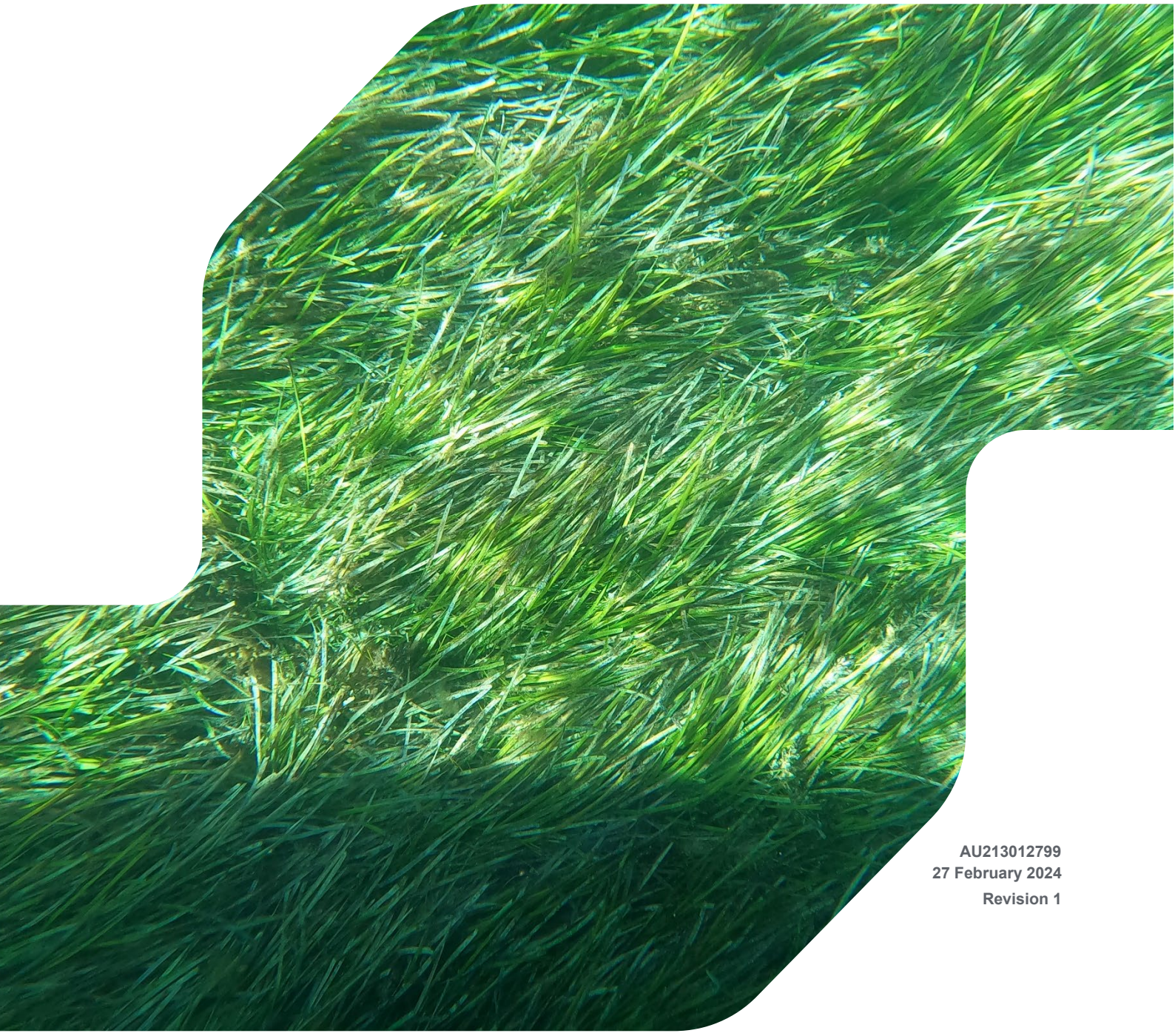
SOUTH THOMSON BARGE LANDING DEVELOPMENT

Marine Fauna and Benthic Habitat Assessment



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Rottnest Island Authority kaadatj Wadjak Noongar moort. Baalap Wadjemup kaaradjiny, baalabang malayin nakolak-ngat wer wirn kalyakoorl noyinang koort boodja-k wer kep-ak.

