives and solving the problem, identify study questions, define alternative outcomes.
3	**Identify information inputs** – Identify data and information needed to answer study questions.
4	**Define the boundaries of the study** – Specify the target population and characteristics of interest, define spatial and temporal limits, scale of inference.
5	**Develop the analytic approach** – Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from findings.
6	**Specify performance or acceptance criteria** – Develop performance criteria for new data being collected or acceptable criteria for existing data being considered for use.
7	**Develop the plan for obtaining data** – Select the resource-effective sampling and analysis plan that meets the performance criteria.

The approach adopted relative to the seven steps presented above is outlined in the OMP (Defence, 2019), and provided below:

3.1.1 Step 1 – State the Problem

PFAS source areas at the Site have been identified to be contributing to the presence of PFAS in groundwater, surface water, soil, and biota within the Management Area at concentrations exceeding the relevant assessment levels.

This has led to a number of elevated exposure risks to human health and the environment.

The previous studies have reported that surface water migration is likely to be the dominant transport mechanism for PFAS to move from the Site into off-Site areas, with off-Site migration identified via Mary Creek and Summercloud Creek to the south and Captains Lagoon and Flat Rock Creek to the north.

The DSI (GHD, 2019a) also confirmed that PFAS is moving off-Site from JBRF and HMAS Creswell via the sewer network, and trace concentrations of PFAS (below the adopted screening criteria) were identified in Lake McKenzie and Lake Windermere. Biota sampling indicated that PFAS concentrations were highest in aquatic organisms at Captains Lagoon, Flat Rock Creek and Mary Creek. Terrestrial organisms on-Site at JBRF and HMAS Creswell were also impacted.

3.1.2 Step 2 – Identify the Goal of the Study

The principal objectives of the OMP aims at resolving the following broad principal study questions:

1. What are the changes and trends in the nature, extent and magnitude of PFAS concentrations in the groundwater, surface water, tank water and sediment within the Management Area?
2. How have the implemented management measures affected the nature, extent and magnitude of PFAS concentrations in the groundwater, surface water and sediment within the Management Area?
3. Has the nature, extent and magnitude of PFAS concentrations changed significantly to warrant a revision of the CSM?
4. Has the nature, extent and magnitude of PFAS concentrations changed significantly to warrant refinement of any existing management measures?

3.1.3 Step 3 – Identify 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, and groundwater, surface water, tank water and sediment collected and analysed for PFAS, as part of the SAQP.
- Field data (i.e. groundwater standing water levels, water quality parameters) on groundwater, surface water and field descriptions of sediment from previous and new data collected as part of the SAQP.
- meteorological data including rainfall
- site status and land use scenarios and whether these have changed
- an appropriate statistical evaluation of the data (e.g. using Mann-Kendall or similar analysis) including short- and long-term trends, in particular for surface water and groundwater concentrations (where there are sufficient data points)
- comparison of data sets to relevant endorsed assessment levels (refer to **Section 4.10**).

3.1.4 Step 4 – Define the Boundaries of the Study

The boundaries that apply for data collection are detailed below:

- the spatial boundary for data collection is the Monitoring Area (refer to **Figure F1** in **Appendix A**).
- the sampling completed as part of the SAQP will be limited to groundwater, surface water, tank and sediment at the frequencies defined in **Section 4.2**.
- the monitoring will be conducted over the initial three-year implementation period.

A review of the OMP will take place annually as part of the Ongoing Monitoring Report (OMR).

3.1.5 Step 5 – Develop the Analytical Approach

The purpose of this step is to define the parameters of interest, specify action levels and combine the outputs of the previous DQO steps to develop a series of options if certain trigger events occur.

The key decision rules for the OMP are:

1. Have the analytical data collected as part of the OMP met the Data Quality Indicators (DQI) developed as part of the SAQP? If yes, then the data can be used for decision making. If no, then an assessment of the need to collect additional data will be required.
2. Does the data indicate a change to the risks defined in the DSI (2019a), HHRA (2019b) and ERA (2020a)? If yes, then further risk assessment may need to be carried out. This may lead to a need to revise the PMAP. If no, then continue monitoring as per the OMP.
3. If reported PFAS concentrations in Lake McKenzie or Lake Windermere increase, then re-assess the PMAP management responses to consider management actions that may be required for the Jervis Bay Territory potable water supply.

4. Does the data conform with the CSM as outlined in the PMAP? If yes, then continue monitoring as per the OMP. If no, then further risk assessment will need to be carried out. This may lead to a need to revise the PMAP.
5. Is the data meeting the DQOs as outlined in the OMP? If yes, then continue monitoring as per the OMP. If not, then a revision to the OMP should be undertaken.

Where data set size permits, trends in PFAS concentrations, including an assessment of temporal and spatial changes, should be assessed using an appropriate statistical analysis approach (e.g. using Mann-Kendall or similar analysis), with a specified level of confidence based upon the number of monitoring rounds completed.

The analytical data will be compared to the relevant assessment levels presented in **Section 4.10** and to the concentrations recorded during prior monitoring rounds (i.e. during the DSI) to evaluate changes in the risk profile and whether revision of the CSM or implemented management measures is warranted. The laboratory limits for samples are to be below the assessment levels, where possible.

3.1.6 Step 6 – Specify Performance or Acceptance Criteria

The potential for significant decision errors will be minimised by completing a robust data validation (QA/QC) program in accordance with the requirements of the OMP (and any subsequent SAQPs). Data quality indicators (DQIs) will be applied to assess the usability of the data prior to making decisions, based on precision, accuracy, representativeness, comparability and completeness. The ASC NEPM (NEPC, 2013) and PFAS NEMP (HEPA, 2020) details the various metrics that can be used to assess data in terms of these DQIs.

3.1.7 Step 7 – Optimise the Design for Obtaining Data

The OMP (Defence, 2020a) provides guidance for preparing a SAQP that is required for each monitoring event, including scope of work, sampling methodologies, monitoring locations and PFAS assessment levels. The SAQP was developed in response to the principal study questions outlined in Step 2 and in line with the DQOs. To maintain the integrity and reliability of data the following measures are to be adopted:

- Field and analytical data are collected in accordance with the PFAS NEMP (HEPA, 2020) and the ASC NEPM (NEPC, 2013)
- Field personnel should be trained and have sufficient experience to complete the fieldwork to an acceptable standard, as per the protocols outlined in the OMP / SAQP and following standards:
  - Department of Defence *Contamination Management Manual* (March 2018, Amended August 2019),
  - Standards Australia (AS/NZS5667.11–1998) *Water Quality – Sampling, part 11: Guidance on sampling of groundwater,*
  - Standards Australia (AS 4482.1-2005) *Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds.*
- Robust field and laboratory quality assurance/quality control protocols are adopted, including implementing suitable fieldwork procedures, and ensuring that sample handling, and transport to and processing by the analytical laboratories is appropriate.
- Use laboratories that are NATA accredited for PFAS analysis and ensure laboratory LORs are suitable to meet the relevant adopted assessment levels, where possible. Note that at selected locations, ultra-trace analysis will be performed to achieve lower LORs.
- Conducting sampling in accordance with AECOM's internal PFAS Sample Collection Guidance.
- Sampling conducted by suitably qualified and experienced field staff who have completed AECOM's internal PFAS 101 Training.
- Basing the sampling upon a CSM developed using the information available at the implementation of the OMP (Defence, 2020a). Updating the CSM as new data becomes available in the course of the implementation of the OMP (Defence, 2020a), as required.

- Progressive review of the data and modification of sampling programs to optimise the value of data generated.
- Continually seeking to identify opportunities for refinement and optimisation of the OMP, including, but not limited to, identifying redundant locations that can be excluded from the monitoring program. This will be achieved through an annual review of the SAQP across the three-year primary implementation period.

3.2 Assessment of Data Quality

The quality of data collected as part of the sampling will be assessed on a range of factors including:

- Documentation and data completeness; and
- Data quality – comparability, representativeness, precision and accuracy of the analytical data.

The project target for data completeness is to achieve 95% of data as suitable for use.

The acceptance criteria for DQIs for samples are provided in **Table 2**.

Table 2 Acceptance Criteria for Data Quality Indicators for Sample Analysis

Data Quality Indicators	Acceptance Criteria
Water and Sediment Samples	
Field Program	Sampling to be completed by suitably qualified and experienced field teams employing appropriate sampling procedures.
Rinsate Blanks	Rinsate blank samples are to be collected at a rate of one per day of sampling (where sampling equipment is reused). Concentrations of PFAS should be less than the laboratory LOR.
Field Blanks	Field blank samples are to be utilised at a rate of one per day of sampling. Concentrations of PFAS should be less than the laboratory LOR.
Field duplicates/Inter-lab duplicates	Field duplicates and inter-laboratory duplicates are to be collected and analysed at a rate of 10% (1 per 10 primary samples). The relative percentage difference (RPD) will be assessed as acceptable if less than or equal to 30% as per the NEPM Schedule B3. Where the results show greater than 30% difference a review of the cause will be conducted (NEPM, 2013). It is noted that RPDs that exceed this range may be considered acceptable where: • results are less than 10 times the LOR (no limit) • results are between 10 and 20 times the LOR and the RPD is less than 50% • heterogeneous materials are encountered.
Laboratory duplicates	The RPD will be assessed as acceptable based on the magnitude of the result: • 0-20% for results more than 20 times the LOR • 0-50% for results between 10 and 20 times the LOR • No limit for results between 0 and 10 times the LOR
Matrix spikes	Recoveries between 70-130% of the theoretical recovery or as nominated in the laboratory's Quality Control report.
Method blanks	Less than the laboratory LOR.
Laboratory control samples	Recoveries between the laboratory-specified range for each particular analyte/analytical suite.

4.0 Sampling Location Methodology

4.1 OMP

The OMP (Defence, 2020a) presents an overview of specific monitoring works to be undertaken and provides the basis for the preparation of this SAQP. This scope of works presented in this SAQP is consistent with that detailed in the OMP (Defence, 2020a).

4.2 Proposed Schedule

The OMP (Defence, 2020a) outlines the monitoring, as follows:

- Surface water, sediment, groundwater and tank water monitoring is to be undertaken biannually at all locations for the first three years of the OMP implementation period, once in October and once in April. A select number of groundwater locations are to be gauged only (not sampled), as indicated in in **Table 4.**
- At the completion of the initial three-year implementation period, the available data should be reviewed and evaluated to determine if the frequency of monitoring should increase or decrease to provide a better understanding of PFAS concentration fluctuations and potential risks to receptors.

A biota sampling plan will be discussed with regulators and key stakeholders if there is statistical evidence in abiotic media to demonstrate a measurable trend in concentrations (i.e. 20% change within a catchment for regulated PFAS compounds). This is considered relevant and appropriate at this site, given the significant contribution of aquatic biota to the diet of residents of Wreck Bay, in addition to the area having tourism significance. The results of the HHRA (GHD, 2019b) and ERA (GHD, 2020a), indicated the potential for elevated PFAS exposure to humans and the environment at a number of locations around the Investigation Area. Ongoing biological monitoring is considered appropriate to track changes in concentrations in biota within the Investigation Area, particularly those that may be consumed by humans.

The initial biannual monitoring event was completed in October 2021. The proposed schedule of fieldworks across the initial three-year period is presented in **Table 3** below.

Table 3 Proposed Fieldwork Schedule

Sampling Round No.	Description of works	Proposed Schedule	Status
1	Biannual groundwater, tank, surface water and sediment sampling	October 2021	Completed
2	Biannual groundwater, tank, surface water and sediment sampling	April 2022	Completed
3	Biannual groundwater, tank, surface water and sediment sampling	October 2022	Completed
4	Biannual groundwater, tank, surface water and sediment sampling	April 2023	Completed
5	Biannual groundwater, tank, surface water and sediment sampling	October 2023	Completed
6	Biannual groundwater, tank, surface water and sediment sampling	April 2024	-

4.3 Sample Locations

4.3.1 Groundwater Sampling Locations

The groundwater locations to be monitored during the biannual events are provided in **Table 4** below and are presented on **Figure F2** in **Appendix A**.

Table 4 Groundwater Sample Locations

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Top of Casing (TOC) Elevation (m AHD)	Screen Interval (mbgl)	Comment (Defence Supplied)	Total
On-Site	AEC E	0020	MW017	0020_MW16, MW16	290356.824	6110784.230	1.998	2 - 5	-	4
		0020	MW109	E_MW04	290249.359	6110647.078	3.632	1 - 2	-	
		0020	MW110	E_MW05	290255.902	6110383.081	8.024	1 - 2	-	
		0020	MW111	F_MW01	290907.196	6110337.651	27.018	1 - 3	-	
	AEC F	0020	MW037	0020_MW01, MW01	290920.419	6110300.515	31.099	3 - 6	-	3
		0020	MW112	F_MW02	290956.700	6110279.210	31.546	1 - 4	-	
		0020	MW115	F_MW03	290946.710	6110307.990	31.260	1.8 - 4.8	-	
	Captains Lagoon	0020	MW012	MW12	291368.004	6110351.283	Unknown	Unknown	-	1
	HMAS Creswell	0020	MW001	CRMW1, CR_MW1	291055.973	6110951.983	2.910	Unknown - 5.99	Gauge only	2
		0020	MW007	MW10, 0020_MW10	290953.549	6110908.313	2.680	0.75 - 3.75	-	
Off-Site	Captains Lagoon	0020	MW102D	CL_MW02, MW102	291128.354	6109825.853	35.392	2.8 - 8.8	-	3
		0020	MW104	CL_MW04	291070.956	6109503.606	47.422	4 - 10	Gauge only	
		0020	MW105	CL_MW05	290876.680	6109825.061	52.044	6 - 12	-	
On-Site	AEC A	0021	MW024	MW12	291025.305	6107522.890	80.537	6 - 9	-	18
		0021	MW061		290764.587	6107648.954	71.590	0.85 – 2.85	-	
		0021	MW062		290703.312	6107693.79	69.850	1 - 3	-	

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Top of Casing (TOC) Elevation (m AHD)	Screen Interval (mbgl)	Comment (Defence Supplied)	Total
On-Site	AEC A	0021	MW101	A_MW01	290828.470	6107551.279	75.084	1 - 2	-	18
		0021	MW102	A_MW02	290787.901	6107710.981	72.299	1 - 1.8	-	
		0021	MW103	A_MW03	290673.210	6107622.859	68.856	1 - 2	-	
		0021	MW104	A_MW04	290635.551	6107468.217	69.524	1 - 2	-	
		0021	MW105	A_MW05	290491.579	6107613.423	64.291	1 - 2	-	
		0021	MW106	A_MW06	290766.014	6107611.265	72.928	1 - 2.5	-	
		0021	MW107	A_MW07	290586.379	6107752.175	67.191	1 - 4	-	
		0021	MW108	A_MW08	290776.799	6107780.714	70.443	1 - 2.5	-	
		0021	MW109	A_MW09	290902.001	6107684.325	74.47	1 - 4	-	
		0021	MW150	-	290743.400	6107591.730	71.510	3 - 5	Gauge only	
		0021	MW151	-	290742.660	6107592.810	71.580	2 - 3	Gauge only	
		0021	MW152	-	290742.080	6107593.740	71.540	1 - 2	Gauge only	
		0021	MW153	-	290694.930	6107632.960	69.360	2.85 - 4.85	Gauge only	
		0021	MW154	-	290693.650	6107632.930	69.350	2 - 3	Gauge only	
		0021	MW155	-	290692.530	6107633.050	69.230	0.75 - 2	Gauge only	
	AEC B	0021	MW110	B_MW01	290363.295	6107310.967	60.047	1 - 2	-	3
		0021	MW111	B_MW02	290306.443	6107493.884	61.074	1 - 2	-	
		0021	MW113	B_MW04	290163.822	6107204.885	52.815	1 - 2	-	

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Top of Casing (TOC) Elevation (m AHD)	Screen Interval (mbgl)	Comment (Defence Supplied)	Total
On-Site	AEC C	0021	MW028	0021_MW08, MW8	290496.309	6108501.849	57.816	3 - 6	-	9
		0021	MW030	MW6	290774.537	6108607.883	52.959	6.8 - 9.8	-	
		0021	MW117	C_MW01	290286.037	6108510.839	56.910	1 - 2	-	
		0021	MW118	C_MW02	290296.314	6108644.899	56.183	1 - 3	-	
		0021	MW119	C_MW03	290516.502	6108733.952	56.601	1 - 2	-	
		0021	MW120	C_MW04	290567.691	6108588.091	55.585	1 - 3	-	
		0021	MW121	C_MW05	290593.764	6108811.096	55.680	0.8 - 2.8	-	
		0021	MW123	C_MW07	290634.696	6108380.753	57.968	1 - 2.8	-	
		0021	MW124	CL_MW01	290887.738	6108606.804	49.826	1 - 2.8	-	
	AEC H	0021	MW025	MW11	289987.817	6108244.758	60.769	2 - 5	-	2
		0021	MW026	MW10	289962.765	6108229.124	60.795	4.75 - 7.75	-	
	JBRF	0021	MW022	MW14	290482.222	6106874.883	67.159	3.8 - 6.8	-	4
		0021	MW112	B_MW03	290367.053	6107026.943	62.949	1 - 2.5	-	
		0021	MW125	FC_MW01	289650.000	6108848.000	48.130	1 - 3	-	
		0021	MW126	FC_MW02	289756.500	6108944.000	47.100	6 - 9	-	
Off-Site	Lakes	0021	MW114	BB_MW01	286611.121	6108524.481	12.325	4 - 7	-	11
		0021	MW115	BB_MW02	286419.100	6107109.342	5.007	1 - 4	-	
		0021	MW128	LM_MW01	289175.060	6108389.365	57.051	2.3 - 5.3	-	
		0021	MW129	LM_MW02	288041.834	6108008.845	47.694	26.1 - 30.6	Supertrace analysis	
		0021	MW130	LW_MW01	288865.496	6109084.007	56.255	26 - 35	Supertrace analysis	

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Top of Casing (TOC) Elevation (m AHD)	Screen Interval (mbgl)	Comment (Defence Supplied)	Total
Off-Site	Lakes	0021	MW135	LM_MW03A	288008.000	6108639.520	47.540	31.27 - 40.27	Supertrace analysis	
		0021	MW136	LM_MW03B	288012.420	6108644.530	47.633	20.05 - 26.05	Supertrace analysis	
		0021	MW137	LM_MW03C	288009.670	6108641.470	47.708	5.05 - 11.05	Supertrace analysis	
		0021	MW138	LW_MW02A	288483.690	6108586.100	52.200	31.4 - 40.4	Supertrace analysis	
		0021	MW139	LW_MW02B	288484.480	6108583.610	52.220	14.6 - 20.6	Supertrace analysis	
		0021	MW140	LW_MW02C	288483.130	6108588.770	52.070	6 - 12	Supertrace analysis	
	Mary Creek	0021	MW131	MC_MW02	-	-	4.767	4 - 7	-	3
		0021	MW132	MC_MW03	-	-	26.593	5.5 - 11.5	-	
		0021	MW133	MC_MW04	-	-	34.361	4 - 10	-	

Note: Eastings, Northings, Historical Name, TOC elevation and Screen Interval sourced from Defence Esdat database. Some coordinates are not displayed for privacy reasons.
The rationale for each sampling location is presented in the OMP (Defence, 2020a).

4.3.2 Tank Sampling Locations

The tank and open pit locations to be monitored during the biannual events are provided in **Table 5** below and are presented on **Figure 2** in **Appendix A**.

Table 5 Tank Sample Locations

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Total
On-Site	AEC A	0021	OTH001	A_S415_SW05	290708.000	6107725.000	6
		0021	OTH002	A_S416_SW02	290823.000	6107565.000	
		0021	OTH003	A_S426_SW01	290724.000	6107686.000	
		0021	OTH004	A_S439_SW03	290774.000	6107614.000	
		0021	OTH005	A_S440_SW01	290769.000	6107616.000	
		0021	OTH006	A_S481_SW04	290790.000	6107660.000	

Note: Eastings, Northings and Historical Name sourced from Defence Esdat database.
The rationale for each sampling location is presented in the OMP (Defence, 2020a).

4.3.3 Surface Water Sampling Locations

The surface water locations to be monitored during the biannual events are provided in **Table 6** below and are presented on **Figure F3** in **Appendix A**.

Table 6 Surface Water Sampling Locations

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Total
On-Site	AEC E	0020	SW016	E_IRRIGATION_03	290414.000	6110321.000	2
		0020	SW018	E_SW01	290309.200	6110291.000	
	AEC F	0020	SW023	F_SW02	290912.600	6110335.600	2
		0020	SW022	F_SW01	290905.500	6110282.500	
	AEC G	0020	SW035	G_SW01	291280.800	6110304.000	3
		0020	SW036	G_SW02	291295.100	6110318.000	
		0020	SW037	G_SW03	291297.200	6110363.000	
	Captains Lagoon	0020	SW004	CL_SW01	291407.300	6110460.000	2
		0020	SW005	CL_SW02	291429.000	6110333.000	
	Flat Rock Creek	0020	SW026	FC_SW01	290792.100	6110775.000	4
		0020	SW027	FC_SW02	290711.900	6110653.000	
		0020	SW029	FC_SW04	290438.300	6110792.000	
		0020	SW030	FC_SW05	289697.800	6109773.900	
Off-Site	Captains Lagoon	0020	SW010	CL_SW07	291680.100	6109788.000	3
		0020	SW011	CL_SW08	291346.100	6109113.000	
		0020	SW012	CL_SW12	291433.700	6110572.400	
	Flat Rock Creek	0020	SW032	FC_SW13	290069.700	6109596.400	2
		0020	SW033	FC_SW14	290794.300	6110816.400	
On-Site	AEC A	0021	SW110	-	290742.283	6107645.754	7

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Total
On-Site	AEC A	0021	SW111	-	290777.142	6107650.561	
		0021	SW112	-	290766.145	6107645.481	
		0021	SW130	-	290675.000	6107623.000	
		0021	SW001	AB_SW01	290683.900	6107696.000	
		0021	SW002	AB_SW02	290621.500	6107560.000	
		0021	SW003	AB_SW03	290662.000	6107484.000	
	AEC B	0021	SW004	AB_SW04	290426.100	6107307.000	5
		0021	SW010	B_SW01	290130.000	6107234.000	
		0021	SW011	B_SW02	290331.600	6107210.000	
		0021	SW127	-	290148.000	6107464.000	
		0021	SW153	-	290246.730	6107540.370	
	AEC C	0021	SW027	FC_SW11	290576.600	6108833.000	1
	Captains Lagoon	0021	SW013	CL_SW09	290873.100	6108648.000	1
	Flat Rock Creek	0021	SW022	FC_SW06	289828.800	6108978.000	3
		0021	SW024	FC_SW08	289800.400	6108710.000	
		0021	SW025	FC_SW09	289582.000	6108602.000	
	Site drainage channels	0021	SW005	AB_SW05	290528.500	6107340.000	9
		0021	SW006	AB_SW06	290499.400	6107309.500	
		0021	SW016	DC_SW01	290494.600	6107370.000	
		0021	SW017	DC_SW02	290419.800	6107633.000	
		0021	SW018	DC_SW03	290362.100	6107842.000	
		0021	SW019	DC_SW04	290590.200	6107975.000	
		0021	SW020	DC_SW05	290288.500	6108275.000	
		0021	SW021	DC_SW06	290578.200	6108252.000	
		0021	SW126	-	290624.000	6107914.000	
Off-Site	Lake McKenzie	0021	SW032	LM_SW01	287669.800	6108447.000	3
		0021	SW034	LM_SW03	288081.200	6108114.000	
		0021	SW035	LM_SW04	288754.700	6108073.000	
	Lake Windermere	0021	SW036*	LW_SW01	288367.610	6109121.670	4
		0021	SW037*	LW_SW02	287861.990	6108927.060	
		0021	SW038*	LW_SW03	288212.200	6109607.000	
		0021	SW040	LW_SW05	288389.420	6109072.680	
	Mary Creek	0021	SW043	MC_SW01	-	-	7
		0021	SW044	MC_SW02	-	-	
		0021	SW045	MC_SW03	-	-	
		0021	SW048	MC_SW06	-	-	

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Total
Off-Site	Mary Creek	0021	SW051	MC_SW09	-	-	
		0021	SW052	MC_SW10	-	-	
		0021	SW053	MC_SW11	-	-	
	Ryan's Swamp	0021	SW083	UN3_SW03	287373.300	6106644.000	1
	Summercloud Creek	0021	SW056	SC_SW01	-	-	5
		0021	SW057	SC_SW02	-	-	
		0021	SW058	SC_SW03	-	-	
		0021	SW059	SC_SW04	291176.200	6107041.800	
		0021	SW085	UN3_SW05	-	-	
	Telegraph Creek	0021	SW060	TC_SW01	292494.900	6109329.200	5
		0021	SW062	TC_SW03	292511.800	6108952.200	
		0021	SW064	TC_SW05	291785.600	6109094.400	
		0021	SW068	TC_SW09	292568.500	6109413.100	
		0021	SW069	TC_SW10	292759.100	6109490.800	
	Unnamed Water Body (Clay Pools)	0021	SW076	UN2_SW01	-	-	5
		0021	SW077	UN2_SW02	-	-	
		0021	SW078	UN2_SW03	-	-	
		0021	SW079	UN2_SW04	-	-	
		0021	SW080	UN2_SW05	-	-	

Notes: Eastings, Northings and Historical Name sourced from Defence Esdat database. Some coordinates are not displayed for privacy reasons.