Ngalak kaadatj nedingar, birdiya wer boordakan Noongar moort. Ngalak karnadjil kaadatj maaman wer noba wirn Ali kalka Nino noyiyang Wadjemup ngardak boodja-k.

Baalabang moort maambart-boort, ngooni-boort,kongk-boort wer Birdiya-boort.

Rottnest Island Authority acknowledge Whadjuk Noongar families. They Wadjemup caring, their culture and spirits always connected Island-to and water-to.

We acknowledge ancestors, Elders and future Noongar families. We truly acknowledge men and boys' spirits who still remain connected Wadjemup under ground-in.

Their family's father-without, brother-without, uncle-without and Elder-without.

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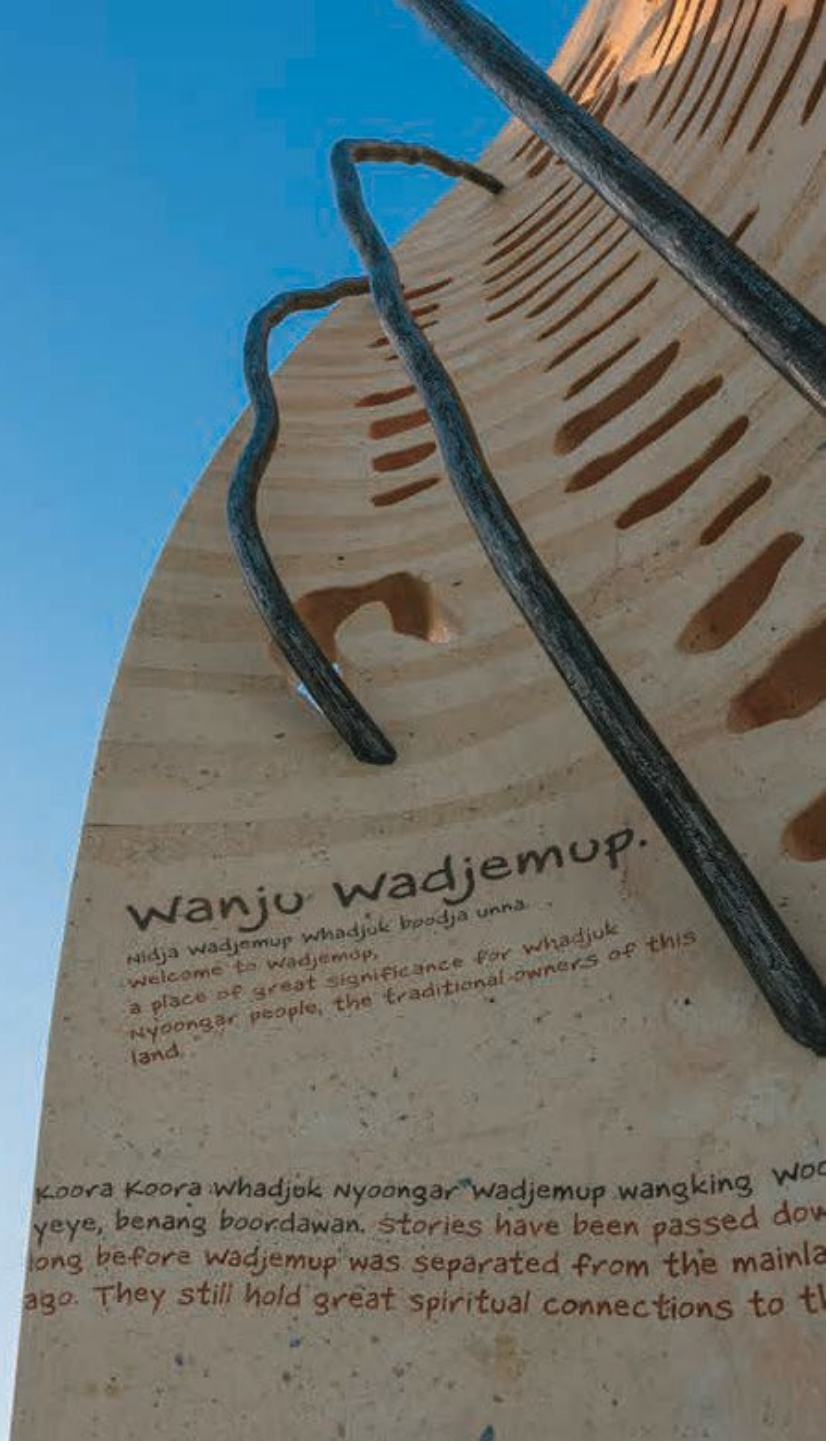