The rationale for each sampling location is presented in the OMP (Defence, 2020a).

***** SW036, SW037, SW038 in Site ID 0021 to be analysed for Super Trace PFAS suite.

4.3.4 Sediment Sampling Locations

The sediment locations to be monitored during the biannual events are provided in **Table 7** below and are presented on **Figure F3** in **Appendix A**.

Table 7 Sediment Sampling Locations

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Total
On-Site	AEC E	0020	SD028	E_SD01	290309.200	6110291.000	1
	AEC F	0020	SD033	F_SD02	290912.600	6110335.600	2
		0020	SD032	F_SD01	290905.500	6110282.500	
	Captains Lagoon	0020	SD018	CL_SD01	291407.300	6110460.000	2
		0020	SD019	CL_SD02	291429.000	6110333.000	
	Flat Rock Creek	0020	SD001	FC_SD01	290792.100	6110775.000	3
		0020	SD002	FC_SD02	290711.900	6110653.000	
		0020	SD004	FC_SD04	290438.300	6110792.000	

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Total
Off-Site	Captains Lagoon	0020	SD024	CL_SD07	291680.100	6109788.000	3
		0020	SD025	CL_SD08	291346.100	6109113.000	
		0020	SD026	CL_SD12	291433.700	6110572.400	
	Flat Rock Creek	0020	SD006	FC_SD13	290069.700	6109596.400	2
		0020	SD007	FC_SD14	290794.300	6110816.400	
On-Site	AEC A	0021	SD001	AB_SD01	290683.900	6107696.000	3
		0021	SD002	AB_SD02	290621.500	6107560.000	
		0021	SD003	AB_SD03	290662.000	6107484.000	
	AEC B	0021	SD004	AB_SD04	290426.100	6107307.000	3
		0021	SD006	B_SD01	290130.000	6107234.000	
		0021	SD007	B_SD02	290331.600	6107210.000	
	AEC C	0021	SD023	FC_SD11	290576.600	6108833.000	1
	Captains Lagoon	0021	SD009	CL_SD09	290873.100	6108648.000	1
	Flat Rock Creek	0021	SD018	FC_SD06	289828.800	6108978.000	3
		0021	SD020	FC_SD08	289800.400	6108710.000	
		0021	SD021	FC_SD09	289582.000	6108602.000	
	Site drainage channels	0021	SD005	AB_SD06	290499.400	6107309.500	8
		0021	SD012	DC_SD01	290494.600	6107370.000	
		0021	SD110		290528.500	6107340.000	
		0021	SD013	DC_SD02	290419.800	6107633.000	
		0021	SD014	DC_SD03	290362.100	6107842.000	
		0021	SD015	DC_SD04	290590.200	6107975.000	
		0021	SD016	DC_SD05	290288.500	6108275.000	
		0021	SD017	DC_SD06	290578.200	6108252.000	
Off-Site	Lake McKenzie	0021	SD028	LM_SD03	288081.200	6108114.000	3
		0021	SD029	LM_SD04	288754.700	6108073.000	
		0021	SD080	LM_SD01	287669.800	6108447.000	
	Lake Windermere	0021	SD030	LW_SD01	288367.61	6109121.67	4
		0021	SD031	LW_SD02	287861.99	6108927.06	
		0021	SD032	LW_SD03	288212.200	6109607.000	
		0021	SD093	LW_SD05	288389.42	6109072.68	
	Mary Creek	0021	SD035	MC_SD01	-	-	7
		0021	SD036	MC_SD02	-	-	
		0021	SD037	MC_SD03	-	-	
		0021	SD040	MC_SD06	-	-	
		0021	SD043	MC_SD09	-	-	

On/Off-Site	Area	Site ID	Location ID	Historical Name	Easting	Northing	Total
Off-Site	Mary Creek	0021	SD044	MC_SD10	-	-	
		0021	SD111		-	-	
	Ryan's Swamp	0021	SD073	UN3_SD03	287373.300	6106644.000	1
	Summercloud Creek	0021	SD046	SC_SD01	-	-	5
		0021	SD047	SC_SD02	-	-	
		0021	SD048	SC_SD03	-	-	
		0021	SD049	SC_SD04	291176.200	6107041.800	
		0021	SD075	UN3_SD05	-	-	
	Telegraph Creek	0021	SD050	TC_SD01	292494.900	6109329.200	5
		0021	SD052	TC_SD03	292511.800	6108952.200	
		0021	SD054	TC_SD05	291785.600	6109094.400	
		0021	SD058	TC_SD09	292568.500	6109413.100	
		0021	SD059	TC_SD10	292759.100	6109490.800	
	Unnamed Water Body (Clay Pools)	0021	SD066	UN2_SD01	-	-	5
		0021	SD067	UN2_SD02	-	-	
		0021	SD068	UN2_SD03	-	-	
		0021	SD069	UN2_SD04	-	-	
		0021	SD070	UN2_SD05	-	-	

Note: Eastings, Northings and Historical Name sourced from Defence Esdat database. Some coordinates are not displayed for privacy reasons.
The rationale for each sampling location is presented in the OMP (Defence, 2020a).

4.4 Sample Collection and Handling

4.4.1 Sampling Methodology

The sampling methodology is presented in **Table 8**.

Table 8 Sampling Methodology

Item	Details
Groundwater gauging	The depth to groundwater will be measured in each monitoring well prior to collection of groundwater samples in accordance with Australian guidance and industry standards.

Item	Details
Groundwater Sample Collection Methodology	Groundwater samples will be collected from monitoring wells using no-purge methodology with HydraSleeves™ which will be installed within the screened interval of the wells a minimum of 4 to 24 hours prior to sampling for the initial sampling round or when necessary to re-deploy. Care should be taken to avoid placing the base of the HydraSleeves™ at the base of the monitoring well, where a build-up of sediment may be present. The installation depth of the HydraSleeves™ is to be recorded (generally as HydraSleeve™ collar depth in mbTOC). HydraSleeves™ are to be installed / deployed in monitoring wells for a minimum of 4 hours prior to sampling, when deployed with bottom weights only, and for a minimum of 24 hours prior to sampling, when deployed with both top and bottom weights, to allow re-stabilisation of the well following disturbance, and if applicable, for the top weight to compress. In the event that a HydraSleeve™ fails to deploy or has been removed inadvertently (i.e. by non-OMP project), the sample will be collected using a dedicated disposable high-density polyethylene (HDPE) bailer, if time or access constraints do not permit re-deployment of the HydraSleeve™ and subsequent sampling in the same sampling event. When sampling with a bailer, a minimum of three well volumes should be purged, and purging should be continued until stabilisation of water quality parameters (to be collected continuously ex-situ) is achieved. If recharge is insufficient during purging, care should be taken to avoid purging the well dry and collecting the sample when reasonable to do so. Once sampling is completed, a new HydraSleeve™ will be deployed at the screened interval depth at each location in preparation for the next scheduled sampling round, where practicable. Hydrasleeve™ sampling will be completed in accordance with the manufacturer's guidance.
Tank water Sample Collection Methodology	Tank and open pit water grab samples will be collected using the sampling methodology provided below for each location: • **OTH001** (Training Water Holding Tank [S415]): Use a bailer to collect water from the opening at the top of the tank, accessed via a ladder • **OTH002** (Fire Main Water Tank [S416]): Use a bailer to collect water from the opening at the top of the tank, accessed via a ladder • **OTH003** (Surface water Oil Separator Reclaim Pit [S426]): Use peristaltic pump to collect water from the open pit • **OTH004** (DCTU Holding Tank [S439]): Collect water from tap connected to tank • **OTH005** (S440 Pit Tank): Use peristaltic pump to collect water from the underground tank • **OTH006** (DLSTRU [S481]): Collect water from open sump tank below unit, directly into sampling containers, or with aid of sampling pole.

Item	Details
Surface water Sample Collection Methodology	Surface water samples will be collected in accordance with the ASC NEPM (NEPC, 2013) and PFAS NEMP (HEPA, 2020). Samples will be collected from either mid-way through the water column or approximately 0.5 m below the surface (if possible) using a 'grab' sample method, without disturbing the bottom of the surface water body and without capturing any surface film, to minimise collection of sediment, or floating materials in the samples. At each location, a new, laboratory supplied container should be lowered into the water with the cap immediately applied once the container is full. Where sampling points cannot be accessed safely, surface water samples will be collected with use of a sampling pole. Description of each sampling location will be recorded (including physical setting, flow observations, presence of sheen or foam etc).
Sediment Sample Collection Methodology	Sediment samples will be collected in accordance with the ASC NEPM (NEPC, 2013) and PFAS NEMP (HEPA, 2020). Sediment samples are to be collected from a depth representative of potentially deposited sediments and collected from within the water body, if possible. Where embankment stability and surface water depth permits, sediment samples will be collected using a hand trowel to a maximum depth of 0.3 m below the sediment surface. Where access to sediment is restricted by bank instability or the presence of surface water, samples will be collected using a hand auger or Dormer Piston Sediment Sampler. A new laboratory supplied container will be used at each location for collection of samples, and any reusable sampling equipment utilised will be de-contaminated between locations. Description of each sampling location and the sample material will be recorded.
QA/QC Samples to be Collected	Field QA/QC samples are to include intra-laboratory duplicate and inter-laboratory duplicate samples (i.e. blind and split duplicates), as well as rinsate blank and field blank samples, as specified in **Section 4.12**. AECOM will collect extra sample volume to enable the laboratory to complete their internal QA/QC analysis. AECOM personnel will attempt to reduce potential heterogeneity in the sample media matrix by dividing the sample collected between primary and intra-laboratory jars or bottles during sampling.

Item	Details
Field Parameters	Temperature, electrical conductivity (EC), dissolved oxygen (DO), ORP (oxidation-reduction potential), pH and observations of water quality will be recorded for all groundwater, surface water and tank water samples, including: • physical indicators such as the presence (and approximate proportion) of suspended solids, colour • the presence/absence and nature of odours and the presence/absence of slicks or sheens on water. Water quality parameters for groundwater samples will be collected ex-situ, from excess water available in the Hydrasleeve™ or bailer, following sampling (where purging is required, additional parameters will be collected prior to sampling as well). Water quality parameters for surface water and tank water samples will be collected in-situ, by placing the water quality meter probe directly in the waterbody being sampled, unless sampling is completed with other equipment (bailer, peristaltic pump or sampling pole), in which case the parameters will be taken ex-situ.
Sample Analysis	All primary samples will be submitted for PFAS extended suite using the standard levels of detection, except for a subset of samples that will be analysed for PFAS extended suite using the super trace levels of detection (for the following JBRF locations: MW129, MW130, MW135, MW136, MW137, MW138, MW139, MW140, SW036, SW037 and SW038), as specified in **Section 4.7.2**.

4.4.2 Decontamination of sampling equipment

To avoid cross-contamination between samples and sample locations, all reusable sampling equipment, such as interface probe and trowel, will be de-contaminated between locations. The proposed method of decontamination is summarised below:

- Preliminary wash and scrub with tap water, after each sampling location
- Wash using Liquinox®
- Rinsed with tap water
- Rinsed with deionised water (supplied by the laboratory).

Clean, disposable nitrile gloves will be worn and replaced between each sample.

4.4.3 Sample Handling and Transport to Laboratory

All samples will be placed on ice in eskies immediately after sampling.

All samples will be kept, if possible, at approximately 4°C during transit to the laboratory.

Samples will be transported directly to the laboratory for analytical testing under standard chain of custody (CoC) procedures. Primary and associated duplicate QA/QC samples will be analysed by Australian Laboratory Services (ALS). The inter-laboratory duplicate samples will be analysed by Envirolab Services (Envirolab).

4.5 Calibration

The calibration of the water quality meter will be tested each day via a “bump test” prior to the commencement of field activities with relevant solutions, including pH, EC and ORP. The calibration will be in accordance with manufacturers’ instructions or NATA publication “General Requirements for Registration: Supplementary Requirement: Chemical Testing (NATA 1993) and Technical Note No. 19 (NATA 1994)”. Where satisfactory calibration cannot be achieved, the water quality data will not be used for interpretive purposes.

Calibration details will be recorded on field sheets and included in the reports for each sampling round.

4.6 Logistics

The laboratory sample containers will be shipped from the laboratory to the AECOM office in Sydney prior to the commencement of fieldwork.

All primary samples will be transported to the laboratory by field staff or by an ALS supplied courier, at the completion of fieldwork. All inter-laboratory duplicate samples will be couriered directly to the secondary laboratory under a separate COC for analysis.

4.7 Analytical Suite and Laboratory Analysis Methods

4.7.1 Laboratory NATA Accreditation Details

The laboratory is required to use NATA accredited methods based on NEPM, US EPA, Table B 15 of the US Department of Defence/Department of Energy (US DOD/DoE) and American Society for Testing and Materials (ASTM) methods as appropriate.

The primary and secondary laboratories selected for this program are ALS (NATA Accreditation Number 825) and Envirolab (NATA Accreditation Number 2901), respectively.

4.7.2 Analytical Schedule

All media sampled will be analysed for the extended PFAS suite in accordance with the Defence (2022) *Standard PFAS Analytical Suite - Guidance Document E* (**Appendix B**). A subset of the locations (MW129, MW130, MW135, MW136, MW137, MW138, MW139, MW140, SW036, SW037 and SW038) will be sampled and analysed for the super trace extended PFAS suite, for consistency with the analytical program adopted in the DSI (GHD, 2019a).

The current laboratory limits of reporting (LOR) for the primary laboratory are described in **Table 9** below.

Table 9 Laboratory Limits of Reporting

Sample Media	Parameter	Technique/Method Reference	LOR
Water	Extended PFAS Suite (Standard)	LCMS	0.01 – 0.1 µg/L
Water	Extended PFAS Suite (Super Trace)	LCMS	0.0003 – 0.002 µg/L
Sediment	Extended PFAS Suite (Standard)	LCMS	0.0002 – 0.001 mg/kg

LCMS = Liquid chromatography mass spectrometry

4.7.3 Validation of Analytical Results

Validation of analytical results may be required in the form of re-analysis by the reporting laboratory or through re-sampling and analysis, to confirm original results. The potential requirement for validation of sample results will be determined in consultation with Defence and will generally apply to results that are first-time detections of PFAS in water matrices, new exceedances of human health guidelines or consecutive increases of PFAS concentrations in sediments.

4.8 Sample Nomenclature

In order to meet Defence data management requirements, a consistent sample nomenclature has been adopted for the Program. All primary samples will be labelled using the following naming convention:

PPPP_XX000_ZZZ_YYMMDD

[property ID]_[type of sample][THREE DIGIT sample number]_[top of sample depth]_[yearmonthday]

e.g. 0020_MW001_191015

Location types and codes are prescribed by the Defence Contamination Management Manual, Annex L Data Management (August 2019) and the Site's investigation history.

Location types relevant to this SAQP include:

- MW = monitoring well
- OTH = other (tanks/pits)
- SW = surface water
- SD = sediment

QA/QC samples will be labelled in accordance with the following convention:

- Blind duplicate (intra-laboratory duplicate): PPPP_QC1XX_YYMMDD
- Split duplicate (inter-laboratory duplicate): PPPP_QC2XX_YYMMDD
- Rinsate blank: PPPP_QC3XX_YYMMDD
- Field blank: PPPP_QC4XX_YYMMDD

4.9 Defence Esdat Requirements

Defence has contracted Earth Science Information Systems (EScIS), to provide contamination data management services through a cloud instance of its Esdat product.

All field and laboratory data collected by AECOM will be uploaded, stored and managed in Defence's Environmental Data Management System (EDMS (ESdat)) in accordance with Section 6 of Annex L to the Defence Contamination Management Manual. AECOM will refer to historical investigation data to ensure consistent location codes are used to enable analysis of data trends. Where required under Annex L, non-compliant location codes will be resolved under direction from Defence.

AECOM will ensure that electronic data deliverables (EDDs) from the laboratory include required information for automatic upload into the EDMS, such as including the correct Project ID in Esdat files and including the Defence ESdat auto-upload email address (DERP.LabReports@esdat.com.au) in the laboratory report recipient list.

AECOM will ensure that field data is uploaded, and laboratory data is uploaded and approved into the EDMS and that QA/QC data is correctly reconciled for each monitoring event.

4.10 Assessment Criteria

Adopted screening criteria references national guidance in the form of the PFAS National Environmental Management Plan, Defence estate and environmental strategies, and Defence PFAS-specific strategies and guidance.

At the time of preparing this SAQP, a number of relevant guidance documents were in circulation in Australia including:

- PFAS National Environmental Management Plan (NEMP) Version 2.0, Heads of EPA (HEPA) Australia and New Zealand. January 2020 (HEPA, 2020)
- Department of Health (DoH), 2017. Health Based Guidance Values for PFAS for use in site investigations in Australia. April 2017 (FSANZ, 2017)
- National Health and Medical Research Council (NHMRC), 2019. Guidance on 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, 2013)

The screening criteria adopted to assess the data generated as part of this SAQP are presented in **Table 10** and **Table 11** below, for human and ecological receptors, respectively. Note that the HEPA NEMP 2.0 (2020) does not provide screening criteria for PFAS in sediments.

Table 10 PFAS Adopted Screening Criteria – Human Receptors

Media	Pathway	Compound	Criteria	Comment/Reference
Water – Groundwater and Surface Water	Drinking water	PFOS + PFHxS	0.07 µg/L	The values presented in the PFAS NEMP (HEPA, 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 the National Health and Medical Research Council's (NHMRC) Australian Drinking Water Guidelines (ADWG, 2022) to determine drinking water values. Results from non-saline groundwater and surface water locations will be compared to these criteria.
		PFOA	0.56 µg/L	
Water – Surface water	Recreational use	PFOS + PFHxS	2 µg/L	In August 2019, NHMRC released guidance on the assessment of PFAS in surface water. Rather than adopting an ingestion rate of 0.2 L of water per day (as per the ADWG formula), NHMRC adjusted this rate with consideration of an event frequency (150 events/year) to calculate an annual ingestion rate of 30 L per year. These values were adopted by the HEPA NEMP 2.0 (2020). All surface water results will be compared to these criteria.
		PFOA	10 µg/L	

Table 11 PFAS Adopted Screening Criteria – Ecological Receptors

Media	Pathway	Compound	Criteria	Comment/Reference
Water – Groundwater and Surface Water	Freshwater and Marine	PFOS	0.00023 µg/L	The values are from the PFAS NEMP, 2020 which endorsed the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The 99% species protection level (for freshwater and interim marine) has been applied for high value conservation systems. This approach is generally adopted for chemicals that bioaccumulate and biomagnify in wildlife. It is proposed that the laboratory LOR is adopted for the purposes of preliminary screening of analytical water results, rather than sole use of the criteria value. All groundwater and surface water results will be compared to these criteria.
		PFOA	19 µg/L	
Water – Groundwater and Surface Water in AEC A	Freshwater	PFOS	31 µg/L	The values are from the PFAS NEMP, 2020 which endorsed the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The 80% species protection level (for freshwater) has been applied for highly disturbed systems. All groundwater and surface water results within the AEC A boundary in JBRT will be compared to these criteria.
		PFOA	1824 µg/L	

4.11 Waste Management

Due to the proposed “no purge” sampling methodology adopted for the majority of the groundwater monitoring locations and the grab samples from the designated surface water and Tank sampling locations, it is not anticipated that significant volumes of liquid waste would be generated that would require on-Site management and disposal. If additional liquid waste is generated it will be disposed of at a facility indicated by Defence.

All consumables (i.e. HydraSleeves™, filter cartridges, low flow tubing, general rubbish) will be bagged and placed in on-Site general waste bins for disposal.

4.12 Field Quality Assurance/Quality Control Sampling

4.12.1 Intra-laboratory and Inter-laboratory Duplicate Samples

Intra-laboratory (blind) duplicate samples and inter-laboratory (split) duplicate samples will be collected and analysed at a minimum frequency of 1 in 10 primary samples, in accordance with the quality control and quality assurance requirements outlined in OMP (Defence, 2020a) and HEPA (2020).

4.12.2 Rinsate Samples

Rinsate blank samples will be collected and analysed at a minimum frequency of 1 per day of fieldworks, in accordance with the quality control and quality assurance requirements outlined in OMP (Defence, 2020a) and HEPA (2020).

Rinsate blanks will be collected by pouring laboratory supplied deionised water over decontaminated sampling equipment that will be re-used (e.g. interface probe, trowel).

4.12.3 Field Blank Samples

Field blank samples will be collected at a rate of 1 sample per fieldwork day by pouring laboratory supplied deionised water into sampling containers. The Field Blank samples will be used to estimate the amount of contamination introduced during sampling from sources such as dust and atmospheric fallout. The sampling containers, with cap removed, are to be placed in the work area while collecting samples.

4.13 Fieldwork Documentation

4.13.1 Field Notes

Field notes will be maintained to record all field sampling events and include observations made at each sample location. Field notes will include general site setting, location information, and information specific to the sample media, as follows:

- Weather conditions, and visual or olfactory conditions at the location
- Location coordinates and means of access, and any changes from previous access to a specific location
- Groundwater samples – the observed characteristics of the sample (e.g. colour, turbidity, presence/absence and nature of odours, presence/absence of slicks or sheens) and measured field water quality parameters (pH, EC, DO, ORP, temperature) will be recorded. Condition of monitoring wells and gauging details will also be recorded.
- Surface water samples – the observed characteristics of the sample (e.g. colour, turbidity, presence/absence and nature of odours, presence/absence of slicks or sheens) and field water quality parameters (pH, EC, DO, ORP, temperature) will be recorded. Additionally, a description of each surface water sampling location will be recorded, such as indicating the waterbody type (lake, stream, etc.), presence/absence of water flow, and waterbody width.
- Sediment samples – the observed characteristics of the sample (e.g. colour, soil type, moisture, presence/absence and odours) and the depth will be recorded.
- The quality control (e.g. duplicate and inter-laboratory duplicate) sample details be recorded.

AECOM's tablet-based Environmental Data Collection and Analysis ('EDCA') tool (or equivalent) may be utilised by field staff to capture consistent field data based on project specific requirements, minimise potential data transcription errors, allow on-the-spot identification of potentially erroneous data in comparison to historical data and facilitate efficient data transfer to multiple data systems including Esdat.

4.13.2 Sample Labels

Sample containers will be labelled, as a minimum, with the following information:

- AECOM project number
- Name of sampler
- Sample ID
- Date of sample collection

An indelible felt pen will be used for labelling, to ensure that the lettering is not erased during transit to the laboratory. Sample containers that are sent to the primary laboratory, ALS, will also be scanned into the laboratory's custom-built mobile app (by scanning the barcode applied to each laboratory-supplied container) for streamlined labelling and Chain of Custody (COC) creation and to ensure compliant sample IDs are used in the field.

4.13.3 Chain of Custody Forms

A COC form will be completed, documenting the sample identification number and analytes. The COC documents the chain of events from sample collection to delivery at the laboratory and provides a

traceable account of sample handling. The form will be signed by both the sample collector and the receiving laboratory, and will include the following information:

- Job number
- Date and time of sample collection
- Sample ids
- Type of containers
- Name of sampler
- Laboratory to be used
- Analyses required
- Any comments
- Signatures of the sampler and laboratory receiver.

In the event that additional samples are collected during the field investigations due to observations made by the field team, (i.e. samples not proposed in this SAQP), Defence will be provided the rationale for collection of those samples and proposed laboratory analyses. Defence approval will be sought to include these samples on the COC and to dispatch these samples to the laboratory.

Upon receipt of the original documents accompanying the samples at the laboratory, the laboratory will provide a sample receipt document (noting the temperature of samples upon receipt, analyses required and any non-conformances) and return the signed COC form and sample receipt notification (SRN) to confirm analyses to be performed and the due date for the analytical results.

4.14 Reporting

4.14.1 Sampling Event Factual Report

AECOM will prepare and submit a Sampling Event Factual Report to Defence following the completion of each sampling event. The Sampling Event Factual Report will include:

- details of the scope completed
- a description of the sampling methodologies used
- identification of any deviations or components of the scope that could not be completed, as well as any additions to the scope.
- a summary of field observations (e.g. any visual or olfactory observations that may indicate impacts to surface water or groundwater) and water quality parameter measurements
- evaluation of the applicability of adopted assessment levels
- a presentation of the analysis results in a table that includes comparisons with PFAS guidelines
- a presentation of groundwater levels for the event on a figure with inferred contours and inferred groundwater flow direction
- review of the suitability of the data for assessment purposes (QA/QC evaluation)
- inclusion of the following information as attachments:
    - Field data including field water quality parameter and gauging measurements
    - Chain of custody forms
    - Laboratory analytical certificates
    - Equipment calibration certificates.

The Sampling Event Factual Report will be provided to Defence no later than four weeks after completion of the field component. AECOM will inform Defence in the case of delays in laboratory results.

4.14.2 Ongoing Monitoring Report

At the end of each 12-month monitoring period, AECOM will prepare and submit an OMR to Defence. These reports will include:

- evidence of compliance with the requirements of the SAQP and meeting stated objectives of the OMP (Defence, 2020a)
- identification of any components of the scope that could not be completed
- a summary of any changes to the monitoring network condition that may affect data integrity, or require rectification works, and recommendations for repair, replacement or decommissioning of a location
- relevant figures depicting sampling locations and site-specific hydrogeological features
- laboratory results and analysis including comparison with the adopted screening criteria
- assessment and commentary on appropriate QA/QC procedures
- data interpretation, including trends in groundwater concentration, gradient and flow directions
- assessment of statistically based trends (as described in Step 3 and 5 of the DQOs) that may inform decision making when it comes to the revision of the OMP (Defence, 2020a) including whether a review of the CSM is required or whether the risk profile has changed overall, or for any specific location at the Site, and a recommendation as to whether this should trigger an OMP and/or PMAP review, or other action.
- inclusion of the following information as attachments:
    - Field data including field water quality parameter and gauging measurements
    - Chain of custody forms
    - Laboratory analytical certificates
    - Equipment calibration certificates.

5.0 Deviations from OMP

While the scope of works and methodology described in this SAQP are generally consistent with that presented in the OMP (Defence, 2020a), a number of points of deviation are noted (refer to **Table 12** below).

Table 12 Deviations from OMP

No.	Description	Rationale
1	Quarterly Sampling Requirement	The OMP (Defence, 2020a) states that quarterly surface water sampling events are required during the initial 12-month implementation period, while also referring to the requirement to complete biannual sampling only. AECOM has sought clarification on the sampling frequency. It was confirmed by Defence via email on 1 June 2021 that only biannual sampling is required as part of the OMP.
2	Sediment Sampling	The OMP (Defence, 2020a) states that ongoing monitoring of sediment is not proposed but lists co-located surface water and sediment locations are part of the sampling program. AECOM has sought clarification on the media to be sampled. It was confirmed by Defence via email on 1 June 2021 that sediment sampling is required (excluding streamflow sediment locations) as part of the OMP.
3	Streamflow Sampling	The OMP (Defence, 2020a) includes streamflow monitoring, as an opportunistic and catchment-based event, occurring in conjunction with six monthly water monitoring events and with at least one wet weather streamflow monitoring event to be undertaken, per catchment, for the first three years of the OMP implementation period. AECOM has sought clarification on the requirement for streamflow monitoring. It was confirmed by Defence via email on 1 June 2021 that streamflow monitoring is no longer required as part of the OMP scope.
4	Wet Weather Sampling	The OMP (Defence, 2020a) recommends that additional surface water sampling events are completed immediately (or as close as possible) following the first heavy rain of autumn period, possibly involving daily monitoring over multiple days at key surface water discharge locations. The OMP also outlines the requirement to complete a streamflow wet weather event. AECOM has sought clarification regarding the requirement for wet weather sampling for surface water and streamflow monitoring. It was confirmed by Defence via email on 1 June 2021 that wet weather sampling events are no longer required as part of the OMP scope.

No.	Description	Rationale
5	Non-PFAS Analysis for Sediment Samples	Section 4.14 of the OMP Request outlines the requirement to analyse a representative sub-set of soil and sediment samples for pH, TOC, CEC and EC. On 27 January 2021, Defence instructed AECOM to discontinue the analysis of samples for non-PFAS analytes unless it was specifically requested in the OMP or approved by Defence. As the OMP (Defence, 2020a) did not specifically request it, the additional non-PFAS analysis for sediment is not required as part of the OMP.
6	Number of Sample Locations	The OMP (Defence, 2020a) contains some discrepancies in the total numbers of locations to be sampled when comparing the locations in Section B.3 Monitoring Locations and locations in Tables D-1, D-2 and D-3 in Appendix D. AECOM has sought clarification regarding this discrepancy. It was confirmed that Tables D-1, D-2 and D-3 in Appendix D contains the correct sampling location plan to be followed for the OMP scope.
7	Groundwater Sampling Methodology	The OMP (Defence, 2020a) specifies that groundwater samples are to be collected using low-flow sampling pumps. AECOM proposes to collect groundwater samples using no-purge methodology with HydraSleeves™. As part of AECOM's tender submission for the Defence OMP Program in March 2019, it was proposed to complete groundwater sampling across all Defence regions utilising no-purge HydraSleeves™. In addition to time and cost saving considerations, the adoption of HydraSleeves™ across the broader program was aimed to improve consistency, quality and comparability of groundwater data across sites and regions. In the event that a HydraSleeve™ fails to deploy or has been removed inadvertently (i.e. by non-OMP project), the sample will be collected using a dedicated disposable bailer.
8	Tank Sampling Methodology	The OMP (Defence, 2020a) did not specify a sampling method for tank sampling. It is noted that grab sampling from tap outlets and low-flow sampling methods will be used for sampling water tank locations (OTH), as outlined in Table 8, and based on methodology instructed by Defence in correspondence dated 1 June 2021, and was revised following the October 2021 sampling event due to safety considerations. The sampling methodology for two tanks (OTH001 and OTH002) has been revised again following the October 2022 sampling event. The tank's outlet taps from which samples were collected previously have been removed, and replaced with a platform ladder with railings, which enables safe access to an opening at the top of the tanks for sampling with use of a bailer.

No.	Description	Rationale
9	Adoption of Revised Recreational Screening Criteria for PFOS+PFHxS and PFOA	The OMP (Defence, 2020a) reported that the human health screening criteria for recreational use of water is 0.07 µg/L for PFOS+PFHxS and 5.6 µg/L for PFOA, consistent with the PFAS NEMP 1.0 (2018) values. However, the National Health and Medical Research Council (NHMRC) has published relevant guidance on PFAS in Recreational Water in 2019, which has revised PFOS+PFHxS and PFOA criteria (for recreational use) to 2 µg/L and 10 µg/L, respectively. The new guidance has been adopted for the SAQP and reflected in **Table 10**.
10	Biannual Sampling Months	The OMP (Defence, 2020a) notes that biannual sampling should ideally occur post-autumn (May/June) and post-spring (November/December). In order to more effectively align the sampling program to the broader NSW OMP program, Defence and AECOM agreed that biannual sampling will be completed in October/November and April/May of each year.
11	QA/QC Sampling Requirements	The OMP (Defence, 2020a) specifies that Trip Blanks are to be collected during the fieldwork program, however as PFAS are not volatile contaminants, AECOM is not proposing to collect these.
12	Monitoring wells MW152 and MW153	Monitoring wells MW152 and MW153 are not identified as part of the OMP scope (Defence, 2020a) however at the request of the Lead Consultant (LC) they have been added as “gauge only” locations.
13	Surface Water locations SW010 and SW011	Surface Water locations SW010 and SW011 are not identified as part of the OMP scope (Defence, 2020a) however at the request of the LC they have been added.
14	Sediment locations SD110 and SD111	Sediment sampling locations SD110 (co-located with SW005) and SD111 (co-located with SW053) are not identified as part of the OMP scope (Defence, 2020a) however at the request of the LC they have been added.
15	Co-located surface water and sediment locations SW070/SD060	During the October 2021 OMP sampling event, the co-located surface water and sediment samples at SD060/SW070 could not be collected due to their position offshore. On 15 March 2022, Defence confirmed that these two locations can be removed from the OMP given that: • the sampling location is not critical in terms of assessment of the nature and extent of the PFAS impacts from the Site. • no precautionary advice is in place for Telegraph Creek.
16	Addition of location 0021_SW153 to the OMP scope	On 7 April 2022, Defence instructed AECOM (via email) to add surface water sample 0021_SW153 to the OMP scope of works at the request of the LC. This location has been added to the biannual surface water sampling scope of works and samples collected will be analysed for PFAS at the standard LOR.

No.	Description	Rationale
17	Addition of location 0021_MW131 to the OMP scope	On 23 January 2023, Defence instructed AECOM (via email) to change the OMP scope for monitoring well 0021_MW131 from being a “gauge only” location to requiring biannual sampling, at the request of the LC.
18	Addition of locations 0021_MW061 and 0021_MW062 to the OMP scope	On 22 November 2023, Defence instructed AECOM to add monitoring wells 0021_MW061 and 0021_MW062 to the OMP scope, requiring biannual sampling, which was a request from the LC.

6.0 References

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Appendix A

Figures

AECOM

N

0 300 600 m

Legend

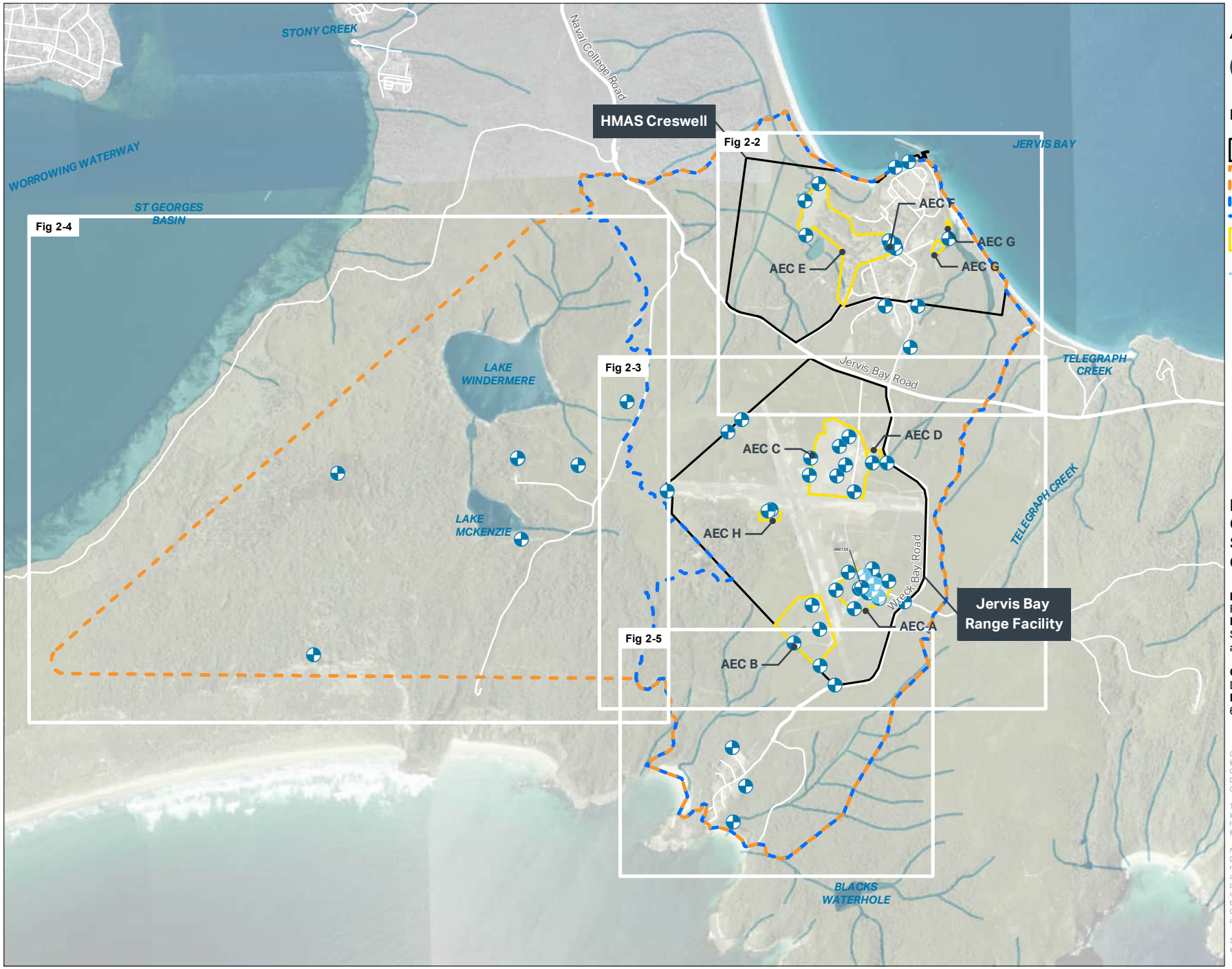
- Defence Site Boundary
- Monitoring
- Management
- Areas of Environmental Concern
- Waterbody/Watercourse

FIGURE F1:
SITE LAYOUT

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

Source:
© Department of Customer Service 2020



AECOM

N

0 440 880 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Monitoring Well Location
- Tank Sample Location

FIGURE F2-1:
GROUNDWATER AND TANK SAMPLE LOCATIONS OVERVIEW

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

Source:
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Legend

- Defence Site Boundary
- Monitoring Area
- Management
- Areas of Environmental Concern
- Waterbody/Watercourse
- Monitoring Well Location

FIGURE F2-2:
GROUNDWATER AND TANK SAMPLE LOCATIONS
HMAS CRESWELL

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

Source:
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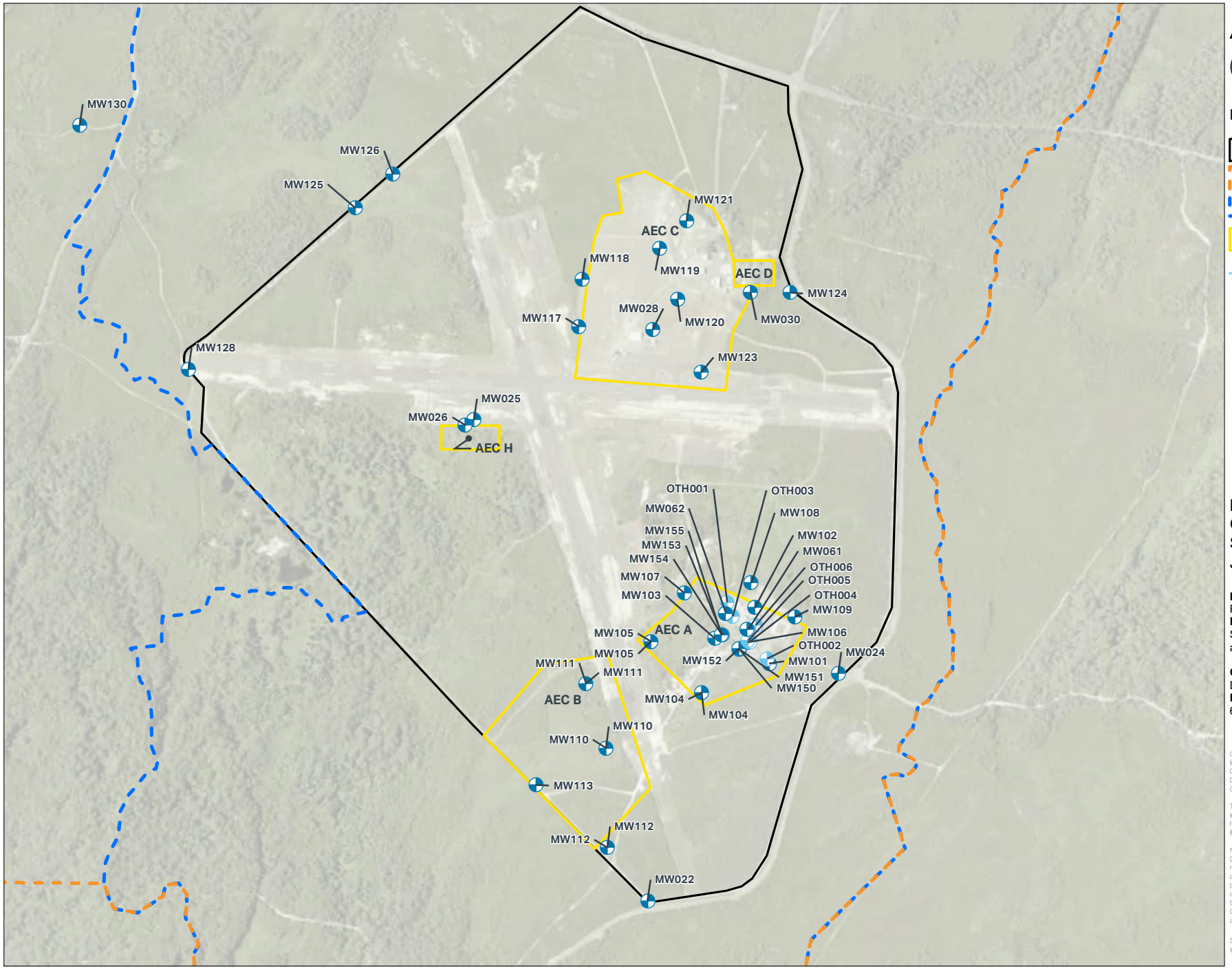

FIGURE F2-3:
GROUNDWATER AND TANK SAMPLE LOCATIONS
JBRF

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

Source:
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AECOM

N

0 230 460 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Monitoring Well Location

FIGURE F2-4:
GROUNDWATER AND TANK SAMPLE LOCATIONS OFFSITE, WEST

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

Source:
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AECOM

N

0 110 220 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Monitoring Well Location

FIGURE F2-5:
GROUNDWATER AND TANK SAMPLE LOCATIONS OFFSITE, SOUTH

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

Source:
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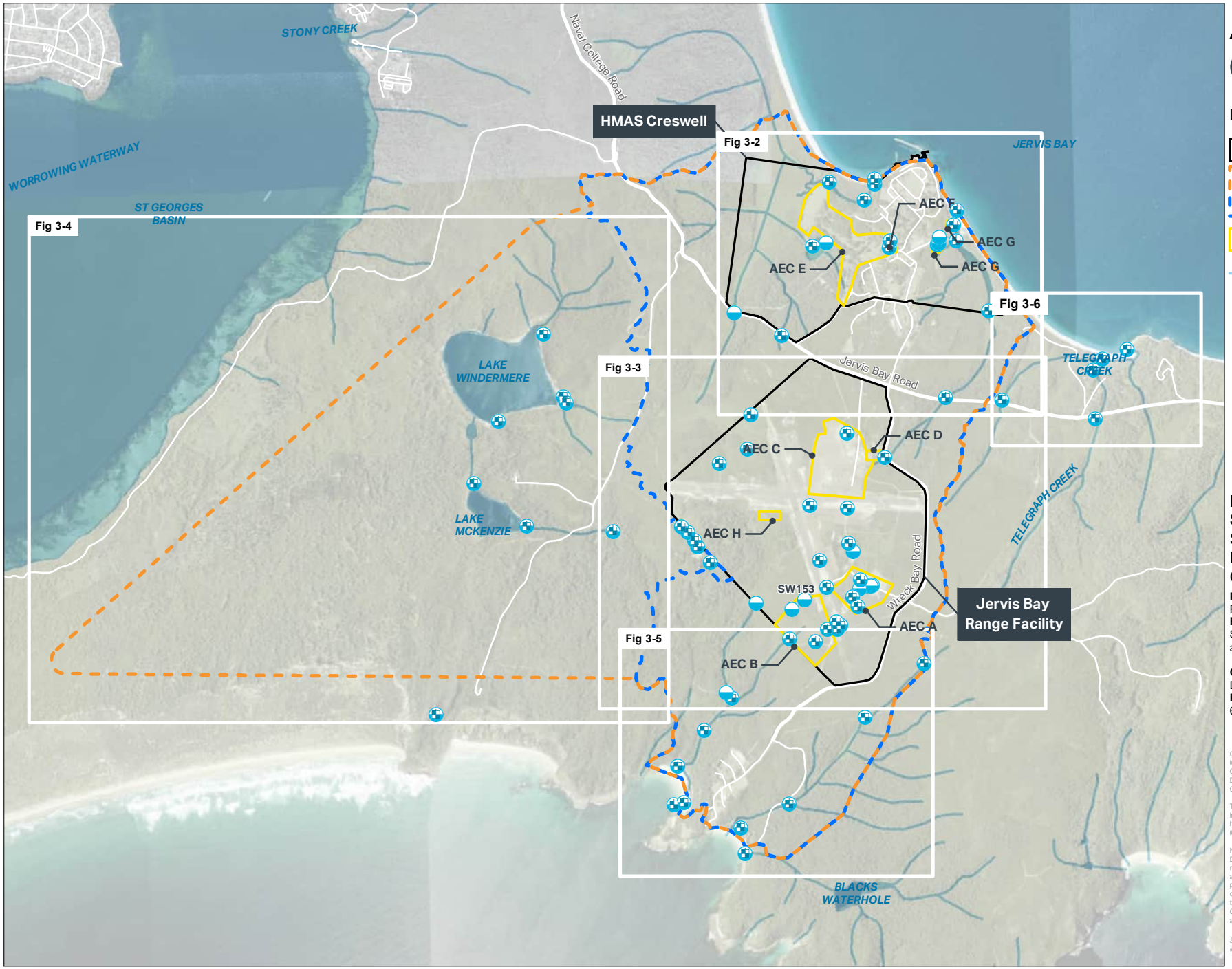

AECOM

N

0 440 880 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Sediment Sample Location
- Surface Water Sample Location

FIGURE F3-1:
SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS OVERVIEW

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

AECOM

N

0 130 260 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Sediment Sample Location
- Surface Water Sample Location

FIGURE F3-2:
SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS
HMAS CRESWELL

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

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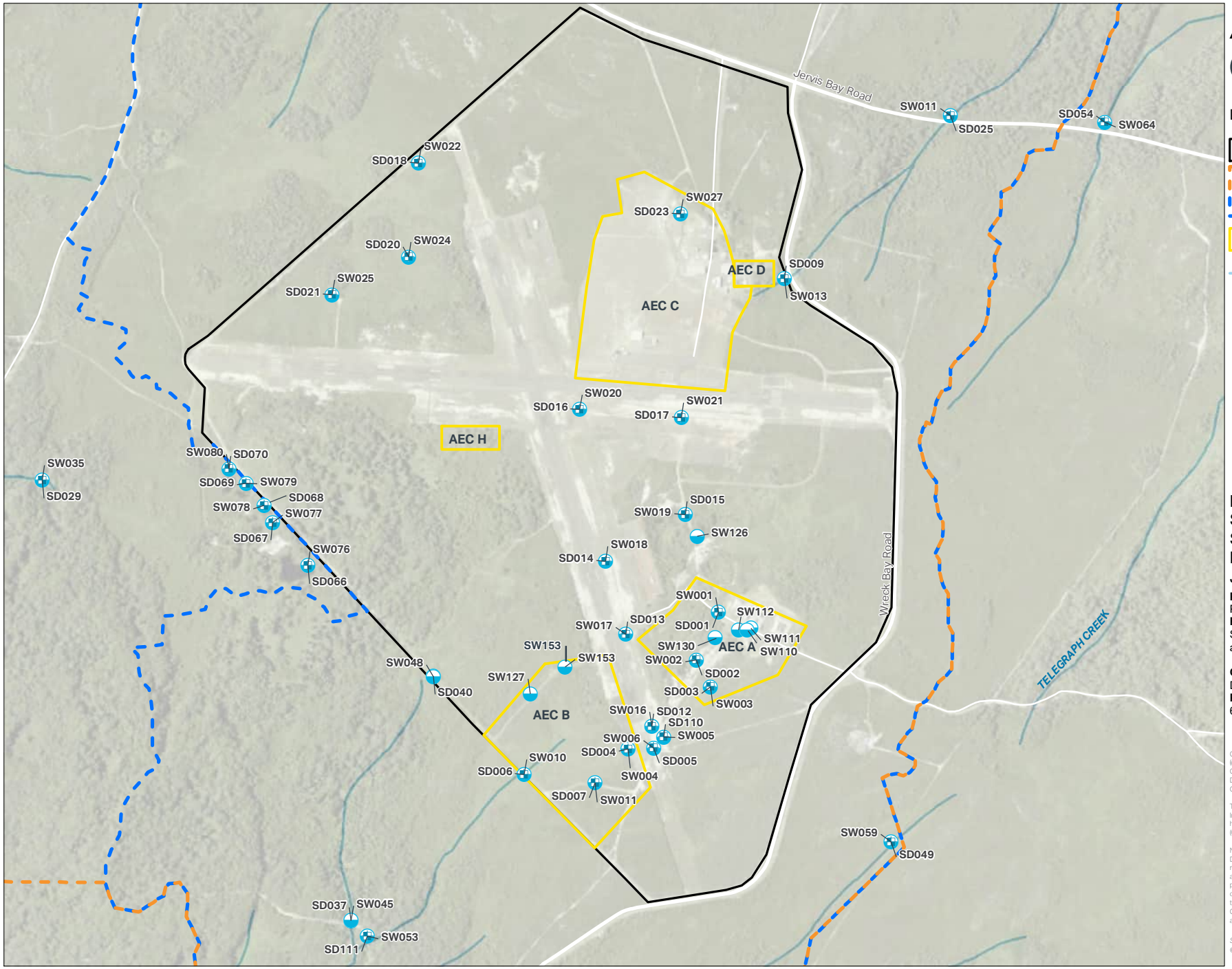