Koora-Yeye-Boordawan-Kalyakoorl

(Past-Present-Future-Forever)
sculpture, Thomson Bay

Document status

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Contents

ABBREVIATIONS – KEY TERMS AND LEGISLATION IV

1 INTRODUCTION 1
1.1 Background and location 1
1.2 Scope of Work 1

2 MARINE FAUNA DESKTOP ANALYSIS 3
2.1 Objectives 3
2.2 Commonwealth legislation 3
2.3 State legislation 3
2.4 Methods 4
2.4.1 Conservation important species 4
2.4.2 Non-conservation important species 4
2.5 Results and Discussion 5
2.5.1 Conservation important species 5
2.5.2 Non-conservation important species 12
2.6 Conclusions 21

3 DESCRIPTION OF BENTHIC HABITAT 22
3.1 Objectives 22
3.2 Methods 22
3.2.1 Field surveys 22
3.2.2 Data processing 23
3.3 Results and Discussion 24
3.3.1 Review of the Local Assessment Unit and habitat mapping by Harvey (2009) 24
3.3.2 Development of a benthic habitat map within the FSA 26
3.3.3 Development of a benthic habitat map within the Main Jetty Survey Area 27
3.3.4 Habitat loss due to the proposed development 31
3.3.5 Cumulative habitat loss 31

REFERENCES 33

Tables

Table 2-1: Species of conservation importance identified in the PMST and DBCA database reports that may occur in Thomspon Bay 7
Table 2-2: Non-conservation important fish species that may occur in Thomson Bay 13
Table 3-1: Classification scheme used in analysis of benthic habitat 23
Table 3-2: Comparison of habitat area estimates within the FSA by RPS (2019 and current) and Harvey (2009), using habitat types described by Harvey (2009) 25
Table 3-3: Habitat class across sites in FSA and expressed as a percentage from the 2023 and 2019 surveys (RPS, 2019b) and the percentage difference between the two surveys. 26
Table 3-4: Habitat class across sites in the area west of the FSA and expressed as a percentage from the 2024 survey. 27
Table 3-5: Area of habitats within development-related footprints using data collected by RPS in 2023 31
Appendix Table 1: EPBC Act (PMST) and BC Act (DBCA database) listed threatened, marine or migratory marine species in the search radius around Thomson Bay 36

Plates

Plate 3-1: Individual living *Posidonia* shoots (site number T10A) (left); accumulation of *Posidonia* wrack and new growth of seagrass at edge of *Posidonia* meadow (site number T10D) (right) in the northwest of the FSA 32

Figures

Figure 1-1: Detail of the proposed South Thomson Bay Maritime Facilities Redevelopment 2
Figure 2-1: Reef Life Survey sites in close proximity to Thomson Bay 5
Figure 3-1: Habitat map of Rottnest Island by Harvey (2009) 25
Figure 3-2: Benthic habitat map of the Field Survey Area and Main Jetty Survey Area within Thomson Bay, Rottnest Island 28
Figure 3-3: Detail of the benthic habitat map within the proposed development area 29
Figure 3-4: Benthic habitat map within the Main Jetty Survey Area, west of the FSA 30

Appendices

Appendix A PMST and DBCA database search results 35
Appendix B Field survey sites and GPS tracks 40
Appendix C Field survey data 43
Appendix D Thomson Bay aerial images 59

ABBREVIATIONS – KEY TERMS AND LEGISLATION

Term	Definition
ALA	Atlas of Living Australia
BC Act	*Biodiversity Conservation Act 2016* (WA)
BCH	Benthic marine communities and habitats
BIA	Biologically Important Area
DBCA	Department of Biodiversity, Conservation and Attractions
DBCA database	DBCA Threatened, Specially Protected and Priority fauna database
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
EP Act	*Environmental Protection Act 1986* (WA)
EPA	Environment Protection Authority (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FSA	Field survey area
ha	Hectare
hrs	Hours
km	Kilometre
kn	Knot
LAU	Local assessment unit
m	Metre
MNES	Matters of National Environmental Significance (Commonwealth)
PMST	Protected Matters Search Tool
QAQC	Quality assurance and quality control
RIA	Rottnest Island Authority
RIMP	Rottnest Island Management Plan
RLS	Reef Life Survey
RPS	RPS AAP Consulting Pty Ltd
WA	Western Australia

1 INTRODUCTION

1.1 Background and location

Wadjemup/ Rottnest Island, Western Australia (WA) is an A-class reserve with significant ecological, cultural, and social values (RIA, 2023). The marine reserve is characterised by a unique blend of tropical and temperate species, and a diverse range of habitats and communities including coral reefs, macroalgal reefs and extensive seagrass meadows. These habitats support over 400 species of fish and are highly valued by the many visitors to the island each year. Conservation of this unique environment in the face of increasing visitor pressure is one of five strategic focus areas highlighted by the Rottnest Island Authority (RIA), the body incorporated within the Department of Biodiversity, Conservation and Attractions (DBCA) which is responsible for the management of Rottnest Island (RIA, 2023).

Thomson Bay, located on the northeastern corner of the island, is designated a multi-use area with a range of facilities including the main ferry jetty, old army jetty and over 200 private moorings. A marine sanctuary zone is also located in the north of the bay. Benthic habitat within the bay is varied and includes seagrass meadows (*Posidonia* spp.) that comprise approximately 30% of the total seagrass area within Rottnest Island's nearshore habitats (RIA, 2023; Harvey, 2009). These meadows, which include *P. sinuosa* and *P. australis* are recognised as a Priority 3 Western Australian Priority Ecological Community by the DBCA due to their importance as a climax community that can take decades to centuries to develop, and their vulnerability to climate change (DBCA, 2023a). Other benthic habitat within Thomson Bay includes macroalgae and bare sand, the latter which may be covered by wrack that accumulates seasonally (RIA, 2023).

The *Rottnest Island Management Plan* (RIMP) *2023 – 2028* (RIA, 2023) identifies the need to redevelop the old army groyne, jetty, and associated shore facilities in south Thomson Bay to alleviate increasing demand for commercial marine and barge services at the main jetty. Initially introduced in the 20-year master plan for Rottnest Island (RIA, 2014), the RIA now intends to progress with this development, known as the South Thomson Bay Maritime Facilities Redevelopment, which comprises a barge landing area, breakwater and groyne constructed from limestone boulders, with seabed spoil from associated dredging operations used as infill (RIA, 2023, Figure 1-1).

The RIA previously contracted RPS in 2018 to undertake preliminary assessment of the environmental impacts anticipated from the proposed development (RPS, 2019a). These impacts were primarily associated with dredging operations and the development footprint on marine benthic communities and habitats (BCH), in particular seagrass meadows, and the marine fauna which inhabit these areas. RPS conducted a desktop fauna survey and baseline benthic habitat surveys in Thomson Bay, delivering a draft report to the RIA in 2019 (RPS, 2019b). Findings of the survey, based on the previous design, determined that there was estimated to be a 1.43 ha direct loss of seagrass at that time. RIA has re-initiated actions towards the redevelopment in 2023, contracting RPS to compile up-to-date information on the Thomson Bay area to determine the potential impacts of the development on the benthic habitats and associated marine fauna.

1.2 Scope of Work

In accordance with the *South Thomson Barge Development – Baseline Study Updates – Scope of Work* and associated clarifications received from the RIA, the scope of marine work included:

- Desktop assessment of conservation (national and WA State listed species) and non-conservation important marine species, that may be present in the Thomson Bay area
- Update the benthic habitat assessment undertaken by RPS in 2019 for the calculation of habitat loss and cumulative habitat loss as a consequence of the proposed development
- Separate description of benthic habitat in the vicinity of the main and fuel jetties, adjacent to and west of the main survey area.

These scopes are addressed below in Sections 2 and 3.