AECOM

N

0 160 320 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Sediment Sample Location
- Surface Water Sample Location

FIGURE F3-3:
SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS
JBRF

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

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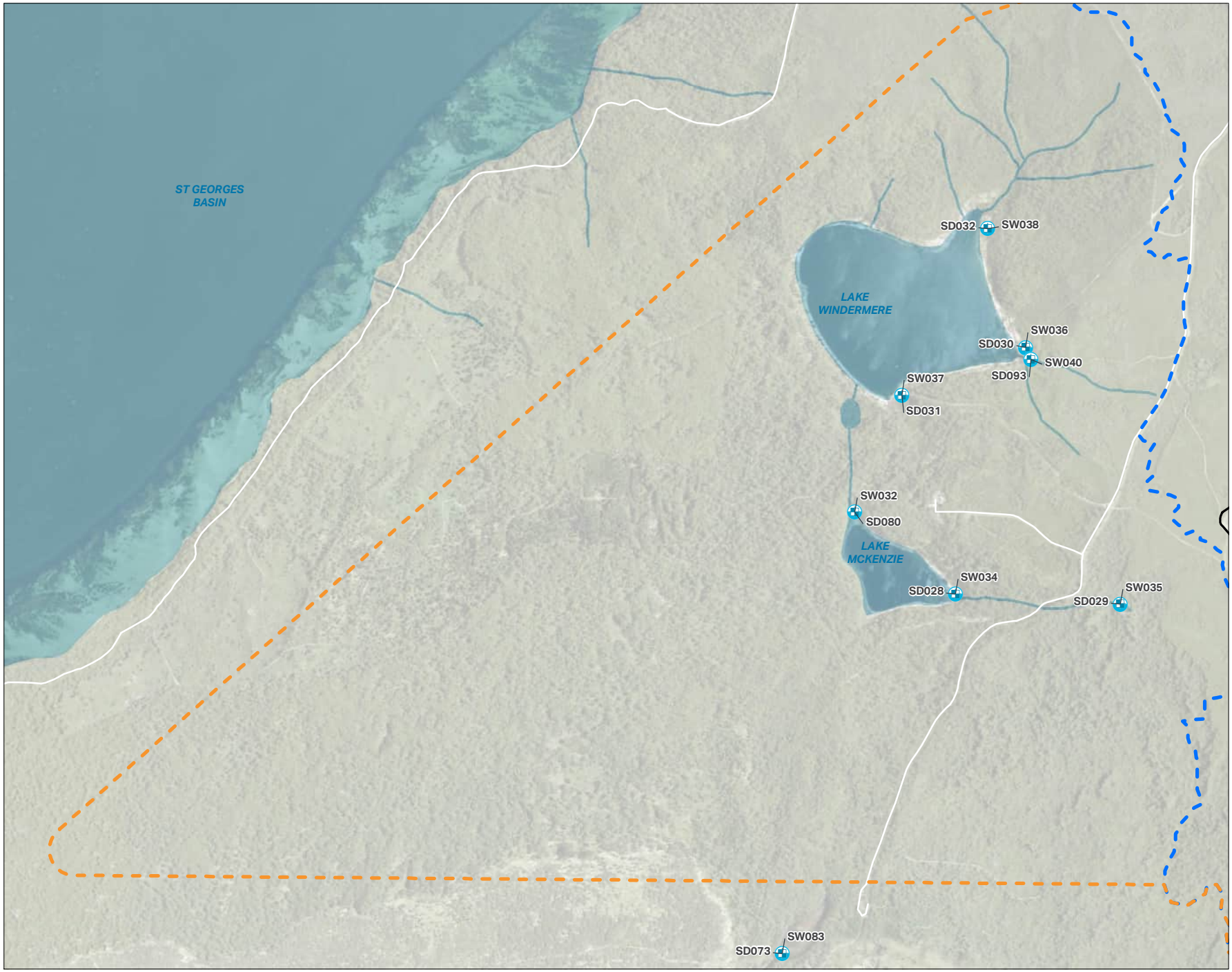

AECOM

N

0 230 460 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Sediment Sample Location
- Surface Water Sample Location

FIGURE F3-4:
SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS OFFSITE, WEST

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
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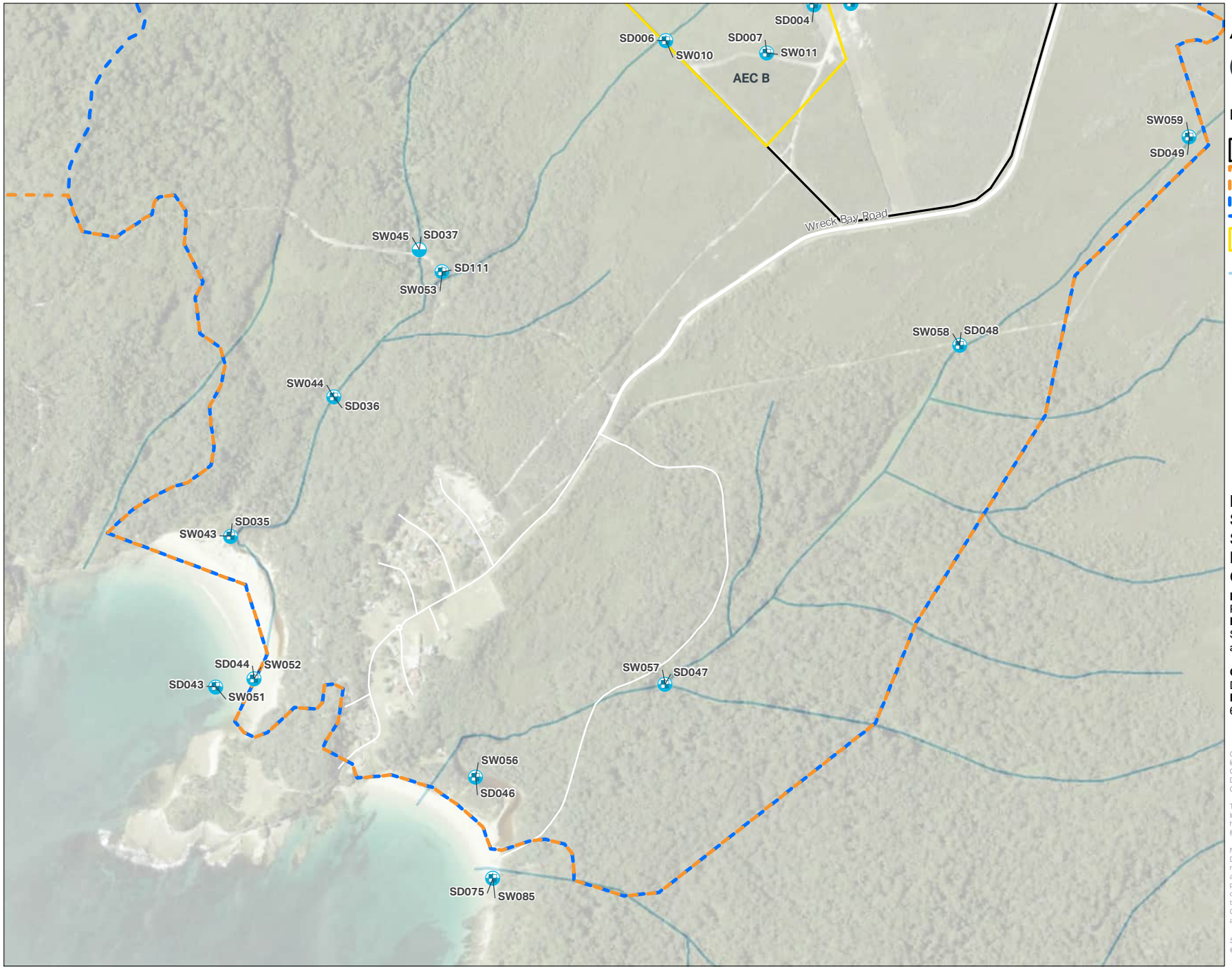

AECOM

N

0 110 220 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Sediment Sample Location
- Surface Water Sample Location

FIGURE F3-5:
SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS OFFSITE, SOUTH

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

Source:
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AECOM

N

0 75 150 m

Legend

- Defence Site Boundary
- Monitoring Area
- Management Area
- Areas of Environmental Concern
- Waterbody/Watercourse
- Sediment Sample Location
- Surface Water Sample Location

FIGURE F3-6:
SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS TELEGRAPH CREEK

PROJECT NAME:
PFAS OMP
REPORT NAME:
SAQP Jervis Bay Range Facility and HMAS Creswell

CLIENT NAME:
Department of Defence
PROJECT NUMBER:
60612562

Source:
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Appendix B

Standard PFAS Analytical Suite Guidance

Australian Government
Defence

Department of Defence

PFAS INVESTIGATION AND MANAGEMENT

GUIDANCE DOCUMENT E
STANDARD PFAS ANALYTICAL SUITE

Document Version History

Document Reference	Revision	Date
AF29889468	1	10 July 2017
AF32594670	2	21 March 2018
AF32594670	3	6 April 2018
BS24034025	4	1 October 2021
BS24034025	5	29 June 2022

Analytical laboratories analyse a range of PFAS which includes a small subset of all possible PFAS. These analytical suites vary between laboratories and over time as new chemical standards become available. The minimum suite required for Defence PFAS investigations and management is listed in Table 1.

Table 1 Minimum PFAS analytical suite for Defence PFAS investigations and management

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

The minimum PFAS analytical suite is based on consideration of analytical capability and the dominant PFAS that are likely to be present in environmental media due to legacy contamination from AFFF used by Defence. In specific instances, for example analysis of AFFF concentrates, it may be necessary to use other methods such as the TOP and/or TOF assays. In these cases, the analytical methods need to be established by data quality objectives (DQOs) for the project.

The laboratory is required to use NATA accredited methods for PFAS quantification based on guidance in the *PFAS National Environmental Management Plan* (NEMP, 2020).

END OF TEXT

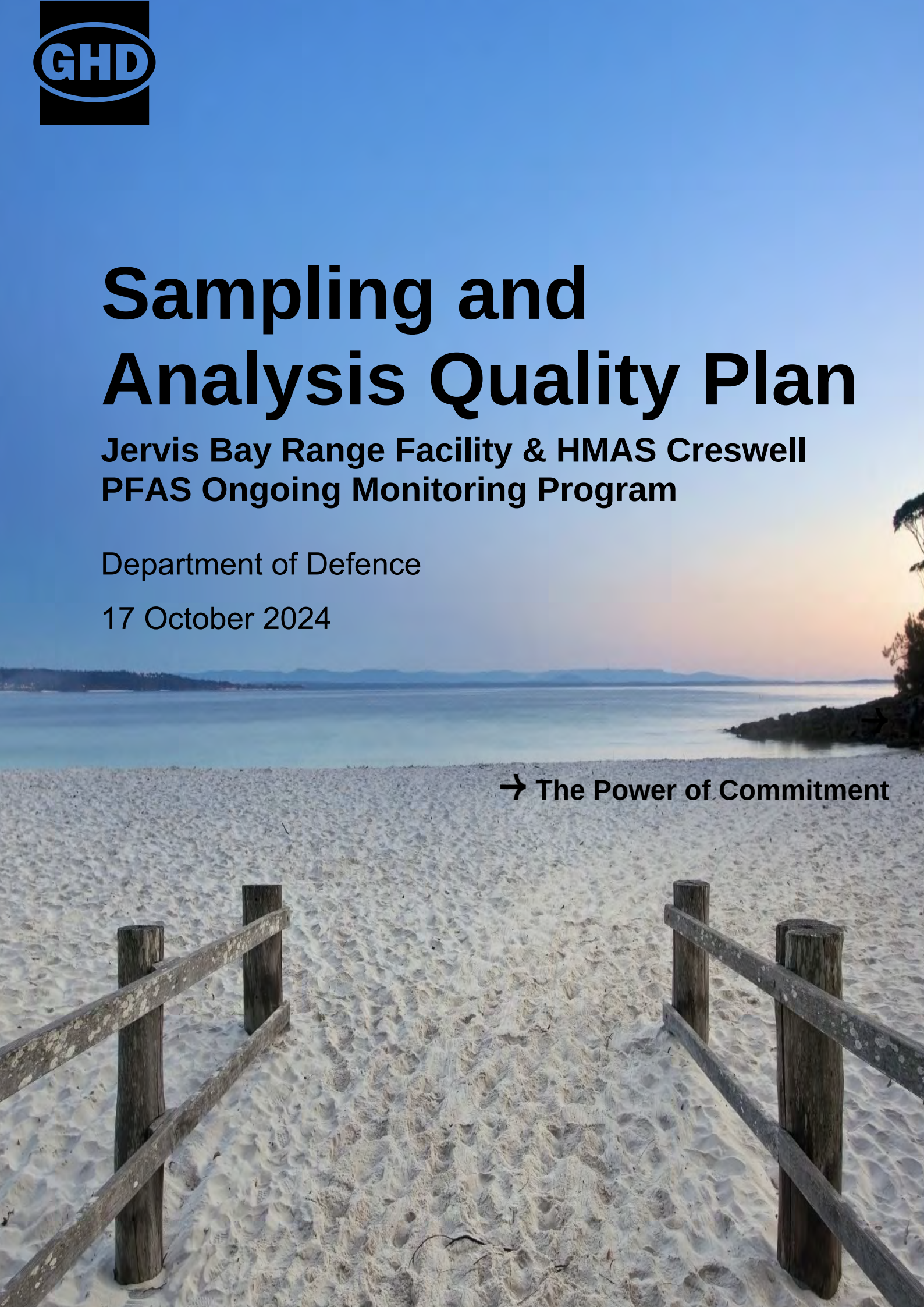
Sampling and Analysis Quality Plan

Jervis Bay Range Facility & HMAS Creswell PFAS Ongoing Monitoring Program

Department of Defence

17 October 2024

→ The Power of Commitment



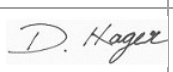
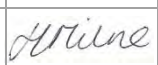
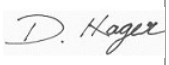
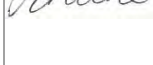
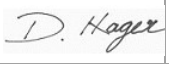
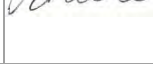
Project name	Shoalhaven PFAS Lead Consultant						
Document title	Sampling and Analysis Quality Plan | Jervis Bay Range Facility & HMAS Creswell PFAS Ongoing Monitoring Program						
Project number	12626622						
File name	12626622_SAQP_JBRF and HMAS Creswell.docx						
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S3	A	A. Terechovs	H. Milne		H. Milne		4/09/2024
S4	B	A. Terechovs	A. Walker D. Hager		H. Milne		4/10/2024
S5	C	H Milne	D. Hager		H Milne		9/10/2024
Final	0	H Milne	D. Hager		H Milne		17/10/2024
[Status code]							

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Figure index (Appendix A)

Appendices

1. Introduction

Department of Defence (Defence) engaged GHD Pty Ltd (GHD) to prepare this Sampling and Analysis Quality Plan (SAQP) to support the per- and poly-fluoroalkyl substance (PFAS) Ongoing Monitoring Plan (OMP) as detailed in the PFAS Management Area Plan (PMAP) (Defence, 2020) at Jervis Bay Range Facility (JBRF) and His Majesty's Australian Ship (HMAS) Creswell (herein collectively referred to as the 'Bases'), as well as the broader Management Area. The Management Area is defined in the PFAS PMAP and refers to onsite areas of HMAS Creswell and JBRF, as well as some of the surrounding areas of Wreck Bay community lands and Booderee National Park. The Management Area has been defined based on surface water catchment areas, as the catchment areas have been demonstrated to be the primary focus areas for PFAS management associated with the Bases, and includes the Mary's Creek catchment, Flat Rock Creek catchment, Captains Lagoon catchment and a portion of the Summercloud Creek catchment. The Bases to be investigated as part of this SAQP are presented on Figure 1, Appendix A.

1.1 Objectives

The purpose of the OMP is to set out requirements for the 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 PMAP have had on PFAS in the environment, and 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.

The purpose of this SAQP is to document the procedures that will be used to obtain data of sufficient quality to meet the objectives of the OMP and to facilitate the ongoing monitoring program.

1.2 Scope of works

The following scope of works are proposed to meet the objectives stated in Section 1.1:

– Develop Data Quality Objectives (DQOs) in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended in 2013 (ASC NEPM) to ensure that field investigations and analyses are undertaken in a way that enables the collection and reporting of reliable data.
– Determine the basis of the assessment including details of the guidelines, policies and legislation that the investigation has been developed for.
– Outline the proposed sampling strategy and methodology to meet the DQOs.
– Outline the proposed analytical program and rationale for sampling.
– Define the Quality Assurance and Quality Control (QA/QC) protocols.
– Specify the reporting requirements to meet the overall project objectives.

Additional sampling locations have been included in this SAQP, in addition to those detailed in the OMP. These are detailed with rationale in Section 4.1

1.3 Guidelines and legislation

This SAQP has been developed with reference to the following guidelines and legislation:

- Australian and New Zealand Guidelines (ANZG) (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
- Department of Defence (2018, amended 2021). *Contamination Management Manual – Annex L Data Management*.
- Department of Defence (2018, amended 2021). *Contamination Management Manual – Annex K Management of PFAS Contamination*.
- Department of Defence (2022). *PFAS Investigation and Management, Guidance Document E Standard PFAS Analytical Suite*.
- Department of Health (DoH) (2017). *Health Based Guidelines Values for PFAS for use in site investigation in Australia*.
- Heads of Environmental Protection Authorities (HEPA) (2020). *PFAS National Environmental Management Plan (NEMP), Version 2.0* (HEPA, 2020).
- National Environment Protection Council (NEPC) (1999, amended 2013). *National Environment Protection (Assessment of Site Contamination) Amendment Measure* (NEPM) *(No. 1)*.
- National Health and Medical Research Council (NHMRC) (2019). *Guidance on PFAS in Recreational Water*.
- Standards Australia (1998). *AS/NZ 5667:1998 Water Quality – Sampling*.

1.4 Limitations

This report has been prepared by GHD for Department of Defence and may only be used and relied on by Department of Defence for the purpose agreed between GHD and Department of Defence as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Department of Defence arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Department of Defence and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Site and environmental setting

2.1 Site details

A summary of the site identification details is provided in Table 1 and the site locality is shown on Figure 1, Appendix A.

Table 1 Site identification summary

Information	Details
Street Address	JBRF accessed off Jervis Bay Road, Jervis Bay, JBT 2540. HMAS Creswell accessed off College Road, Jervis Bay, JBT 2540.
Latitude and Longitude	Approximate centre of JBRF runways: -35.145799, 150.696237. Approximate centre of HMAS Creswell Base: -35.128741, 150.706023.
Site Area	JBRF is approximately 313 hectares (Ha), and HMAS Creswell is approximately 274 Ha.
Military Area (Property ID)	Jervis Bay – HMAS Creswell – ACT_0020. – JBRF – ACT_0021.
Local Government Area	Jervis Bay Territory.
Traditional custodians	Koori people, now primarily represented by the Wreck Bay Aboriginal Community.
Current Land Use	HMAS Creswell is an active Royal Australian Navy (RAN) base and training facility (including on-site accommodation and offices), and JBRF is an active airfield and training facility with associated infrastructure.
Surrounding land use	Land uses surrounding the JBRF and HMAS Creswell facilities include the following: – North: To the north of JBRF is Booderee National Park (BNP) and Jervis Bay Village [1] is followed by HMAS Creswell. To the north of HMAS Creswell is Jervis Bay (including Jervis Bay Marine Park), Hyams Beach (and village) and Vincentia residential areas. – East: Bushland of BNP (including Telegraph Creek, Green Patch and Iluka camping grounds), beyond which is the Pacific Ocean. – South: To the south of HMAS Creswell is Jervis Bay Village [1] and an area of BNP, followed by Jervis Bay Road and JBRF. Wreck Bay community lands and Wreck Bay Village residential area lie south of JBRF. This area belongs to the Wreck Bay community and is referred to herein as the 403 lands. – West: Bushland of BNP [2], including Lake Windermere (potable water supply) and Lake McKenzie, Caves Beach, Bherwerre Barrier, beyond which is the estuary of St George's Basin.

Table Notes:

1 - Jervis Bay Village is a residential community with a primary school, police station, local store and the offices of WBACC, BNP and Jervis Bay Territory Administration (JBTA).

2 - Wreck Bay Aboriginal Community Council (WBACC), own the lands, which are leased and managed by BNP.

2.2 Environmental setting

Table 2 provides a summary of the sites environmental setting, with further detail provided in various GHD reports (see Section 6).

Table 2 Environmental setting summary

Item	Description
Climate	The Jervis Bay region has an oceanic climate, with the Bases located on a coastal peninsula. – Temperature: generally moderate, with the mean maximum temperature ranging from 15.6 ºC to 26.4 ºC (JBRF airfield station - ID 068264: 2018 to March 2023). – Rainfall: generally evenly spread throughout the year, with the highest volume of rainfall typically occurring during the month of June (mean monthly rainfall amount of 164 mm). – Wind direction is variable, both daily (morning and afternoons) and seasonally, with no discernible primary wind direction.
Topography and site drainage	JBRF and HMAS Creswell are located on the southern peninsula of Jervis Bay Territory. The JBRF airfield is located on the ridgeline known as the Bherwerre Peninsula at an elevation of approximately 50 m Australian height datum (m AHD). HMAS Creswell is located on a headland between Hyams Beach and Captains Beach at an elevation of approximately 30 m AHD, on the foreshore of Jervis Bay. Surface water runoff from JBRF and HMAS Creswell is generally likely to flow into natural features such as creeks and lagoons via open shallow drains and underground culverts (discussed further under 'hydrology').
Hydrology	Surface water flows at the site are noted to be complex, and variable in flow regime based on topographic and temporal changes. There is estimated to be over 20 different small catchments and creek lines, with JBRF located at the top of the catchment area on the plateau. Runoff from JBRF that travels to the north flows into Jervis Bay via incised valley creeks through HMAS Creswell from two main drainage catchments (Flat Rock Creek and Captains Lagoon). JBRF also drains southwards via Mary Creek into Wreck Bay. Summercloud Creek is located to the east of Mary Creek and drains to Summercloud Bay. These creeks are characterised by a series of swamps and wetlands, where standing water is often present. Approximate surface water catchment areas are shown on Figure 2 in Appendix A. It is noted that surface water flows through wetland areas, as well as through the Clay Pools (also referred to as 'the unnamed pools') located south-west of JBRF runways adjacent to the south-western site boundary, are challenging to characterise and are therefore not well understood.
Soil landscape	Although the Office of Environment and Heritage has developed soil and landscape maps for many parts of NSW and ACT, there are no soil and landscape maps currently available for the Jervis Bay area. The natural soil encountered within the site during the DSI (GHD, 2019) was generally dominated by brown/grey sands, sandy clay and clayey sands (Pleistocene sediments and Holocene sediments). Most investigation locations encountered bedrock from near surface to depths of 2.5 m below ground level (m bgl).
Acid sulfate soils (ASS)	With reference to *The Land and Water Conservation Acid Sulfate Soil Risk Map* (1997), Huskisson (Tulau, M.J., 1997a) and *Sussex Inlet* (Tulau, M.J., 1997b), JBRF and HMAS Creswell are described as follows in relation to ASS: – JBRF: no known occurrences of ASS materials, and land management activities are not likely to be affected by ASS materials. – The main base areas of HMAS Creswell: no known occurrences of ASS, however there is the potential for ASS to be present around Flat Rock Creek and Captains Lagoon: • The Flat Rock Creek area and the north-west of the former golf course: a low probability of ASS, with ASS potentially found in an estuarine/back swamp environment and at near surface (between 0 to 1 m bgl). • Captains Lagoon: high probability of ASS in the bottom sediments, and there may be a severe environmental risk if bottom sediments are disturbed by activities such as dredging. The map also describes the area surrounding the lagoon as having a low probability of ASS. These are described as originating from both estuarine and aeolian environments, and potentially found at depths of up to 1 m bgl.

Item	Description
Geology	With reference to the *Geoscience Map of Jervis Bay Territory and Beecroft Peninsula* (1:25,000) (Abell, R.S., 1992), both JBRF and HMAS Creswell are underlain by the following geological units: – Quaternary, Holocene sediments – Grey-white and yellow-light brown sand. – Quaternary, Pleistocene sediments – Pale grey leached quartz sand veneering yellow-brown feldspathic sand with podzolic soil profiles. – Tertiary, Ferruginous quartz gravel. – Tertiary, White kaolinitic clay - weathered Permian dolerite. – Late Permian, Porphyritic dolerite - dykes and sills. – Early Permian, Snapper Point Formation (known locally as the Jervis Bay Sandstone, or Snapper Rock) – Quartz pebbly sandstone and minor conglomerate. Exposed sandstone and conglomerate can be observed in sections of JBRF and around the upper catchment of Mary Creek. The geology encountered during the DSI (GHD, 2019) was consistent with the published information above. Fill material, comprising both imported and re-worked natural material, was also encountered predominantly around the JBRF facility.
Hydrogeology	Based on the results of the DSI (GHD, 2019) and SEI (GHD, 2022a) reports, the following terminology has been adopted to describe the hydrogeological units identified at the Base: – 'upper aquifer' - unconfined and includes Pleistocene and Holocene sediments and the upper weathered and highly fractured portion of the Permian sandstone bedrock. Considered to be recharged by rainfall that subsequently discharges to down-gradient wetland systems and surface water. Tidally-influenced in coastal areas of HMAS Creswell. – 'lower aquifer' - comprises the deeper, more competent bedrock of the Permian sandstones. It behaves as a fractured rock aquifer where groundwater flow is controlled by secondary features i.e. joints, faults and primary features such as bedding planes. Groundwater modelling and interpolated contours indicate an upward head gradient from the lower aquifer to the upper aquifer in coastal areas of the Base, particularly in the vicinity of Flat Rock Creek. Groundwater flow for both aquifers is generally consistent with the topography, with highest groundwater elevations near the RAN School of Ship Survivability and Safety (RAN SSSS). Groundwater flow in the upper aquifer is radial predominantly to the north, west and south, with an easterly component towards Captains Lagoon at HMAS Creswell, and is inferred to discharge to surface water features. The upper and lower aquifers are connected; however: – The reduced hydraulic conductivity of the lower aquifer relative to the upper aquifer means that groundwater flow will occur preferentially through the upper aquifer. Contaminant migration would therefore generally be restricted in the lower aquifer, except where bedrock fracturing might provide a preferential migration pathway. – The upper aquifer is not expected to be hydraulically connected to Lake McKenzie and Lake Windermere to the west of the site. – Results from some investigation locations were indicative of perched groundwater at JBRF. However, the occurrences were isolated and discontinuous.
Groundwater and surface water use	JBRF, HMAS Creswell and Wreck Bay Village are supplied with mains water from the Jervis Bay Water Treatment Plant (WTP) located east of RAN SSSS, which sources water from Lake Windermere. The supply pipe and distribution pipes are predominantly underground, and traverse Booderee National Park and JBRF to/from the WTP. GHD conducted a community survey in July 2017 (GHD, 2017) regarding groundwater and surface water use, with the following results: – All respondents use mains supplied water for drinking purposes. – No groundwater wells were reported, recorded or licenced for potable abstraction. – On occasion, some members of the community use surface water for drinking and recreational (swimming) purposes.

Item	Description
Ecology	**Terrestrial ecology** JBRF and HMAS Creswell is surrounded by Booderee National Park. Open forest and woodland comprise the majority of vegetation at HMAS Creswell (55.4% of the site). JBRF has been described as predominantly dry heath scrubland (45.7% of the site), with wet health/sedgeland, ponds, wetlands and maintained areas comprising 33.1% of the area (SKM, 2006). GHD undertook an ecological assessment of the site in March 2021. A total of 79 terrestrial vertebrate species were recorded across the site, including threatened and migratory species. **Aquatic ecology** Generally speaking, aquatic habitat is limited within the footprint of JBRF and HMAS Creswell Bases. The Clay Pools directly south of JBRF are home to a large population of eastern long neck turtles, as well as dense communities of rushes and sedges. The area contains permanent water, and so also contains a variety of macroinvertebrates such as dragonflies, caddisflies and water skaters. HMAS Creswell is located within a Special Purpose Zone of the JBMP, which supports a wide variety of landforms and aquatic habitats. The region supports over 230 algae, hundreds of invertebrate species, over 210 reef fish species, sharks, rays, many marine mammals, birds and reptiles, including several threatened species.
Heritage	Jervis Bay has a long history of indigenous Australian settlement. The Aboriginal community of Wreck Bay is located south of JBRF, and the Jervis Bay area is of high heritage and cultural significance to this community. Booderee is home to the Yuin and Koori people of Wreck Bay. The Wreck Bay settlement was established by Koori people in the early 1900s. Koories favoured the area because of strong traditional and cultural ties, proximity to both the bush and the sea for the collection of food and other resources, and distance from non-Aboriginal settlements (Renwick, 2000).

2.3 Conceptual site model

The conceptual site model (CSM) is presented in the PMAP which summarised the linkages between sources, exposure pathways and receptors. Further assessments of risk exposure pathways are presented in the DSI (GHD, 2019a), HHERA (GHD, 2019b) and the ERA (GHD, 2020a).

2.3.1 Sources

The CSM identified several sources of PFAS which was divided into two distinct groups:

– Primary sources of PFAS: identified as areas of PFAS contamination where aqueous film forming foam (AFFF) was used or stored, for example, a fire training area.
– Secondary sources of PFAS: identified as areas containing 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.

The PFAS source areas have been identified through previous investigations, including the DSI (GHD, 2019a) and Supplementary DSI (GHD, 2020b). These potential source areas are referred to as areas of environmental concern (AECs) and have been identified in Table 3 below and Figure 2, Appendix A.

Table 3 Summary of identified PFAS source zones associated with the management area

AEC	Base area	Area activity	Historic / ongoing source?	Catchment / Inferred discharge area [1]
AEC A	JBRF	RAN SSSS – Used for fire training exercises, which have historically used AFFF containing PFAS.	Historic, with ongoing secondary sources from impacted environmental media.	– Captains Lagoon – Mary Creek
AEC B	JBRF	Wetland areas downgradient of the RAN SSSS, prior to the site boundary. Receiving water body for PFAS impacted surface water runoff, which has acted as a 'sink' and now secondary source area for PFAS impacts.	Historic, with ongoing secondary sources from impacted environmental media.	– Mary Creek
AEC C	JBRF	Former Fire Training Area (FFTA), now the parachute training school – Historically used for fire training exercises, which used and stored AFFF containing PFAS. A portion of this area is occupied by the new Helicopter Aircrew Training System (HATS) facility.	Historic, with ongoing secondary sources from impacted environmental media.	– Captains Lagoon – Flat Rock Creek
AEC D	JBRF	Former hanger building - a former building that was reportedly 'exploded or demolished', and it was assumed that legacy AFFF may have been used in an emergency situation as a fire suppressant.	Historic, with potential ongoing secondary sources from impacted environmental media.	– Captains Lagoon
AEC H	JBRF	Former hydrocarbon drum disposal area 'South of Kalkarra Pad' (previously remediated) – PFAS not assessed during remediation works for the area, however waste products may have been associated with former firefighting activities at JBRF.	Historic	– Flat Rock Creek
-	JBRF	Remaining areas of JBRF not associated with an AEC, which are shown to contain PFAS in soils and surface water from legacy AFFF disposal areas.	Ongoing secondary sources from impacted environmental media.	– Captains Lagoon – Flat Rock Creek
AEC E	HMAS Creswell	HMAS Creswell former golf course - Currently irrigated using treated effluent, which contains PFAS.	Ongoing	– Flat Rock Creek
AEC F	HMAS Creswell	HMAS Creswell Fire Station – historic storage and use of AFFF containing PFAS for firefighting and training purposes.	Historic, with ongoing secondary sources from impacted environmental media.	– Flat Rock Creek
AEC G	HMAS Creswell	HMAS Creswell Sewage Treatment Plant - processes wastewater from all of JBT, including wastewater originating from JBRF.	Ongoing	– Captains Lagoon
-	HMAS Creswell	Remaining areas of HMAS Creswell - Currently irrigated using treated effluent, which contains PFAS.	Ongoing	– Flat Rock Creek – Captains Lagoon

Table Notes:

1 – Inferred discharge area for both surface water and groundwater.

2.3.2 Migration pathways

PFAS can travel from a source to human or environmental receptors via transport pathways, such as surface water, groundwater and stormwater. The primary transport pathways of PFAS from the above source areas are via groundwater and surface water pathways. The PFAS migration pathways at the Bases and surrounding management area can be summarised as:

– Surface runoff containing PFAS contaminated water and sediment, along established surface drains and informal drainage routes (including wetland areas).
– Vertical migration from soil (and to a lesser extent, concrete) to groundwater.
– Migration of groundwater to a discharge area, including standing water bodies, creeks and wetland areas.
– Sewage infrastructure that links JBRF to the STP at HMAS Creswell - effluent, groundwater and surface water from fire training grounds can enter sewers and migrate rapidly via this mechanism, effectively short circuiting slower groundwater migration.
– Active distribution of PFAS impacted waters via effluent irrigation system.

Other catchment areas in or adjacent to the Management Area that do not contain any identified AECs and are not identified in Table 3 are:

– Telegraph Creek.
– Summercloud Creek.
– Lake McKenzie and Lake Windermere Catchments.

2.3.3 Receptors and risk

The following potential receptors associated with the catchment area include:

– Human health:
  - JBRF and HMAS Creswell personnel and site users (including intrusive maintenance workers).
  - Booderee National Park workers and recreational users (off-site).
  - Residents of Jervis Bay village and Wreck Bay village (off-site).
– Ecology and environment:
  - On and off-site terrestrial ecological receptors (flora and fauna).
  - On and off-site groundwater and surface water aquatic ecology (flora and fauna).
– Human health:
  - Wreck Bay residence.
  - JBRF and HMAS Creswell personnel and site users (including intrusive maintenance workers).

Potentially elevated risk associated with PFAS contamination from the Base to receptors as identified in the HHRA (GHD, 2019b) and ERA (GHD, 2020a) can be summarised as:

– Human health:
  - Drinking surface water from Mary Creek by Wreck Bay community members.
  - Recreational use of Mary Creek by Wreck Bay community members.
  - Consumption of aquatic invertebrates from Mary Creek by Wreck Bay community members.
  - Consumption of terrestrial mammalian offal by Wreck Bay community members.
  - Consumption of aquatic invertebrates from Flat Rock Creek and Captains Lagoon by recreational users of Booderee National Park.
  - Consumption of finfish from Captains Lagoon by recreational users of Booderee National Park.

– Ecological health (refer to the ERA (GHD, 2020a) for specific ecological exposure groups)
    - JBRF: food chain exposure for terrestrial and aquatic higher-order birds, aquatic mammals (headwaters of Mary Creek only), reptiles and amphibians. Direct contact for flora and fauna in aquatic environments associated with Mary Creek headwaters.
    - HMAS Creswell: food chain exposure for reptiles and amphibians. Direct contact for flora and fauna in aquatic environments.
    - Captains Lagoon: food chain exposure for middle-order birds, mammals, reptiles and amphibians. Direct contact for flora and fauna in aquatic environments.
    - Flat Rock Creek: food chain exposure for lower-order birds, and reptiles and amphibians. Direct contact for flora and fauna in aquatic environments.
    - Mary Creek: food chain exposure for middle-order birds, mammals, reptiles and amphibians. Direct contact for flora and fauna in aquatic environments.

In addition to the potentially elevated risks identified in the HHRA/ERA outlined above, investigations undertaken since the HHRA and ERA have identified the following 'unknown', 'possible' or 'likely' SPR linkages that warrant or potentially warrant further investigation:

– Migration of impacted soils and/or sediments in runoff to the Clay Pools, and subsequent direct contact or ingestion and bioaccumulation by Wreck Bay community members.
– Surface water migration to discharge area, and subsequent direct contact or ingestion, and bioaccumulation by Residents of Jervis Bay village (off-site).
– Active distribution of PFAS impacted waters via sewerage network and/or effluent irrigation system, and subsequent direct contact or ingestion, and bioaccumulation by BNP workers and recreational users (off-site), residents of Jervis Bay village and Wreck Bay village (off-site), and on and off-site ecological receptors.
– Direct contact or ingestion of impacted groundwater onsite, and bioaccumulation by onsite ecological receptors.
– Groundwater migration to discharge areas, and subsequent direct contact or ingestion, and bioaccumulation by Booderee National Park workers and recreational users (off-site).

3. Data quality assessment

3.1 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.
– Determined 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 4. They have been prepared in line with the DQO process as outline in the ASC NEPM (Schedule B2) (NEPC, 2013).

Table 4 Data quality objectives

Process	Description
Step 1: State the problem	The Bases have legacy PFAS contamination in a range of environmental media, at concentrations which may pose an unacceptable risk to some human health and ecological receptors. Management measures (including remediation works) are therefore required to mitigate the identified potential risks. The overarching project objective is to transition the Bases from investigation and management under the PMAP (specific to PFAS management) to ongoing monitoring as per standard Defence protocols. The 'problem' as it stands is that a robust, site wide data set is required to meet both the objectives outlined above. Specifically, assessment of temporal changes in PFAS concentrations are required to assist in informing management measures instigated at the Bases, and to justify transition to standard monitoring protocols. This will allow (if required) the update and refinement of the CSM, human health and ecological risk assessment and inform management decisions by Defence and state agencies.
Step 2: Identify the decision/goal of the study	This OMP is aimed at resolving the following broad principal study questions: 1. What are the changes and trends in the nature, extent and magnitude of PFAS concentrations in the groundwater and surface water within the Management Area? 2. Has the nature, extent and magnitude of PFAS concentrations changed significantly to warrant a revision of the HHRA and/or ERA? 3. Has the nature, extent and magnitude of PFAS concentrations changed significantly to warrant refinement of any existing management measures?
Step 3: Identify the information inputs	The following inputs are required to resolve the principal study questions outlined in Step 2, and confirm that the conclusions of the HHRA and ERA remain valid: – PFAS concentrations in groundwater, surface water and sediment from previous and future monitoring events. – Field data (i.e. groundwater standing water levels, physio-chemical parameters, flow, colour and turbidity) on groundwater, surface water and field descriptions of sediment. – Weather conditions preceding sampling events, particularly rainfall events. – Site status and land use scenarios and whether these have changed. – An appropriate statistical evaluation of the data including short and long term trends, in particular for surface water and groundwater concentrations (where there are sufficient data points). – Comparison of data sets to relevant endorsed assessment levels (Refer to Section 4.5).
Step 4: Define the boundaries of the study	The spatial boundaries of the study are identified as the lateral extent of the PFAS Management Area. The timeframes for the study is three years from implementation of the OMP, after which the OMP will require formal review (noting an annual general review is also required). Data collected from previous OMP events and site investigations will also be included as part of this investigation.

Process	Description
	The frequency of the sampling is defined in Section 4.
Step 5: Develop the analytical approach/decision rules	The analytical and field data will be used to assess changes to the nature, extent and magnitude of PFAS in surface water, groundwater and sediment to broadly assess the effectiveness of implemented management measures. Two approaches will be used: – Step 1 – Tier 1 screening assessment: The analytical data will be compared to the relevant assessment levels presented in Section 4.5 including consideration of laboratory error margins. – Step 2 – Trend and site wide population assessment: new data will be compared to the concentrations recorded during prior monitoring events to evaluate changes at individual locations and in population groups defined by catchment area and the location in source, pathway or receptor zones. The overall assessment objective is to determine if there is a change in the site risk profile, and whether revision of the HHRA / ERA or implemented management measures is warranted. Specifically, this includes the following decision outcomes: – If concentrations of PFAS demonstrate discernible increasing trends and/or new data is outside of the existing population data set, trigger actions as outlined in the OMP shall be considered. – If concentrations of PFAS demonstrate stable or declining trends, meet the OMP cessation trigger, and do not pose any unacceptable risks to identified receptors, then no further action is required other than to complete the period of monitoring specified.
Step 6: Specify performance or acceptance criteria	The potential for significant decision errors will be minimised by completing a robust data validation (quality assurance / quality control [QA/QC]) program in accordance with the requirements of the OMP (and any subsequent SAQPs). Data quality indicators (DQIs) will be applied to assess the usability of the data prior to making decisions, based on precision, accuracy, representativeness, comparability and completeness. The ASC NEPM (NEPC, 2013) and PFAS NEMP (HEPA, 2020) details the various metrics that can be used to assess data in terms of these DQIs, and the adopted DQIs for this investigation are defined in Section 3.2. If detections of PFAS are reported in field blanks or rinsate blanks, then consideration of potential for cross contamination between sample locations and what impact this has on conclusions of trends is required.
Step 7: Develop the plan for obtaining data	The OMP provides guidance for preparing a SAQP that is required for each monitoring event, including scope of work, sampling methodologies, monitoring locations and PFAS assessment levels. The SAQP should be developed in response to the principal study questions outlined in Step 2, to meet these DQOs, and to comply with the monitoring plan outlined in the OMP. To maintain the integrity and reliability of data the following measures should be adopted: – Field and analytical data are collected in accordance with the PFAS NEMP (HEPA, 2020) and the ASC NEPM (NEPC, 2013). – Field personnel should be trained and have sufficient experience to complete the fieldwork to an acceptable standard, as per the protocols outlined in the OMP / SAQP. – Robust field and laboratory quality assurance/quality control protocols are to be adopted, outlined in the SAQP. – Use laboratories that are National Association of Testing Authorities (NATA) accredited for PFAS analysis and ensure laboratory limits of reporting (LORs) are suitable to meet the relevant adopted assessment levels outlined in Section 4.5. This SAQP is intended to meet the requirements of the OMP and provides the methods that shall be used to obtain data of sufficient quality.

3.2 Assessment of data quality

The acceptance criteria for DQIs are based on the DQOs outlined in Section 3.1 and are provided in Table 5.

Table 5 DQI acceptance criteria

DQI	Acceptance criteria
Field QA/QC	
Field program	Fieldwork is to be undertaken by suitably experienced field staff in accordance with the sampling procedures outlined in this SAQP.
Rinsate blank samples (where sampling equipment is reused)	Rinsate blank samples should be collected at a rate of one per day of monitoring and analysed for PFAS. The concentration of PFAS should be less than the laboratory LOR.
Trip blank samples	Trip blank samples for PFAS should be submitted to the laboratory at a rate of one per batch. The concentration of PFAS should be less than the laboratory LOR.
Intra- and inter-laboratory duplicates	Intra- and inter-laboratory duplicates are each to be collected and analytes at a rate of 1 in 10 primary samples. The relative percentage differences (RPDs) are to be calculated for all primary and field duplicate pairs and will be considered acceptable based on the following RPD limits: - 200% for concentrations within 1 to 10 times the analyte LOR. - 50% for concentrations within 10 to 30 times the analyte LOR. - 30% for concentrations greater than 30 times the analyte LOR.
Laboratory QA/QC	
Laboratory duplicates	Laboratory duplicate sample RPDs are to be less than: - 20% for high level concentrations (i.e. greater than 20 times the analyte LOR). - 50% for medium level concentrations (i.e. between 10 and 20 times the analyte LOR).
Matrix spikes	Matrix spike recoveries are to be in the range of 70 to 130% of the theoretical recovery or as nominated in the laboratory's QC report.
Method blanks	Method blank samples are to have a concentration less than the laboratory LOR.
Laboratory control samples	The recovery of laboratory control samples are to be within the laboratories' specified range for the particular analyte or analytical suite.

4. Sampling rationale and methodology

4.1 The OMP

The OMP (Defence, 2020) outlines the requirements for the monitoring works to be undertaken and provides the basis for the preparation of this SAQP. With consideration that this is the fourth year of monitoring, a continuation of existing monitoring schedule is adopted. This SAQP is for the second of the 2024 biannual events (Spring); the April (Autumn) 2024 event was conducted by AECOM.

The scope of works presented in this SAQP is consistent with that presented in the OMP with the exception of the following updates.

Table 6 Deviations from OMP

Location	Deviation	Rationale
0020_MW001	Update to sampling location (rather than gauging only).	Boundary location and mass flux transect (Lower Flatrock Creek).
0020_MW008	Add location to OMP.	Mass flux transect (Lower Flatrock Creek).
0020_MW052		PFAS characterisation on groundwater flow divide.
0020_MW055		Mass flux transect (Lower Captains Lagoon).
0020_MW056		
0020_MW057		
0020_MW058		
0020_MW059		
0020_MW068		Mass flux transect (Lower Flatrock Creek).
0020_MW104	Update to sampling location (rather than gauging only).	Insufficient data collected at this location previously to establish baseline conditions.
0020_MW108	Add location to OMP.	Mass flux transect (Lower Flatrock Creek).
0020_SW054		Pathway - AEC F and AEC to Flat Rock Creek.
0020_SW057		Pathway - Jervis Bay village to Captains Lagoon.
0021_MW018		Boundary well to BNP.
0021_MW020		Boundary well to Clay Pools.
0021_MW021		Boundary well to Lakes catchment area.
0021_MW060		Mass flux transect - AEC B.
0021_MW061		Added in April 2024 by AECOM.
0021_MW062		Added in April 2024 by AECOM.
0021_MW063		Mass flux transect - AEC A.
0021_MW064		
0021_MW065		
0021_MW070		Mass flux transect - AEC B.
0021_MW071		
0021_MW072		
0021_MW127		Mass flux transect - Upper Captains Lagoon.
0021_MW134		

Location	Deviation	Rationale
0021_MW150	Update to sampling location (rather than gauging only).	Source zone - AEC A. The depth of this location is 5 m bgl, screened in sandstone bedrock. Location required to assess vertical distribution.
0021_MW153	Update to sampling location (rather than gauging only).	Source zone - AEC A - rock. The depth of this location is 5 m bgl, screened in sandstone bedrock. Location required to assess vertical distribution.
0021_MW160	Add location to OMP.	Boundary well to the lakes catchment area.
0021_MW163		Mass flux transect - Upper Flat Rock Creek, and boundary location.
0021_MW164		Potential source area - wider JBRF, upgradient of Flat Rock Creek.
0021_SD011		Assess potential changes to Mary Creek at site boundary.
0021_SD188		Receptor environment - clay at Summercould creek used for ceremonial purposes.
0021_SW153		Added in April 2024 by AECOM.
0021_SW188		Receptor environment - seepage of groundwater at Summercould creek.
0021_SW211		New location - Receptor environment, more practical than SW051.
0021_MW131	Update to sampling location (rather than gauging only)	Boundary location and mass flux transect (Lower Flatrock Creek).

A summary of the number of locations to be included in this event is provided in Table 7. All monitoring locations are presented on figures in Appendix A and tabulated in Appendix B. It is noted that off-site monitoring locations will require the agreement of the WBACC and Booderee National Parks prior to the monitoring event.

Table 7 Number of monitoring locations

Media	Total number of locations
Groundwater	88
Surface water	78
Sediment	64
Tanks (OTH)	6
Total # locations	*236*

4.2 Sample collection and handling

4.2.1 Groundwater sampling

The groundwater sampling methodology is presented in Table 8.

Table 8 Groundwater sampling methodology

Item	Description
Technical guidelines	Australian Standard 5667:*1998 Water Quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS 5667.1:1998)*. Australian Standard 5667:*1998 Water Quality – Sampling, Part 11: Guidance on the Sampling of Groundwaters (AS 566.11:1998)*. ASC NEPM (NEPC, 2013) PFAS NEMP (HEPA, 2020)

Item	Description
Field screening and gauging	The monitoring wells will be gauged in each monitoring well prior to collection of groundwater samples using a decontaminated oil/water interface probe to measure standing water level (SWL) and assessed for the potential presence of LNAPL (light non-aqueous phase liquid) and DNAPL (dense non-aqueous phase liquid). In addition, the base depth of the monitoring wells will be measured. Depth measurements will be referenced to the top of well casing as an established datum.
Field chemistry and sampling	A groundwater sample will be collected from each well using no-purge methodology with HydraSleeves™, which will be installed within the screened interval of the wells. New HydraSleeves™ will be used for annual sampling event. It is noted that prior to the initial sampling round, or when HydraSleeves™ must be re-deployed, the HydraSleeves™ will need to be installed in the well before sampling for a minimum of: – 4 hours when deployed with bottom weights only. – 24 hours when deployed with top and bottom weights. The timeframes outlined above are to allow for re-stabilisation of the standing water level in the well following a disturbance. Care should be taken to avoid placing the base of the HydraSleeves™ at the base of the monitoring well, where a build-up of sediment may be present. The installation depth of the HydraSleeves™ is to be recorded (generally as HydraSleeve™ collar depth in mbTOC). During the monitoring event, if a groundwater well is found to not contain a HydraSleeve™ the procedure is as follows: – If time or access restraints are present, a sample will be collected using a dedicated, disposable high-density polyethylene (HDPE) bailer. It is noted that in this instance, a minimum of three well volumes should be removed and water removal continued until stabilisation of water quality parameters is achieved. If recharge is insufficient and there is a risk of the well becoming dry, a sample can be collected prior to this. – If there are no time or access restraints, the HydraSleeve™ will be re-deployed and the minimum timeframes outlined above, depending on deployment set up, will need to be achieved before sampling. Field parameters (pH, electrical conductivity (EC), oxygen redox potential (redox), dissolved oxygen (DO) and temperature) will be measured and recorded for all groundwater locations prior to sample collection. In addition, observations of water quality such as the colour, turbidity level, and the presence/absence of odour or sheen will be recorded. Retrieved groundwater samples will immediately be filled from the HydraSleeve™ into laboratory supplied containers suitable for the requested analyses. The sample containers will be labelled with the job number, sample identification and date collected.
Decontamination	Prior to and following the collection of each groundwater sample, all non-disposable sampling equipment will undergo decontamination including: – Washing of equipment with phosphate/PFAS-free detergent (Liquinox) and/or – Rinsing of equipment with laboratory supplied PFAS-free water.
Quality assurance and quality control (QA/QC)	The following field QA/QC samples will be collected and analysed for PFAS (standard suite) as part of the groundwater sampling program: – One intra-laboratory duplicate per ten primary samples. – One inter-laboratory duplicate per ten primary samples. – One rinsate sample per day of sampling. – One trip blank per batch.