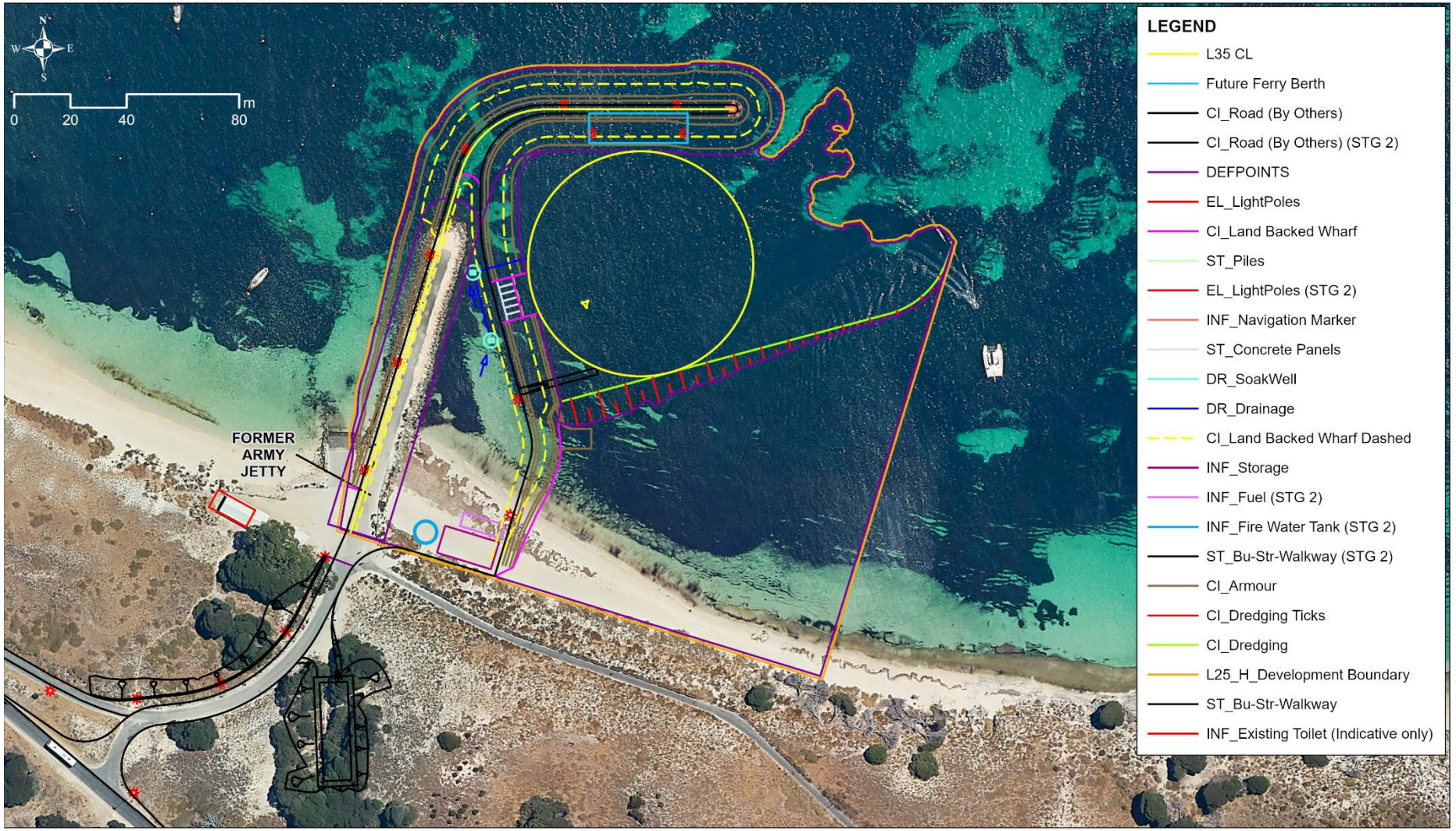

Figure 1-1: Detail of the proposed South Thomson Bay Maritime Facilities Redevelopment

2 MARINE FAUNA DESKTOP ANALYSIS

2.1 Objectives

Specific objectives of the marine fauna assessment were to:

- Identify and describe the seasonal presence of species that are protected under Commonwealth and WA legislation and likely to occur within a five kilometre (km) radius of the proposed development (noting this was revised to a 10 kilometre radius for species protected under WA legislation on advice from the DBCA)
- Identify non-conservation important fish species that have been recorded within or require habitat present in Thomson Bay, including description of habitat preferences and distribution of these species in Australian waters.

2.2 Commonwealth legislation

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation that provides a legal framework to protect and manage Matters of National Environmental Significance (MNES). Under the EPBC Act, an action requires approval from the minister if it has, will have, or is likely to have, a significant impact on MNES. The *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DoE 2013) outlines a self-assessment process to assist in determining whether the proposed action may have a 'significant' impact on MNES. If a proposal is likely to have a significant impact on MNES, then it must be referred for assessment under the EPBC Act.

MNES are defined as:

- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Ramsar wetlands of international importance
- The Commonwealth marine environment
- World Heritage properties
- The Great Barrier Reef Marine Park
- National Heritage places
- Nuclear actions
- A water resource, in relation to coal seam gas development and large coal mining development
- Protected marine species include species listed nationally as marine, threatened (Critically Endangered, Endangered, Vulnerable, Conservation Dependent), migratory, and all cetaceans (DCCEEW, 2023a).

2.3 State legislation

The *Biodiversity Conservation Act 2016* (BC Act) is the WA legislation that informs the environmental regulation process through providing a legal framework for protecting biodiversity, with an emphasis on threatened species and threatened ecological communities. The BC Act provides for species, subspecies, or populations of native animals (fauna) to be listed as Specially Protected, Threatened (Critically Endangered, Endangered or Vulnerable) or Extinct in WA, based on the national distribution of species that have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such (DBCA, 2023b).

Under the BC Act, a species or ecological community may be listed as threatened by the Minister for Environment. This gives special protection to the threatened species or threatened ecological community. Activities which may result in the taking or disturbance of all fauna requires lawful authority under the BC Act. Ministerial Authorisation under Section 40 of the BC Act is required to take or disturb threatened species.

2.4 Methods

2.4.1 Conservation important species

Fauna protected under the EPBC Act and BC Act was identified via desktop searches, as described below.

2.4.1.1 Commonwealth

A desktop search of the Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool (PMST) was undertaken on 26 October 2023, to identify MNES and other matters protected by the EPBC Act that may occur within a five-kilometre radius of the proposed development site (Appendix A).

2.4.1.2 State

A desktop search of the DBCA Threatened, Specially Protected and priority fauna database (DBCA database) was undertaken on request of RPS by the DBCA on 3 November 2023 (Appendix A). For this purpose, the DBCA recommended a 10 km 'buffer size' for waters around Rottnest Island, based on the number of records available in the general area and the range of local species. In data-rich areas, buffer sizes are reduced, whereas in data-deficient areas, buffer sizes are increased. This flexibility caters for complexity and ensure more meaningful results.

While originally stated in the scope of works (RPS DBCARIAQ1524, proposal to deliver the survey and assessment), the DBCA NatureMap search intended to supplement the above was not conducted because this online service is no longer available.

2.4.1.3 Determining likelihood of occurrence

The PMST and DBCA database reports were initially filtered to remove terrestrial and wetland species. For the remaining species the criteria for identifying those likely to occur within Thomson Bay and the development area were:

- Record of occurrence within five kilometres of Thomson Bay in the Atlas of Living Australia (ALA)
- Overlap with a Biologically Important Area (BIA).

Noting that all syngnathids listed in the PMST and/or DBCA database reports were considered likely to be present within Thomson Bay due to their cryptic nature and reduced likelihood of detection. Whilst seabirds and shorebirds were included in the list of species identified by the database reports (Appendix A) they were not assessed for likelihood of occurrence within Thomson Bay due to their mobility and capacity to move away from disturbance caused by development activities.

To provide further context for both the likelihood of the species being present and the potential impact of the proposed development on the population (if any), the distribution and/or habitat of each species within the search radius of Thomson Bay is described (as listed in the PMST results), together with their seasonal presence.

2.4.2 Non-conservation important species

The identity of non-conservation important species was achieved via a search of online literature. As described on the Wadjemup Rottnest Island website (https://www.rottnestisland.com/learn/sustainability/marine-sanctuary-zones), a large diversity of species is found in marine waters of Rottnest Island. Therefore, the online search focussed on marine species of fish that have been recorded or require habitat present in Thomson Bay (noting that marine mammals and reptiles are covered under the search of conservation-important species, and habitat forming species covered in the next section).

The online literature search utilised the following resources to identify fish species recorded in the waters in and around Thomson Bay:

- Hoschke, A., Whisson, G., & Moore, G. I. 2019. *Complete list of fishes from Rottnest Island 2019*. Compiled from a range of sources (including previous literature, ALA records and Reef Life Survey data)

- iNaturalist citizen science observation platform: *Fishes of Rottnest Island* (iNaturalist, 2023), which compiles up-to-date citizen science observations of marine fishes around Rottnest Island
- Reef Life Survey (RLS) citizen science program data (AODN, 2023). Utilises trained SCUBA divers to undertake standardised visual surveys in areas around Australia, including Rottnest Island.