4.2.2 Surface water sampling

The surface water sampling methodology is presented in Table 9, which will be used for both the transitional event and annual OMP events.

Table 9 Surface water sampling methodology

Item	Description
Technical guidelines	Australian Standard 5667:*1998 Water Quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS 5667.1:1998)*.

Item	Description
	Australian Standard 5667:*1998 Water Quality – Sampling, Part 6: Guidance on the Sampling of rivers and streams (AS 566.6:1998)*. ASC NEPM (NEPC, 2013). PFAS NEMP (HEPA, 2020).
Field chemistry and sampling	A surface water sample will be collected as a 'grab sample' mid-way through the water column or approximately 0.5 m below the surface at the individual surface water sampling locations. If the reachable water column is less than 0.5 m deep, the sample will be collected from at least half the water depth, and care should be taken to avoid surface films entering the sample. If the water column is greater than 0.5 m deep, the sample should be taken 20 to 30 cm below the surface of the water. Each individual sample will be collected into a new laboratory-supplied, unpreserved sample container with new nitrile gloved hands. An extendable sampling pole may be used for easier sample collection. Field parameters (pH, EC, redox, DO and temperature) will be measured and recorded for all groundwater locations. In addition, observations of water quality such as the flow (flowing or not flowing), colour, turbidity level, and the presence/absence of odour or sheen will be recorded. The sample containers will be labelled with the job number, sample identification and date collected.
Quality assurance and quality control (QA/QC)	The following field QA/QC samples will be collected and analysed for PFAS (standard suite) as part of the surface water sampling program: - One intra-laboratory duplicate per ten primary samples. - One inter-laboratory duplicate per ten primary samples. - One rinsate sample per day of sampling (where applicable). - One trip blank per batch.

4.2.3 Sediment sampling

The sediment sampling methodology is presented in Table 10, which will be used for both the transitional event and annual OMP events.

Table 10 Sediment sampling methodology

Item	Description
Technical guidelines	ASC NEPM (NEPC, 2013). PFAS NEMP (HEPA, 2020). Australian Standard 5667:*1999 Water Quality – Sampling, Part 12: Guidance on sampling of bottom sediments.*
Field chemistry and sampling	Sediment samples are to be representative of potentially deposited sediments and collected from a depth from within the water body using a hand trowel to a maximum depth of 0.3m below the sediment surface. If this is not possible (due to embankment instability and/or high surface water depth), samples will be collected using a hand auger. A new laboratory supplied container will be used at each location for collection of samples and the sample containers will be labelled with the job number, sample identification and date collected. Description of each sampling location and the sample material will be recorded on the field notes.
Decontamination	If re-usable sampling equipment is used, then prior to and following the collection of each sediment sample the equipment must undergo decontamination including: - Washing of equipment with phosphate/PFAS-free detergent (Liquinox) and/or - Rinsing of equipment with laboratory supplied PFAS-free water.
Quality assurance and quality control (QA/QC)	The following field QA/QC samples will be collected and analysed for PFAS (standard suite) as part of the sediment water sampling program: - One intra-laboratory duplicate per ten primary samples. - One inter-laboratory duplicate per ten primary samples. - One rinsate sample per day of sampling (where applicable). - One trip blank per batch.

4.2.4 Infrastructure tank water sampling

The tank water sampling methodology is presented in Table 11, which will be used for the transitional event only.

Table 11 Infrastructure tank sampling methodology

Item	Description
Technical guidelines	Australian Standard 5667:*1998 Water Quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS 5667.1:1998)*. ASC NEPM (NEPC, 2013). PFAS NEMP (HEPA, 2020).
Field chemistry and sampling	Tank and open pit water grab samples will be collected using the sampling methodology provided below for each location: – OTH001 (Training Water Holding Tank [S415]): Use a bailer to collect water from the opening at the top of the tank, accessed via a ladder. – OTH002 (Fire Main Water Tank [S416]): Use a bailer to collect water from the opening at the top of the tank, accessed via a ladder. – OTH003 (Surface water Oil Separator Reclaim Pit [S426]): Use peristaltic pump to collect water from the open pit. – OTH004 (DCTU Holding Tank [S439]): Collect water from tap connected to tank. – OTH005 (S440 Pit Tank): Use peristaltic pump to collect water from the underground tank. – OTH006 (DLSTRU [S481]): Collect water from open sump tank below unit, directly into sampling containers, or with aid of sampling pole. Field parameters (pH, EC, redox, DO and temperature) will be measured and recorded for all sampling locations. In addition, observations of water quality such as the flow (if present), colour, turbidity level, and the presence/absence of odour or sheen will be recorded.
Quality assurance and quality control (QA/QC)	The following field QA/QC samples will be collected and analysed for PFAS (standard suite) as part of the surface water sampling program: – One intra-laboratory duplicate per ten primary samples. – One inter-laboratory duplicate per ten primary samples. – One rinsate sample per day of sampling (where applicable). – One trip blank per batch.

4.2.5 Sample handling and transport to laboratory

Following collection of each batch of samples, samples will be immediately stored in a cool, dark environment (esky) prior to being forwarded to the NATA accredited analytical laboratory within the specified holding times along with a standardised chain of custody (COC) form. Analyses will be undertaken on a standard turnaround time of five business days, and analytical results will be emailed to GHD as a compiled report from the laboratory (as Esdat files and PDF report).

4.2.6 Calibration

Prior to use in the field, all field instruments (i.e. water quality meter, interface probe) are to be calibrated by the equipment supplier to optimise the accuracy of the measurements taken. The calibration certificate from the equipment supplier will be checked by the field team to confirm the field instruments are in good working condition.

All calibration certificates for equipment hired will be collected as part of the field documentation and presented as an attachment in the Sampling Event Report.

4.2.7 Waste management

The proposed groundwater sampling methodology utilising HydraSleeves™ is not considered to generate a volume of liquid waste that requires management or disposal.

All solid waste, comprising of dedicated sampling equipment (i.e. HydraSleeves™, bailers, gloves etc) and general rubbish will be collected and disposed in general waste bins present on-site.

4.3 Analytical suite and laboratory analysis methods

4.3.1 Laboratory NATA accreditation details

The NATA accredited laboratories selected for this monitoring program are as follows:

– Primary laboratory: Australian Life Science (ALS) Environmental, Smithfield, New South Wales (NATA Accreditation No. 825).
– Secondary laboratory: Eurofins, Girraween, New South Wales (NATA Accreditation No. 1261).

4.3.2 Analytical schedule

All groundwater, surface water, tank water and sediment samples collected as part of the monitoring program will be submitted for standard level analysis of the standard 28 PFAS suite. Analysis will be conducted to a standard laboratory limit of reporting (LOR), which is <0.01 ug/L and <0.0002 mg/kg for waters and soils/sediments respectively.

4.3.3 Validation of analytical results

After completion of a monitoring event, analytical results will be reviewed and may need to be validated to confirm the original results if a QAQC discrepancy is considered possible. This would be achieved by requesting re-analysis of a sample by the laboratory or, if required, re-sampling and analysis. GHD would seek approval from Defence prior to mobilisation to site for re-sampling.

4.4 Data management

4.4.1 Sample nomenclature

All sample naming will be in accordance with the Defence Contamination Management Manual (DCMM), specifically Annex L (Data Management). Sample IDs will follow the nomenclature below:

PPPP_XX000_YYMMDD

Where for this monitoring program:

– PPPP = Property ID = ‘0020’ for HMAS Creswell and ‘0021’ for JBRF.
– XX = Location type, e.g. ‘MW’ for monitoring well or ‘SW’ for surface water.
– 000 = Three-digit sample number = e.g. ‘027’.
– YYMMDD = Sample date by year, month then day, e.g. ‘240801’.

The above example would provide a sample ID (at HMAS Creswell) of ‘0020_MW027_240801.’

QA/QC samples will be labelled in accordance with DCMM Annex L, as per the following nomenclature:

– Intra-laboratory duplicate (blind): PPPP_QC1XX_YYMMDD.
– Inter-laboratory duplicate (split): PPPP_QC2XX_YYMMDD.
– Rinsate blank: PPPP_QC3XX_YYMMDD.
– Trip blank: PPPP_QC5XX_YYMMDD.

4.4.2 Defence ESdat requirements

All field and analytical data collected as part of this monitoring program will be uploaded, stored and managed in the Defence Environmental Data Management System (EDMS) in accordance with DCMM Annex L using ESdat software. After completion of a monitoring event, field and analytical data will be uploaded into ESdat prior to submission of the factual report for the sampling event.

4.5 Adopted screening criteria

The relevant guidelines and legislation reviewed at the time of this report to define the adopted screening criteria are outlined in Section 1.3.

The adopted screening criteria to assess the PFAS data in this monitoring program for human health and ecological receptors as per the OMP is presented in Table 12.

Table 12 Summary of adopted screening criteria

Media	Receptor	Guideline
Groundwater and surface water	Ecology	NEMP (2020) – freshwater and marine water 95% species protection.
	Human health	NEMP (2020) – Drinking water.
		NEMP (2020) – Recreational.
Sediments	Ecology	Exposure Point Concentrations (as detailed in ERA (GHD, 2020a)).
	Human health	Exposure Point Concentrations (as detailed in HHRA (GHD, 2019b)).

4.6 Quality assurance / quality control sampling

4.6.1 Field duplicate and inter-laboratory duplicate samples

Intra-laboratory (blind) and inter-laboratory (split) duplicates are to be collected and analysed for PFAS in accordance with the PFAS NEMP 2.0 (HEPA, 2020) at a minimum frequency of 1 in 10 primary samples.

4.6.2 Rinsate samples

Rinsate blank samples are to be collected at a rate of one per day of monitoring where re-usable sampling equipment has been used (e.g. interface probe, trowel). The rinsate blank sample is collected by pouring laboratory supplied deionised water over the decontaminated sampling equipment into the appropriate sampling container for PFAS analysis.

4.6.3 Trip blank samples

Trip blank samples will be used to estimate the amount of contamination introduced during the transport and storage of samples from the time of sampling to the time of analysis. Trip blanks are laboratory supplied and will be collected at a rate of 1 sample per fieldwork and analysed for PFAS at standard LOR.

4.7 Field documentation

4.7.1 Field notes

All sampling locations for each monitoring round will have an accompanying field record which will include information specific to the location type. This information is summarised in Table 13.

Table 13 Summary of fieldwork documentation

Media	Information to be recorded
Groundwater	- Standing water level and depth of well measurements. - Date, time and field staff present. - Field parameters (pH, EC, redox, DO and temperature). - Observations of colour, turbidity, presence/absence of odour or sheen. - Intra- or inter-laboratory duplicates collected (if applicable). - Other comments (i.e. access) (if applicable).
Surface water	- Date, time and field staff present. - Field parameters (pH, EC, redox, DO, temperature and turbidity). - Observations of colour, turbidity, presence/absence of odour or sheen. - Environmental observations such as weather, temperature, slope and erosion. - Hydrological observations such as flow (flowing or not flowing) and estimated width and depth of water body with photographs of each sample point. - Intra- or inter-laboratory duplicates collected (if applicable). - Other comments (i.e. access) (if applicable).
Sediment samples	- Depth of sample from sediment surface level. - Observations of colour, soil type, moisture, presence/absence of odour or sheen. - Environmental observations such as weather, temperature, slope and erosion. - Intra- or inter-laboratory duplicates collected (if applicable). - Other comments (i.e. access) (if applicable).

All calibration certificates for equipment hired during fieldwork will be collected and presented in the Sampling Event Report as part of the field documentation.

4.7.2 Sample labels

Sample containers will be labelled with the following identification:

– Project number.
– Sample identification (as per the nomenclature outlined in Section 4.4).
– Sampler name.
– Sample collection date.

4.7.3 Chain of Custody (COC) forms

For each batch of samples prepared in the field, a COC form will be completed and sent with the samples to the laboratory. The COC form will include information such as the project number and name, sample identification and date, requested analyses and will be signed by the field staff representative. Upon receipt of samples at the laboratory, the COC will be signed by a laboratory staff member.

If additional samples are collected during monitoring based on field observations which are not from sampling locations included in this SAQP, GHD will seek approval from Defence for analysis of these samples.

5. Reporting

5.1 Sampling event report

After each monitoring event, information, field and laboratory data will be documented in a Sampling Event Report prepared in accordance with Defence *PFAS Ongoing Monitoring Program Reporting Guidance* (Defence, 2024) and will include:

- The scope of works undertaken including constraints and assumptions.
- Deviations from SAQP/OMP and associated implications (if any).
- Sampling methodology.
- PFAS screening criteria.
- Evaluation of the quality assurance and quality control to assess the adequacy for interpretative use.
- Summary of the field observations including weather conditions, surface water, visual and olfactory.
- Results and discussions including field parameters and analytical results, with comparison to historical conditions and screening criteria, and consideration of results and other information against OMP triggers.
- Conclusions and summary of key findings.
- Figures presenting management area, site layout and source areas (including CSR ids) surface water flow direction, PFAS distribution figures for each media.
- A tabulated summary of field observations and parameters and laboratory analytical results which includes comparison with the adopted assessment criteria.
- Attachments for all field and laboratory documentation, such as:
    - Field records for groundwater, sediment and surface water monitoring locations.
    - Equipment calibration certificates.
    - Chain of custody forms.
    - Laboratory analytical certificates.

5.2 Ongoing monitoring report

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

The Ongoing Monitoring Report will report on the objectives of the OMP, as outlined in Section 1.

The Ongoing Monitoring Report will be prepared in accordance with the Defence *PFAS Ongoing Monitoring Program Reporting Guidance* (Defence, 2024) and will include:

- A summary of deviations to the requirements of the SAQP (if applicable).
- A summary of any changes to the condition of the monitoring network that may affect the integrity of the data collected, or which may require repair, reinstatement or decommissioning.
- Contextual and ancillary information that has occurred in the broader management area that may affect monitoring results, such as remediation projects, infrastructure projects and weather events.
- Figures which present all sampling locations and site-specific hydrogeological features.
- A tabulated summary of laboratory analytical results for the specified period which includes comparison with the adopted assessment criteria.
- A QA/QC assessment and evaluation.
- Data interpretation, including trends in groundwater concentration, gradient and flow directions.

- Assessment of statistically based trends that may inform decision making during review of the OMP, including whether:
  - A review of the CSM is required.
  - The risk profile has changed across the site or at a specific location.
  - An OMP or PMAP review is required.
- Overall summary of the changes and extent of PFAS and whether monitoring has met the objectives of the OMP.
- Assessment of data against triggers detailed in the OMP and recommendations for responses.
- Inclusion of the following information as attachments:
  - Previous OMP factual reports.
  - This SAQP.

6. References

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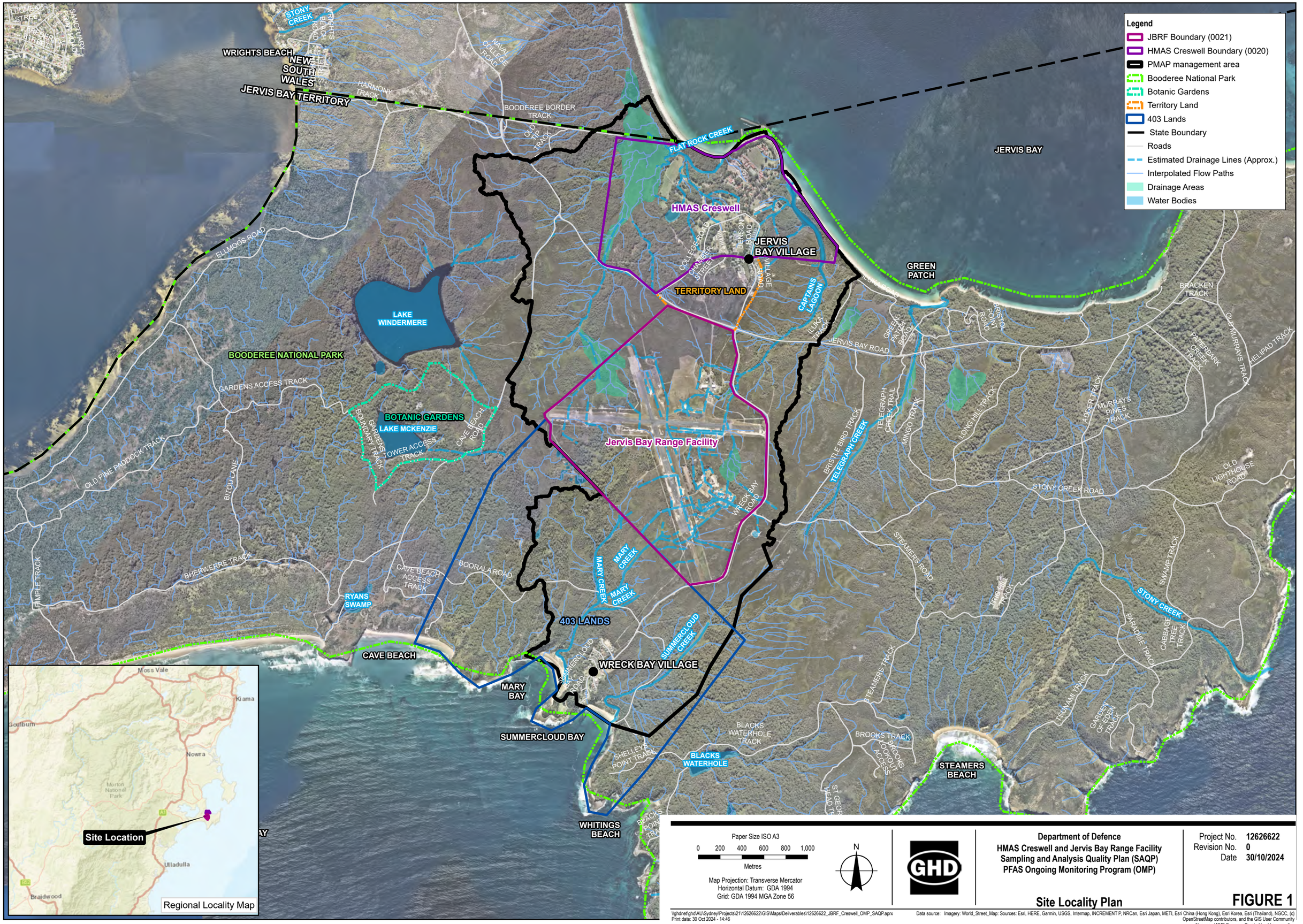
Tulau, M.J., 1997b. *Acid Sulfate Soil Risk Map, Sussex Inlet. Scale 1:25,000. Second Edition. Department of Land and Water Conservation, NSW,* s.l.: s.n.

Appendices

Appendix A

Figures



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Grid: GDA 1994 MGA Zone 56

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Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)

Project No. **12626622**
Revision No. **0**
Date **30/10/2024**

Site Locality Plan

FIGURE 1

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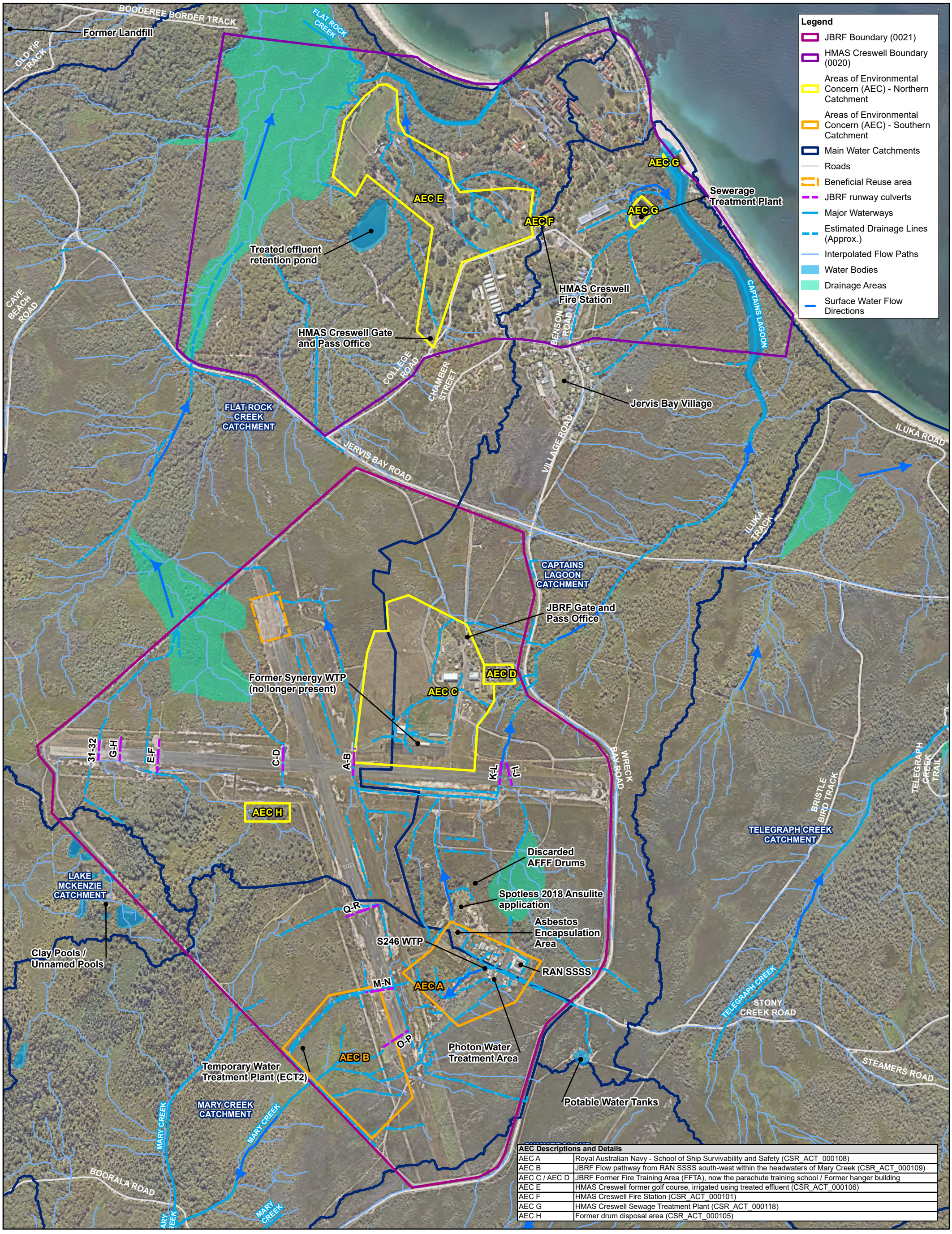

AEC Descriptions and Details	
AEC A	Royal Australian Navy - School of Ship Survivability and Safety (CSR_ACT_000108)
AEC B	JBRF Flow pathway from RAN SSSS south-west within the headwaters of Mary Creek (CSR_ACT_000109)
AEC C / AEC D	JBRF Former Fire Training Area (FFTA), now the parachute training school / Former hanger building
AEC E	HMAS Creswell former golf course, irrigated using treated effluent (CSR_ACT_000106)
AEC F	HMAS Creswell Fire Station (CSR_ACT_000101)
AEC G	HMAS Creswell Sewage Treatment Plant (CSR_ACT_000118)
AEC H	Former drum disposal area (CSR_ACT_000105)

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Grid: GDA 1994 MGA Zone 56

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Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)