Hoschke et al. (2019) compiled a list of 440 fish species recorded within the waters surrounding Rottnest Island. To refine this list to species that have been recorded in or that require habitat found within the development footprint or wider Thomson Bay, the iNaturalist resource was first searched, to identify all citizen science observations within this area. Then, the Reef Life Survey data, which utilises techniques that aim to capture both fish swimming within the water column as well as cryptobenthic fishes, were downloaded from across all survey years (2008 – 2023), for three nearshore sites in close proximity to Thomson Bay (Duck Rock South, Kingston Reef, The Count; Figure 2-1), in the absence of surveys occurring within the bay itself.

To provide further context for both the likelihood of the fish species being present, and the potential impact of the development on the population (if any), the habitat for which each species is typically associated and their broader distribution within Australian waters was described, using the Atlas of Living Australia (ALA, 2023), Fishes of Australia (FoA, 2024) and FishBase (Froese & Pauly, 2023) online resources.

Figure 2-1: Reef Life Survey sites in close proximity to Thomson Bay

2.5 Results and Discussion

A summary of the search results is provided below, identifying the conservation and non-conservation important matters returned and the relevance of the search results to the proposed development.

2.5.1 Conservation important species

Full results of the PMST and DBCA database searches are provided in Appendix A. These searches identified 41 threatened marine fauna species and 92 listed marine or migratory marine fauna species that may occur within Thomson Bay, including various marine megafauna (i.e., sharks, turtles, cetaceans), fish and seabirds. These species have diverse habitat preferences and lifestyles including highly mobile species (e.g., southern bluefin tuna), transient species that are not dependent on the habitat within Thomson Bay (e.g., cetaceans), and site-attached species such as syngnathids.

Based on criteria described in Section 2.4.1.3 and descriptions provided in the search results, 43 of those species listed in Appendix A are considered more likely to occur (conservatively at least) within Thomson Bay (Table 2-1), including the following species with overlapping BIAs:

- Australian sea lion (the development is within the foraging BIA for this species)
- Humpback whale (the development is within the migration BIA for this species)
- Pygmy blue whale (the development is within the distribution BIA for this species)
- Southern right whale (the development is within the migration BIA for this species.).

Of note is the potential presence of 26 syngnathid species, which are of relatively low (listed) conservation status but conservatively expected to be in the area due to their habitat preferences. Of these species, 20 may utilise seagrass habitats, during some of or all of their life history stages (Table 2-1). These species may also be more susceptible to impacts associated with development activities due to their small size and limited mobility.

Table 2-1: Species of conservation importance identified in the PMST and DBCA database reports that may occur in Thomspon Bay

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Species	**Common**	**EPBC Act**	**BC Act**		
Fish					
Acentronura australe	Southern pygmy pipehorse	Listed	Not included	Species or species habitat may occur within area	Inhabit algal reefs and seagrass beds, to depths of up to 30 m (FoA, 2024).
Campichthys galei	Gale's pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit shelly or rubble substrates and sparse seagrass beds, to depths of up to 18 m (FoA, 2024).
Choeroichthys suillus	Pig-snouted pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit rubble habitats of inshore coral reefs, to depths of up to 15 m (FoA, 2024).
Halicampus brocki	Brock's pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit coral and algal reefs, to depths of up to 45 m (FoA, 2024).
Heraldia nocturna	Upside-down pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit sheltered inshore rocky reefs, to depths of up to 30 m (FoA, 2024).
Hippocampus angustus	Western spiny seahorse	Listed	Not included	Species or species habitat may occur within area	Inhabit sheltered algal reefs and seagrass beds, to depths of up to 30 m (FoA, 2024).
Hippocampus breviceps	Short-head seahorse	Listed	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 15 m (FoA, 2024).
Hippocampus subelongatus	West Australian seahorse	Listed	Not included	Species or species habitat may occur within area	Inhabit macroalgal beds, muddy substrates, jetty pylons and moorings to depths of up to 25 m (FoA, 2024).
Histiogamphelus cristatus	Rhino pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and adjacent sandy areas, to depths of up to 17 m (FoA, 2024).
Lissocampus caudalis	Australian smooth pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit rubble habitats, macroalgal beds and seagrass beds and rocky reefs, to depths of up to 15 m (FoA, 2024).
Lissocampus fatiloquus	Prophet's pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit rocky and sand habitats, and seagrass and macroalgal beds, to depths of up to 10 m (FoA, 2024).
Lissocampus runa	Javelin pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds and rubble substrates, to depths of up to 20 m (FoA, 2024).