Site Layout

Project No. **12550948**
Revision No. **0**
Date **30/10/2024**

FIGURE 2

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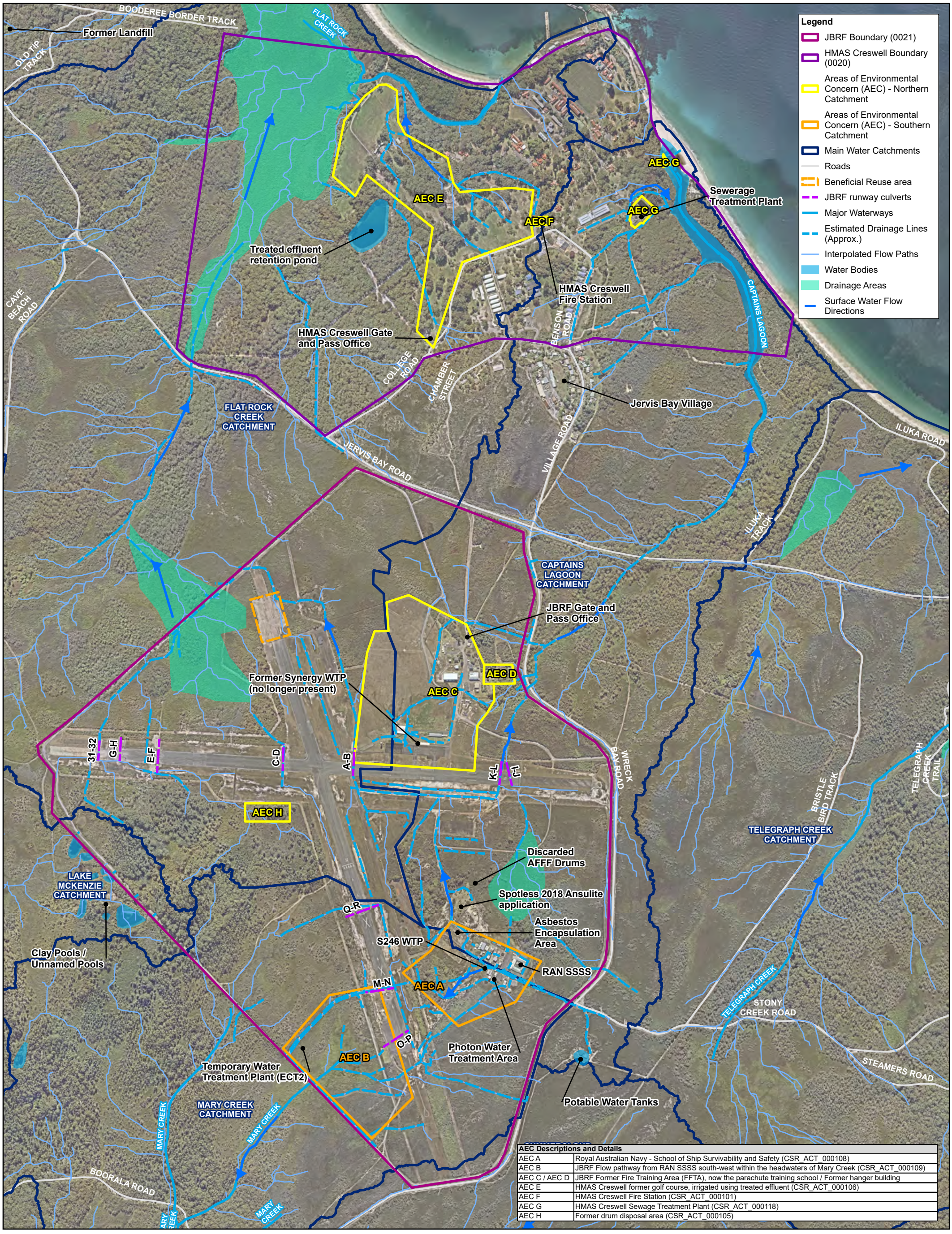

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AEC F	HMAS Creswell Fire Station (CSR_ACT_000101)
AEC G	HMAS Creswell Sewage Treatment Plant (CSR_ACT_000118)
AEC H	Former drum disposal area (CSR_ACT_000105)

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Grid: GDA 1994 MGA Zone 56

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Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)

Site Layout

Project No. **12550948**
Revision No. **0**
Date **30/10/2024**

FIGURE 2

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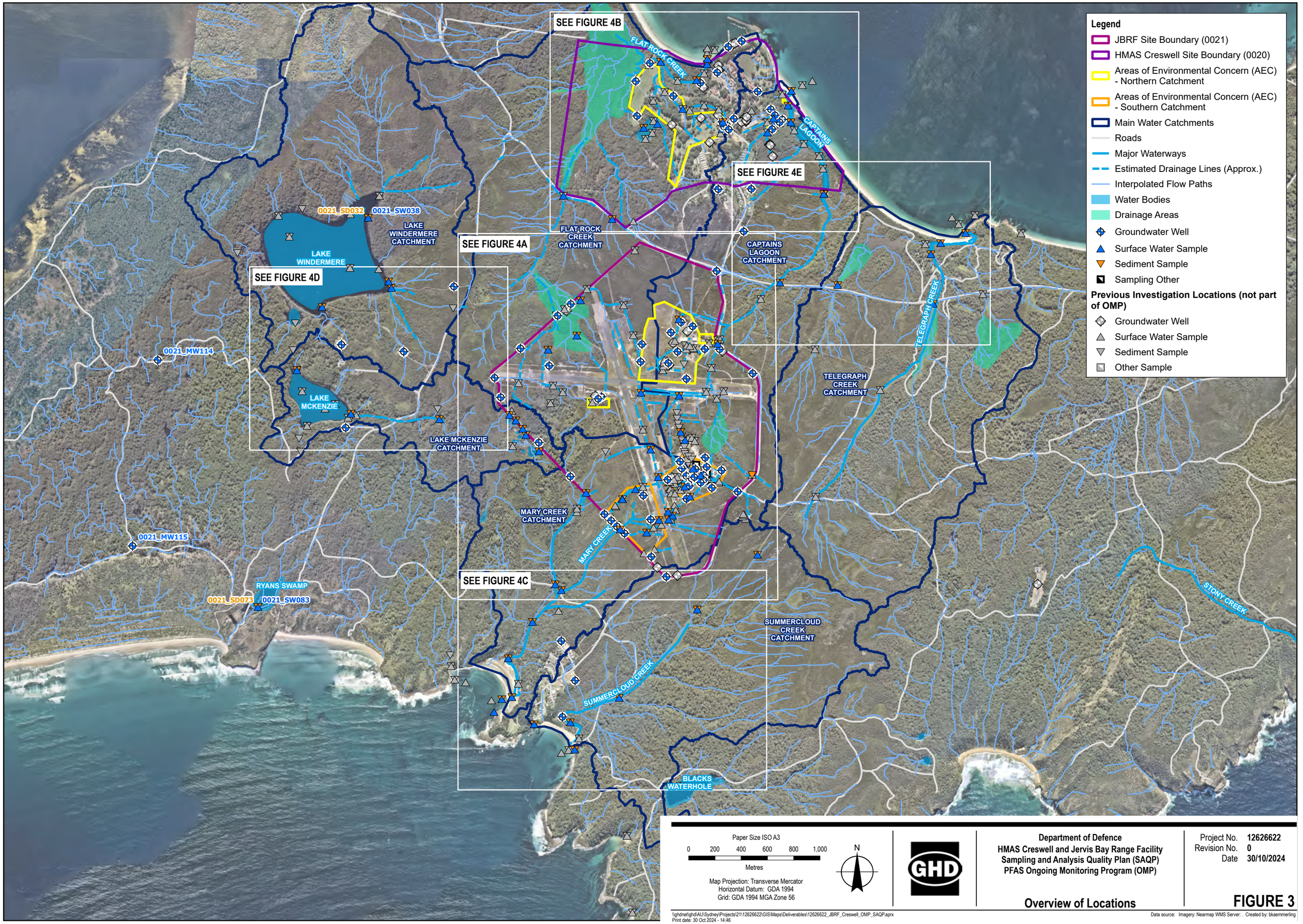

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Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)

Overview of Locations

Project No. **12626622**
Revision No. **0**
Date **30/10/2024**

FIGURE 3

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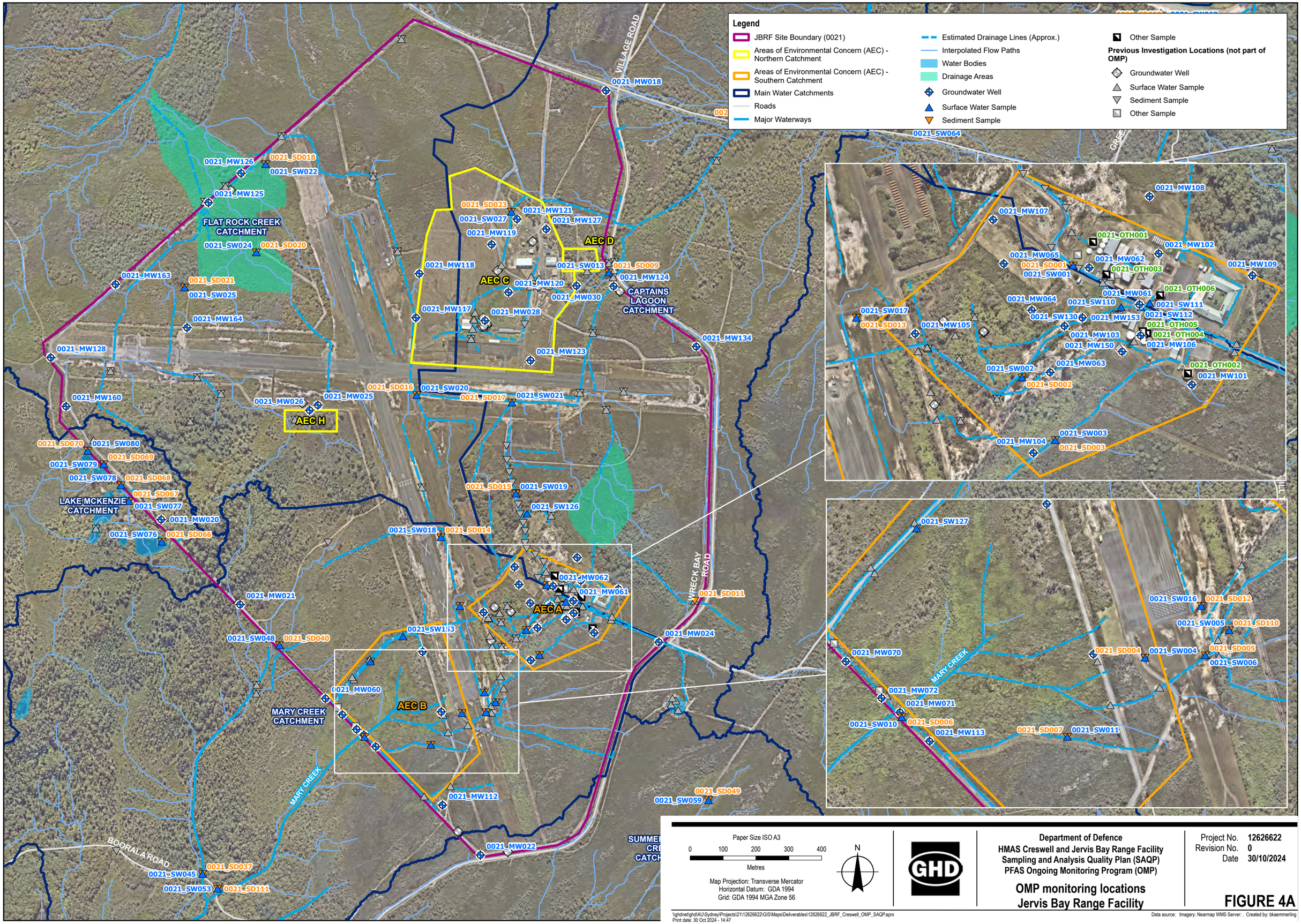

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Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)

OMP monitoring locations Jervis Bay Range Facility

Project No. **12626622**
Revision No. **0**
Date **30/10/2024**

FIGURE 4A

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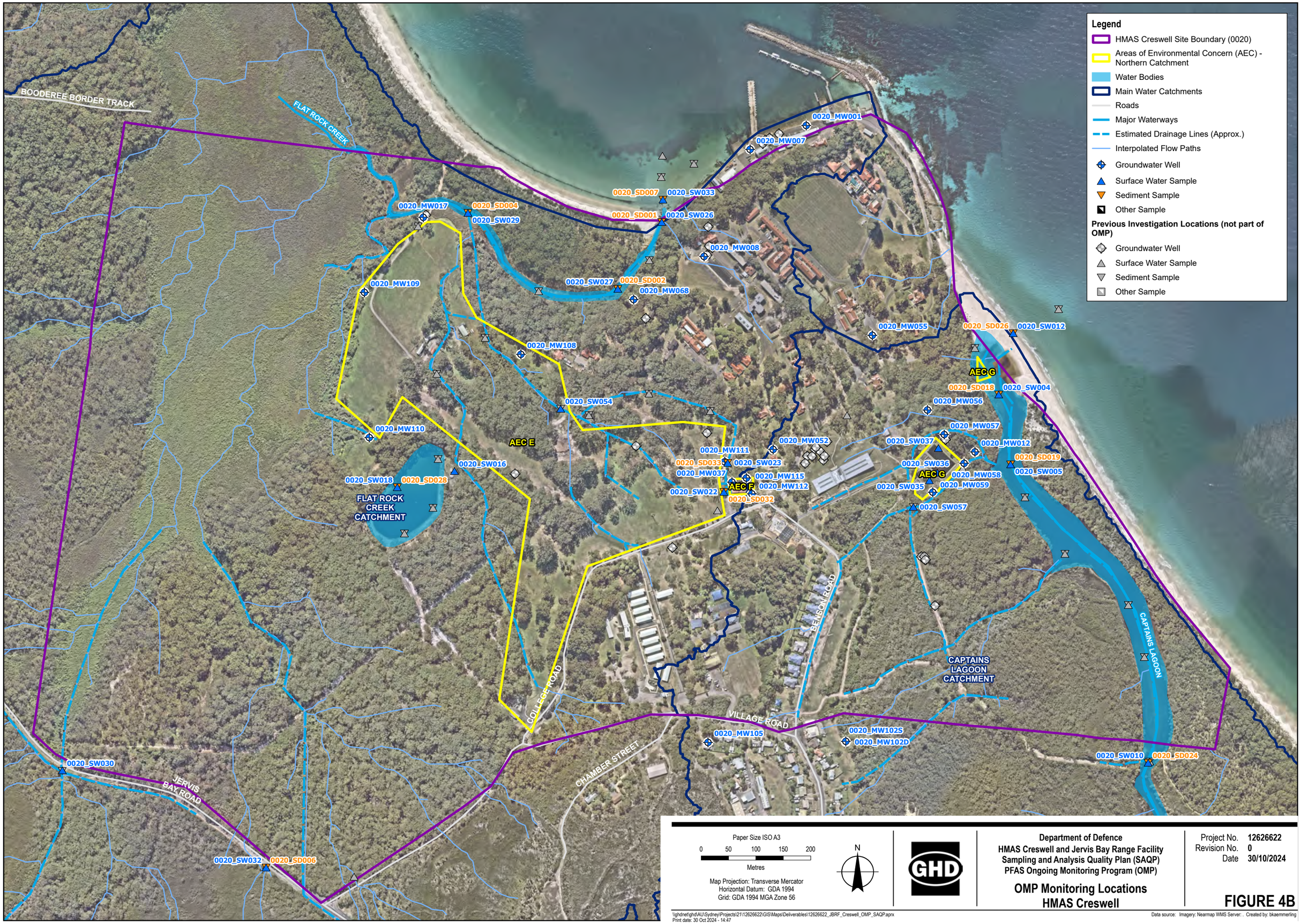
Legend
HMAS Creswell Site Boundary (0020)
Areas of Environmental Concern (AEC) - Northern Catchment
Water Bodies
Main Water Catchments
Roads
Major Waterways
Estimated Drainage Lines (Approx.)
Interpolated Flow Paths
Groundwater Well
Surface Water Sample
Sediment Sample
Other Sample
Previous Investigation Locations (not part of OMP)
Groundwater Well
Surface Water Sample
Sediment Sample
Other Sample
BOODEREE BORDER TRACK
FLAT ROCK CREEK
0020_MW001
0020_MW007
0020_SD007
0020_SW033
0020_MW017
0020_SD004
0020_SW029
0020_SD001
0020_SW026
0020_MW008
0020_MW109
0020_SW027
0020_SD002
0020_MW068
0020_MW055
0020_SD026
0020_SW012
0020_MW108
AEC G
0020_SD018
0020_SW004
0020_SW054
0020_MW056
0020_MW110
AEC E
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0020_SD033
0020_SW023
0020_SW036
0020_SW005
0020_MW037
0020_MW115
AEC G
0020_MW058
0020_SW018
0020_SD028
AEC F
0020_MW112
0020_SW035
0020_MW059
FLAT ROCK CREEK CATCHMENT
0020_SW022
0020_SD032
0020_SW057
BENSON ROAD
CAPTAINS LAGOON
CAPTAINS LAGOON CATCHMENT
COLLEGE ROAD
VILLAGE ROAD
0020_MW105
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Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)
OMP Monitoring Locations
HMAS Creswell
Project No. 12626622
Revision No. 0
Date 30/10/2024
FIGURE 4B
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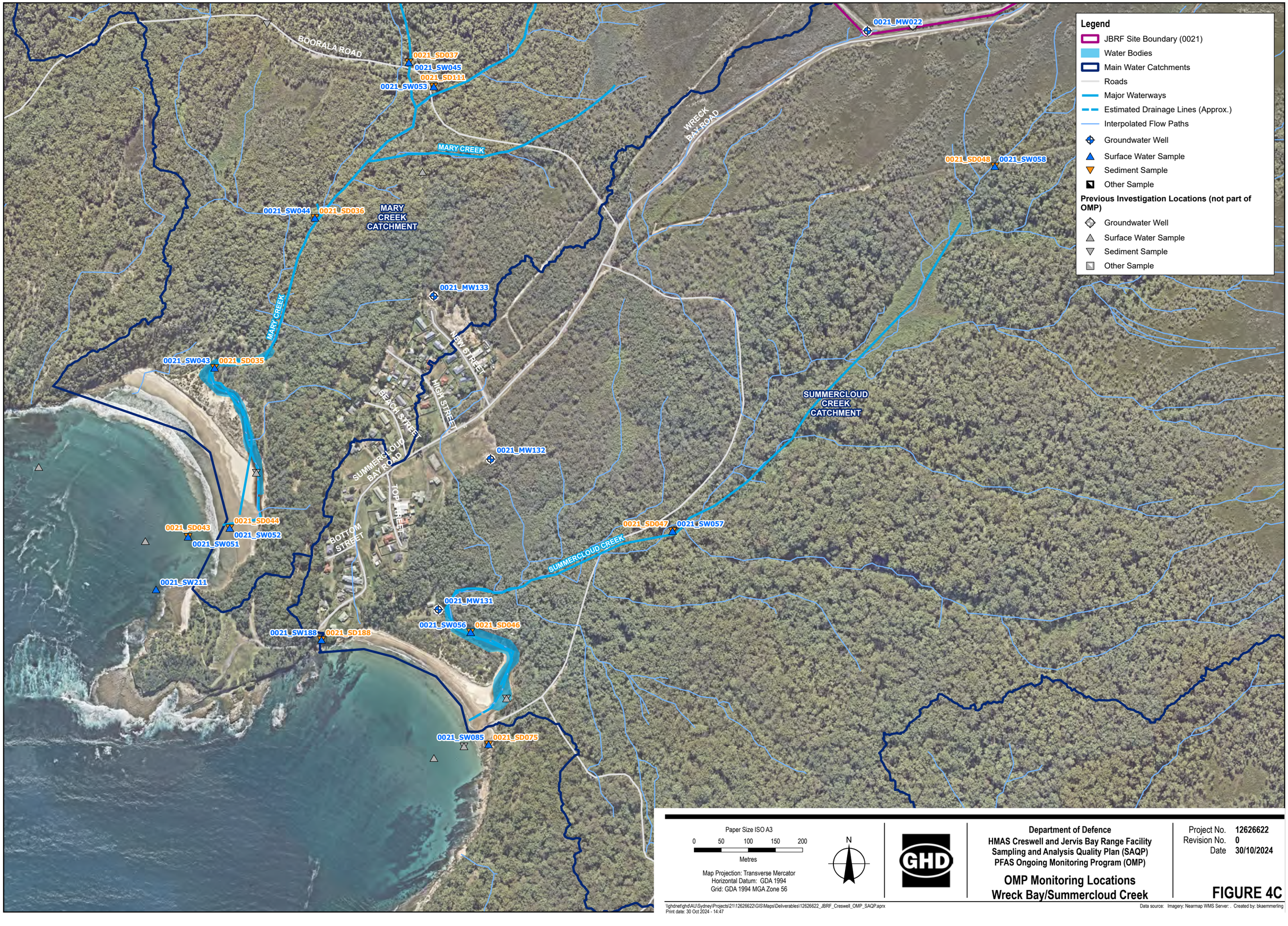

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Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)

OMP Monitoring Locations Wreck Bay/Summercloud Creek

Project No. **12626622**
Revision No. **0**
Date **30/10/2024**

FIGURE 4C

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Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)

OMP Monitoring Locations
The Lakes

Project No. **12626622**
Revision No. **0**
Date **30/10/2024**

FIGURE 4D

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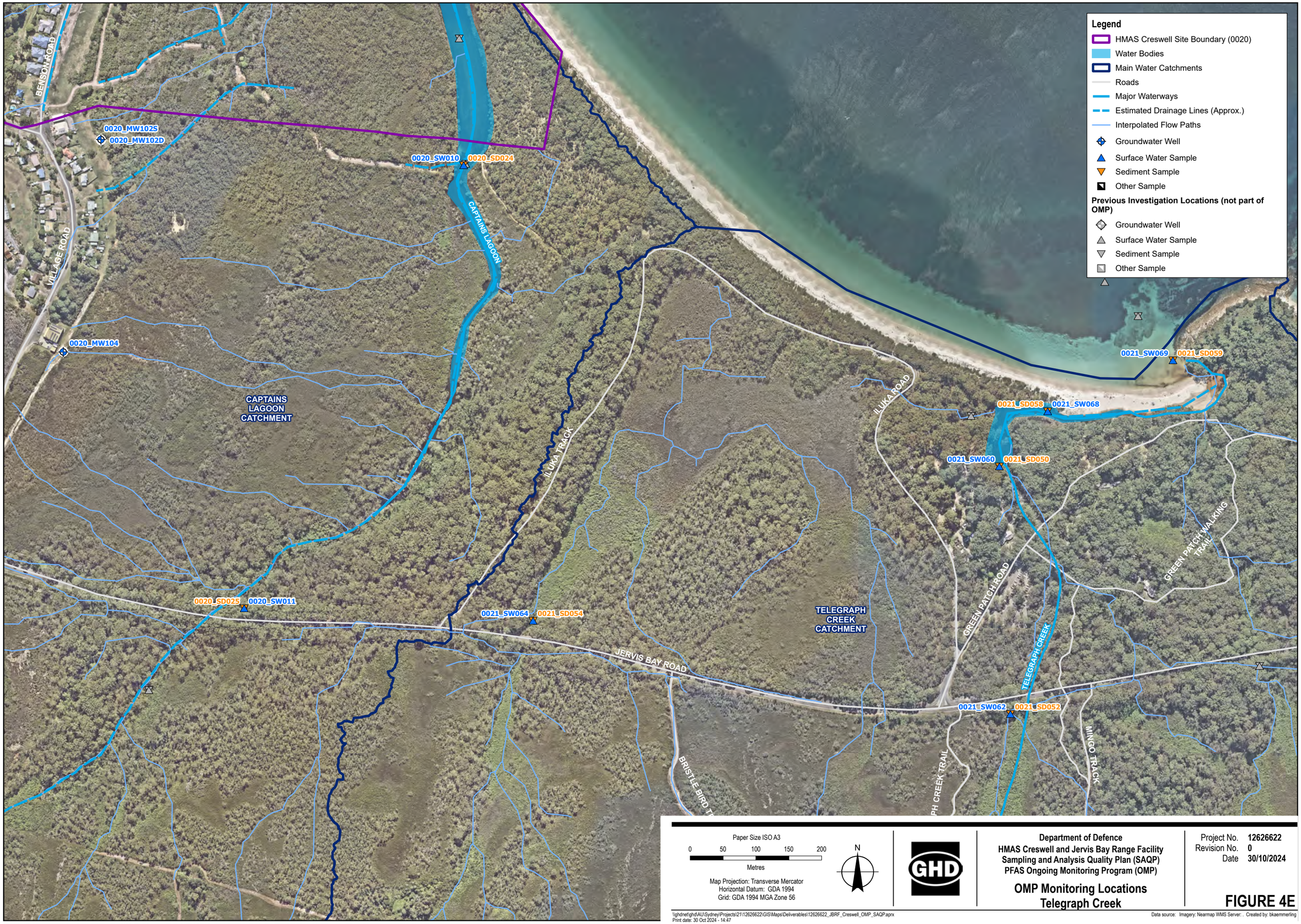

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GHD

Department of Defence
HMAS Creswell and Jervis Bay Range Facility
Sampling and Analysis Quality Plan (SAQP)
PFAS Ongoing Monitoring Program (OMP)

OMP Monitoring Locations
Telegraph Creek

Project No. **12626622**
Revision No. **0**
Date **30/10/2024**

FIGURE 4E

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Appendix B

OMP sampling locations

Table B 1 Groundwater sampling locations

Area	Monitoring Zone [1]	Location ID	Historical ID	Easting	Northing	Top of casing elevation (m AHD)	Screen interval (m bgl)	Reference Figure
HMAS Creswell	HMAS Creswell	0020_MW001	CRMW1, CR_MW1	291055.973	6110951.983	2.91	UN - 5.99	Figure 4B
		0020_MW007	MW10, 0020_MW10, MW010	290953.549	6110908.313	2.68	0.75 - 3.75	Figure 4B
		0020_MW008		290869.482	6110712.769	16.793	UN	Figure 4B
		0020_MW017	MW017	290356.824	6110784.230	1.998	2.0 - 5.0	Figure 4B
		0020_MW055		291176.672	6110568.705	16.199	1.6 - 3.6	Figure 4B
		0020_MW056		291277.242	6110432.172	8.055	1.1 - 4.1	Figure 4B
		0020_MW068		290740.920	6110634.150	12.91	4.7 - 7.7	Figure 4B
	AEC E	0020_MW108	E_MW03	290535.033	6110533.974	9.305	1.0 - 2.0	Figure 4B
		0020_MW109	E_MW04	290249.359	6110647.078	3.632	1.0 - 2.0	Figure 4B
		0020_MW110	E_MW05	290258.269	6110381.933	8.024	1.0 - 2.0	Figure 4B
	AEC F	0020_MW037		290920.419	6110300.515	31.099	3.0 - 6.0	Figure 4B
		0020_MW052		290995.578	6110360.290	27.662	0.7 - 2.2	Figure 4B
		0020_MW111	F_MW01	290907.196	6110337.651	27.018	1 - 3	Figure 4B
		0020_MW112	F_MW02	290956.700	6110279.210	31.546	1.0 - 4.0	Figure 4B
		0020_MW115		290946.710	6110307.990	31.26	1.8 - 4.8	Figure 4B
	AEC G	0020_MW012	MW12, MW012A	291364.036	6110355.680	3.901	3.0 - 6.0	Figure 4B
		0020_MW057		291307.942	6110387.453	6.05	0.8 - 3.8	Figure 4B
		0020_MW058		291344.189	6110334.919	6.131	2.0 - 5.0	Figure 4B
		0020_MW059		291287.010	6110282.037	10.065	1.0 - 3.0	Figure 4B
	Captains Lagoon	0020_MW102D	CL_MW02, 0020_MW102	291128.354	6109825.853	35.392	2.8 - 8.8	Figure 4B
		0020_MW102S	CL_MW02A, 0020_MW102A	291128.241	6109826.993	35.388	1.0 - 2.0	Figure 4B
		0020_MW104	CL_MW04	291070.956	6109503.606	47.422	4.0 - 10.0	Figure 4E
		0020_MW105	CL_MW05	290876.680	6109825.061	52.044	6.0 - 12.0	Figure 4B
JBRF	AEC A	0021_MW061		290764.587	6107648.954	71.59	0.85 - 2.85	Figure 4A
		0021_MW062		290703.312	6107693.790	69.85	1 - 3	Figure 4A

Area	Monitoring Zone [1]	Location ID	Historical ID	Easting	Northing	Top of casing elevation (m AHD)	Screen interval (m bgl)	Reference Figure
		0021_MW063		290655.768	6107566.497	68.68	0.7 - 5.0	Figure 4A
		0021_MW064		290633.558	6107642.063	68.26	0.7 - 5.0	Figure 4A
		0021_MW065		290599.451	6107698.659	68.15	1.0 - 5.0	Figure 4A
		0021_MW101	A_MW01	290828.470	6107551.279	75.084	1.0 - 2.0	Figure 4A
		0021_MW102	A_MW02	290787.901	6107710.981	72.299	1.0 - 1.8	Figure 4A
		0021_MW103	A_MW03	290673.210	6107622.859	68.856	1.0 - 2.0	Figure 4A
		0021_MW104	A_MW04	290635.551	6107468.217	69.524	1.0 - 2.0	Figure 4A
		0021_MW105	A_MW05	290491.579	6107613.423	64.291	1.0 - 2.0	Figure 4A
		0021_MW106	A_MW06	290766.014	6107611.265	72.928	1.0 - 2.5	Figure 4A
		0021_MW107	A_MW07	290586.379	6107752.175	67.191	1.0 - 4.0	Figure 4A
		0021_MW108	A_MW08	290776.799	6107780.714	70.443	1.0 - 2.5	Figure 4A
		0021_MW109	A_MW09	290902.001	6107684.325	74.47	1.0 - 4.0	Figure 4A
		0021_MW150		290743.400	6107591.730	71.51	3.0 - 5.0	Figure 4A
		0021_MW151		290742.660	6107592.810	71.58	2 - 3	Figure 4A
		0021_MW152		290742.080	6107593.740	71.54	1 - 2	Figure 4A
		0021_MW153		290694.930	6107632.960	69.36	2.85 - 4.85	Figure 4A
		0021_MW154		290693.650	6107632.930	69.35	2 - 3	Figure 4A
		0021_MW155		290692.530	6107633.050	69.23	0.75 - 2	Figure 4A
	AEC B	0021_MW060		290010.902	6107351.267	56.46	0.7 - 3.0	Figure 4A
		0021_MW070		290062.002	6107301.998	55.07	UN	Figure 4A
		0021_MW071		290127.795	6107240.119	51.63	UN	Figure 4A
		0021_MW072		290105.450	6107257.561	52.19	UN	Figure 4A
		0021_MW110	B_MW01	290363.295	6107310.967	60.049	1 - 2	Figure 4A
		0021_MW111	B_MW02	290306.443	6107493.884	61.117	1 - 2	Figure 4A
		0021_MW112	B_MW03	290367.053	6107026.943	62.949	1.0 - 2.5	Figure 4A
		0021_MW113	B_MW04	290163.822	6107204.885	52.785	1.0 - 2.0	Figure 4A
	AEC C	0021_MW117	C_MW01	290286.037	6108510.839	56.91	1.0 - 2.0	Figure 4A
		0021_MW118	C_MW02	290296.314	6108644.899	56.183	1.0 - 3.0	Figure 4A

Area	Monitoring Zone [1]	Location ID	Historical ID	Easting	Northing	Top of casing elevation (m AHD)	Screen interval (m bgl)	Reference Figure
		0021_MW119	C_MW03	290516.502	6108733.952	56.601	1.0 - 2.0	Figure 4A
		0021_MW120	C_MW04	290567.691	6108588.091	55.585	1.0 - 3.0	Figure 4A
		0021_MW121	C_MW05	290593.764	6108811.096	55.68	0.8 - 2.8	Figure 4A
		0021_MW123	C_MW07	290634.696	6108380.753	57.968	1.0 - 2.8	Figure 4A
	JBRF	0021_MW020		289511.025	6107896.296	62.15	5.0 - 8.0	Figure 4A
		0021_MW021		289751.053	6107637.677	60.365	5.0 - 8.0	Figure 4A
		0021_MW022		290482.222	6106874.883	67.159	3.8 - 6.8	Figure 4A
		0021_MW024		291025.305	6107522.890	80.537	6 - 9	Figure 4A
		0021_MW025		289987.817	6108244.758	60.769	2 - 5	Figure 4A
		0021_MW026	MW10	289962.765	6108229.124	60.795	4.75 - 7.75	Figure 4A
		0021_MW028	0021_MW08, MW8	290496.309	6108501.849	57.816	3.0 - 6.0	Figure 4A
		0021_MW030	MW6	290774.537	6108607.883	52.959	7.0 - 9.8	Figure 4A
		0021_MW125	FC_MW01	289654.800	6108861.450	48.13	1.0 - 3.0	Figure 4A
		0021_MW126	FC_MW02	289754.280	6108950.770	47.1	6.0 - 9.0	Figure 4A
		0021_MW127	FC_MW03	290682.480	6108780.580	54.49	4.0 - 7.0	Figure 4A
		0021_MW128	LM_MW01	289175.060	6108389.365	57.051	2.3 - 5.3	Figure 4A
		0021_MW160		289221.681	6108240.792	59.011	3.0 - 6.0	Figure 4A
		0021_MW163		289372.054	6108612.776	53.015	0.9 - 2.9	Figure 4A
		0021_MW164		289589.895	6108480.526	54.039	1.0 - 3.0	Figure 4A
	Captains Lagoon	0021_MW018		290864.247	6109202.482	50.001	5.0 - 8.0	Figure 4A
		0021_MW124	CL_MW01, 0020_MW101	290887.738	6108606.804	49.826	1.0 - 2.8	Figure 4A
	Telegraph Creek	0021_MW134	TC_MW01	291139.191	6108422.681	59.307	4.0 - 7.0	Figure 4A
403 lands	Mary Creek	0021_MW131	MC_MW02	-	-	4.767	4.0 - 7.0	Figure 4C
		0021_MW132	MC_MW03	-	-	26.593	5.5 - 11.5	Figure 4C
		0021_MW133	MC_MW04	-	-	34.361	4.0 - 10.0	Figure 4C
BNP	Bherwerre Barrier	0021_MW114	BB_MW01	286611.121	6108524.481	12.325	4 - 7	Figure 3
		0021_MW115	BB_MW02	286419.100	6107109.342	5.007	1 - 4	Figure 3

Area	Monitoring Zone [1]	Location ID	Historical ID	Easting	Northing	Top of casing elevation (m AHD)	Screen interval (m bgl)	Reference Figure
	Lake McKenzie	0021_MW129	LM_MW02	288041.834	6108008.845	47.694	26.0 - 30.6	Figure 4D
		0021_MW135	LM_MW03A	288008.000	6108639.520	47.54	31.27 - 40.27	Figure 4D
		0021_MW136	LM_MW03B	288012.420	6108644.530	47.633	20.05 - 26.05	Figure 4D
		0021_MW137	LM_MW03C	288009.670	6108641.470	47.708	5.05 - 11.05	Figure 4D
	Lake Windermere	0021_MW130	LW_MW01	288865.496	6109084.007	56.255	26.0 - 35.0	Figure 4D
		0021_MW138	LW_MW02A	288483.690	6108586.100	52.2	31.4 - 40.4	Figure 4D
		0021_MW139	LW_MW02B	288484.480	6108583.610	52.22	14.6 - 20.6	Figure 4D
		0021_MW140	LW_MW02C	288483.130	6108588.770	52.07	6.0 - 12.0	Figure 4D

Table Notes:
1 – Refer to Table 3 for catchment areas for each monitoring zone
Note: Historical ID, Eastings, Northings, Top of Casing Elevation and Screen Interval are sourced from the Defence ESdat database.
UN = Unkown

Table B 2 Surface water sampling locations

Area	Monitoring zone [1]	Location ID	Historical ID	Easting	Northing	Reference figure
HMAS Creswell	AEC E	0020_SW016	E_IRRIGATION_03	290413.700	6110320.660	Figure 4B
		0020_SW018	E_SW01	290309.190	6110291.120	Figure 4B
		0020_SW054	-	290607.550	6110434.400	Figure 4B
	AEC F	0020_SW022	F_SW01	290905.520	6110282.520	Figure 4B
		0020_SW023	F_SW02	290912.600	6110335.640	Figure 4B
	AEC G	0020_SW035	G_SW01	291280.770	6110303.610	Figure 4B
		0020_SW036	G_SW02	291295.140	6110317.650	Figure 4B
		0020_SW037	G_SW03	291297.200	6110362.770	Figure 4B
		0020_SW057	-	291251.460	6110255.210	Figure 4B
	Captains Lagoon	0020_SW004	CL_SW01	291407.300	6110460.470	Figure 4B
		0020_SW005	CL_SW02	291429.040	6110332.850	Figure 4B
		0020_SW012	CL_SW12	291433.740	6110572.470	Figure 4B
	Flatrock Creek	0020_SW026	FC_SW01	290792.130	6110775.460	Figure 4B

Area	Monitoring zone [1]	Location ID	Historical ID	Easting	Northing	Reference figure
		0020_SW027	FC_SW02	290711.880	6110653.450	Figure 4B
		0020_SW029	FC_SW04	290438.300	6110792.310	Figure 4B
		0020_SW033	FC_SW14	290794.330	6110816.420	Figure 4B
JBRF	AEC A	0021_SW110	-	290742.283	6107645.754	Figure 4A
		0021_SW111		290777.142	6107650.561	Figure 4E
		0021_SW112		290766.145	6107645.481	Figure 4A
		0021_SW126		290624.000	6107914.000	Figure 4A
		0021_SW130		290675.000	6107623.000	Figure 4A
	AEC A/B	0021_SW001	AB_SW01	290683.950	6107696.480	Figure 4A
		0021_SW002	AB_SW02	290621.530	6107560.200	Figure 4A
		0021_SW003	AB_SW03	290662.010	6107483.790	Figure 4A
		0021_SW004	AB_SW04	290426.130	6107306.540	Figure 4A
		0021_SW005	AB_SW05	290528.500	6107340.000	Figure 4A
		0021_SW006	AB_SW06	290499.460	6107309.510	Figure 4A
	AEC B	0021_SW010	B_SW01	290129.980	6107234.120	Figure 4A
		0021_SW011	B_SW02	290331.580	6107210.140	Figure 4A
		0021_SW127	-	290148.000	6107464.000	Figure 4A
		0021_SW153		290246.730	6107540.370	Figure 4A
	JBRF	0021_SW016	DC_SW01	290494.610	6107369.610	Figure 4A
		0021_SW017	DC_SW02	290419.840	6107632.750	Figure 4A
		0021_SW018	DC_SW03	290362.060	6107842.210	Figure 4A
		0021_SW019	DC_SW04	290590.230	6107975.270	Figure 4A
		0021_SW020	DC_SW05	290288.470	6108274.910	Figure 4A
		0021_SW021	DC_SW06	290578.190	6108252.420	Figure 4A
	Captains Lagoon	0021_SW013	CL_SW09	290873.110	6108648.010	Figure 4A
	Telegraph Creek	0021_SW068	TC_SW09	292568.590	6109413.150	Figure 4E
	Flatrock Creek	0021_SW022	FC_SW06	289828.770	6108977.950	Figure 4A
		0021_SW024	FC_SW08	289800.400	6108709.600	Figure 4A
		0021_SW025	FC_SW09	289581.990	6108602.420	Figure 4A

Area	Monitoring zone [1]	Location ID	Historical ID	Easting	Northing	Reference figure
		0021_SW027	FC_SW11	290576.620	6108832.990	Figure 4A
	Mary Creek	0021_SW048	MC_SW06	289870.790	6107513.250	Figure 4A
	Lake McKenzie	0021_SW032	LM_SW01	287669.770	6108446.980	Figure 4D
		0021_SW034	LM_SW03	288081.200	6108114.260	Figure 4D
	Lake Windermere	0021_SW037	LW_SW02	287861.990	6108927.060	Figure 4D
		0021_SW040	LW_SW05	288389.420	6109072.680	Figure 4D
403 lands	Mary Creek	0021_SW043	MC_SW01	-	-	Figure 4C
		0021_SW044	MC_SW02	-	-	Figure 4C
		0021_SW045	MC_SW03	-	-	Figure 4C
		0021_SW051	MC_SW09	-	-	Figure 4C
		0021_SW052	MC_SW10	-	-	Figure 4C
		0021_SW053	MC_SW11	-	-	Figure 4C
	Unnamed Water Bodies	0021_SW076	UN2_SW01	-	-	Figure 4A
		0021_SW077	UN2_SW02	-	-	Figure 4A
		0021_SW078	UN2_SW03	-	-	Figure 4A
		0021_SW079	UN2_SW04	-	-	Figure 4A
		0021_SW080	UN2_SW05	-	-	Figure 4A
		0021_SW085	UN3_SW05	-	-	Figure 4C
	Summercloud Creek	0021_SW056	SC_SW01	-	-	Figure 4C
		0021_SW057	SC_SW02	-	-	Figure 4C
		0021_SW058	SC_SW03	-	-	Figure 4C
		0021_SW059	SC_SW04	-	-	Figure 4A
		0021_SW188	-	-	-	Figure 4C
	Wreck Bay	0021_SW211	-	-	-	Figure 4C
BNP	Lake McKenzie	0021_SW035	LM_SW04	288754.650	6108073.370	Figure 4D
	Lake Windermere	0021_SW036	LW_SW01	288367.610	6109121.670	Figure 4D
		0021_SW038	LW_SW03	288212.170	6109606.520	Figure 3
	Telegraph Creek	0021_SW060	TC_SW01	292494.990	6109329.250	Figure 4E
		0021_SW062	TC_SW03	292511.830	6108952.300	Figure 4E

Area	Monitoring zone [1]	Location ID	Historical ID	Easting	Northing	Reference figure
		0021_SW064	TC_SW05	291785.650	6109094.410	Figure 4E
		0021_SW069	TC_SW10	292759.140	6109490.850	Figure 4E
	Captains Lagoon	0020_SW010	CL_SW07	291680.090	6109787.760	Figure 4E
		0020_SW011	FC_SW05	291346.100	6109113.370	Figure 4E
	Flatrock Creek	0020_SW030	FC_SW05	289697.860	6109773.990	Figure 4B
		0020_SW032	FC_SW13	290069.730	6109596.410	Figure 4B
	Ryan's Swamp	0021_SW083	UN3_SW03	-	-	Figure 3

Table Notes:
1 – Refer to Table 3 for catchment areas for each monitoring zone
Note: Historical ID, Eastings, Northings, Top of Casing Elevation and Screen Interval are sourced from the Defence ESdat database.
UN = Unkown

Table B 3 Sediment sampling locations

Area	Monitoring Zone [1]	Location ID	Historical ID	Easting	Northing	Figure Reference
HMAS Creswell	AEC E	0020_SD028	E_SD01	290309.190	6110291.120	Figure 4B
	AEC F	0020_SD032	F_SD01	290905.540	6110282.540	Figure 4B
		0020_SD033	F_SD02	290912.600	6110335.640	Figure 4B
	Captains Lagoon	0020_SD018	CL_SD01	291407.300	6110460.470	Figure 4B
		0020_SD019	CL_SD02	291429.040	6110332.850	Figure 4B
		0020_SD025	CL_SD08	291346.100	6109113.370	Figure 4E
		0020_SD026	CL_SD12	291433.740	6110572.470	Figure 4B
	Flatrock Creek	0020_SD001	FC_SD01	290792.130	6110775.460	Figure 4B
		0020_SD002	FC_SD02	290711.880	6110653.450	Figure 4B
		0020_SD004	FC_SD04	290438.300	6110792.310	Figure 4B
		0020_SD007	FC_SD14	290794.330	6110816.420	Figure 4B
JBRF	AEC A/B	0021_SD001	AB_SD01	290683.950	6107696.480	Figure 4A
		0021_SD002	AB_SD02	290621.530	6107560.200	Figure 4A
		0021_SD003	AB_SD03	290662.010	6107483.790	Figure 4A
		0021_SD004	AB_SD04	290426.130	6107306.540	Figure 4A

Area	Monitoring Zone [1]	Location ID	Historical ID	Easting	Northing	Figure Reference
		0021_SD005	AB_SD06	290499.460	6107309.510	Figure 4A
		0021_SD110		290528.500	6107340.000	Figure 4A
	AEC B	0021_SD006	B_SD01	290129.980	6107234.120	Figure 4A
		0021_SD007	B_SD02	290331.580	6107210.140	Figure 4A
	JBRF	0021_SD012	DC_SD01	290494.610	6107369.610	Figure 4A
		0021_SD013	DC_SD02	290419.840	6107632.750	Figure 4A
		0021_SD014	DC_SD03	290362.060	6107842.210	Figure 4A
		0021_SD015	DC_SD04	290590.230	6107975.270	Figure 4A
		0021_SD016	DC_SD05	290288.470	6108274.910	Figure 4A
		0021_SD017	DC_SD06	290578.190	6108252.420	Figure 4A
	Captains Lagoon	0021_SD009	CL_SD09	290873.110	6108648.010	Figure 4A
		0021_SD011	CL_SD11	291134.200	6107649.000	Figure 4A
	Flatrock Creek	0021_SD018	FC_SD06	289828.770	6108977.950	Figure 4A
		0021_SD020	FC_SD08	289800.400	6108709.600	Figure 4A
		0021_SD021	FC_SD09	289581.990	6108602.420	Figure 4A
		0021_SD023	FC_SD11	290576.620	6108832.990	Figure 4A
	Mary Creek	0021_SD040	MC_SD06	-	-	Figure 4A
403 lands		0021_SD035	MC_SD01	-	-	Figure 4C
		0021_SD036	MC_SD02	-	-	Figure 4C
		0021_SD037	MC_SD03	-	-	Figure 4C
		0021_SD043	MC_SD09	-	-	Figure 4C
		0021_SD044	MC_SD10	-	-	Figure 4C
	Unnamed Water Bodies	0021_SD066	UN2_SD01	-	-	Figure 4A
		0021_SD067	UN2_SD02	-	-	Figure 4A
		0021_SD068	UN2_SD03	-	-	Figure 4A
		0021_SD069	UN2_SD04	-	-	Figure 4A
		0021_SD070	UN2_SD05	-	-	Figure 4A
		0021_SD075	UN3_SD05	-	-	Figure 4C
	Summercloud Creek	0021_SD046	SC_SD01	-	-	Figure 4C

Area	Monitoring Zone [1]	Location ID	Historical ID	Easting	Northing	Figure Reference
		0021_SD047	SC_SD02	-	-	Figure 4C
		0021_SD048	SC_SD03	-	-	Figure 4C
		0021_SD188		-	-	Figure 4C
	Wreck Bay	0021_SD111		-	-	Figure 4C
BNP	Lake McKenzie	0021_SD028	LM_SD03_WW	288081.200	6108114.260	Figure 4D
		0021_SD029	LM_SD04	288754.650	6108073.370	Figure 4D
		0021_SD080	LM_SD01	287669.770	6108446.980	Figure 4D
	Lake Windermere	0021_SD030	LW_SD01	288367.610	6109121.670	Figure 4D
		0021_SD031	LW_SD02	287861.990	6108927.060	Figure 4D
		0021_SD032	LW_SD03	288212.170	6109606.520	Figure 3
		0021_SD093	LW_SD05	288389.420	6109072.680	Figure 4D
	Telegraph Creek	0021_SD050	TC_SD01	292494.990	6109329.250	Figure 4E
		0021_SD052	TC_SD03	292511.830	6108952.300	Figure 4E
		0021_SD054	TC_SD05	291785.650	6109094.410	Figure 4E
		0021_SD058	TC_SD09	292568.590	6109413.150	Figure 4E
		0021_SD059	TC_SD10	292759.140	6109490.850	Figure 4E
	Captains Lagoon	0020_SD024	CL_SD07	291680.090	6109787.760	Figure 4B
	Flatrock Creek	0020_SD006	FC_SD13	290069.730	6109596.410	Figure 4B
	Summercloud Creek	0021_SD049	SC_SD04	291176.250	6107041.830	Figure 4A
	Ryan's Swamp	0021_SD073	UN3_SD03	-	-	Figure 3

Table Notes:
1 – Refer to Table 3 for catchment areas for each monitoring zone
Note: Historical ID, Eastings, Northings, Top of Casing Elevation and Screen Interval are sourced from the Defence ESdat database.
UN = Unkown

Table B 4 Tank sampling locations

Media	Area	Monitoring Zone	Location ID	Historical ID	Easting	Northing	Figure Reference
Tank surface water	JBRF	AEC A	0021_OTH001	A_S415_SW05	290708.100	6107725.080	Figure 4A

Media	Area	Monitoring Zone	Location ID	Historical ID	Easting	Northing	Figure Reference
			0021_OTH002	A_S416_SW02	290823.460	6107565.010	Figure 4A
			0021_OTH003	A_S426_SW01	290724.240	6107685.500	Figure 4A
			0021_OTH004	A_S439_SW03	290773.710	6107613.960	Figure 4A
			0021_OTH005	A_S440_SW01	290768.630	6107616.290	Figure 4A
			0021_OTH006	A_S481_SW04	290789.590	6107660.100	Figure 4A

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