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Maroubra perserrata	Sawtooth pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit coral reefs, to depths of up to 25 m (FoA, 2024).
Mitotichthys meraculus	Western crested pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds to depths of up to 10 m (FoA, 2024).
Nannocampus subosseus	Bonyhead pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit a range of habitats including seagrass and macroalgal beds, sandy and coral reef habitats, to depths of up to 14 m (FoA, 2024).
Phycodurus eques	Leafy seadragon	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and algal reefs, to depths of up to 50 m (FoA, 2024).
Phyllopteryx taeniolatus	Common seadragon	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and algal reefs, to depths of up to 50 m (FoA, 2024).
Pugnaso curtirostris	Pugnose pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 11 m (FoA, 2024).
Solegnathus lettiensis	Gunther's pipefish	Listed	Not included	Species or species habitat may occur within area	Little is known about the habitat for this species.
Stigmatopora argus	Spotted pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds, to depths of up to 8 m (FoA, 2024).
Stigmatopora nigra	Widebody pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit sheltered seagrass and macroalgal beds, to depths of up to 35 m (FoA, 2024).
Syngnathoides biaculeatus	Double-end pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, to depths of up to 10 m (FoA, 2024).
Urocampus carinirostris	Hairy pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds, to depths of up to 6 m (FoA, 2024).
Vanacampus margaritifer	Mother-of-pearl pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, rocky and sandy substrates, to depths of up to 15 m (FoA, 2024).
Vanacampus phillipi	Port Phillip pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, to depths of up to 25 m (FoA, 2024).
Vanacampus poecilolaemus	Longsnout pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 18 m (FoA, 2024).
Sharks					
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	Not included	Species or species habitat likely to occur within area	Undertake annual foraging and breeding migrations. Known to aggregate in the

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
					Shoalwater Islands Marine Park, where peak numbers are observed during January and February (López et al. 2022; 2023).
Carcharias taurus (west coast population)	Grey nurse shark (west coast population)	Vulnerable	Not included	Congregation or aggregation known to occur within area	Year-round presence. Seasonal migration patterns have not been observed (Last & Stevens 2009, DCCEEW, 2023b).
Carcharodon carcharias	White shark	Vulnerable, Migratory	Vulnerable	Species or species habitat known to occur within area	Have been shown to undertake migrations north along the WA coast during spring and return in summer; however, coastal movements are not synchronous i.e., some sharks move north while others move south during the same period (McAuley et al. 2016). They are frequently recorded in waters around fur seal and sea lion colonies, including in the Perth region (ALA, 2023; DCCEEW, 2023b), where they are more likely to be present during spring and early summer and least likely to be present during late summer and autumn (SharkSmart 2018).
Mammals					
Neophoca cinerea	Australian sea lion	Endangered	Endangered	Species or species habitat likely to occur within area. The development footprint is located within the foraging BIA for this species.	Has an asynchronous non-annual breeding cycle with cycles ranging from 16 to 20 months and pupping occurring at different times throughout the South-West Marine Region (DCCEEW, 2023b).
Eubalaena Australis	Southern right whale	Endangered, Migratory	Vulnerable	The development footprint is located within the migratory BIA for this species**	Southern temperate to subpolar waters including marine areas of southern Australia from May to October. The migratory period within the migration BIA up the west coast of WA is April to October (ALA; NCVA, 2023).
Balaenoptera musculus brevicauda	Pygmy blue whale	Endangered	Not included	Known to occur in the area. The development footprint is located within the distribution BIA for this species.	The northbound migration past Perth Canyon occurs between April and July (peak May to June), with the return migration from October to January (peak

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
					November to early December; Thums et al. 2022).
Megaptera novaeangliae	Humpback whale	Migratory	Conservation Dependent, Migratory	Species or species habitat known to occur within area. The development footprint is located within the migratory BIA for this species.	The annual peak northbound migration along the Jurien Bay to Carnarvon migration route occurs between June and July, while the southbound migration peak occurs between September and October (ALA, 2023; DCCEEW, 2023b; Jenner et al. 2001).
Orcinus orca	Killer whale, Orca	Migratory	Not included	Species or species habitat may occur within area	Mating is known to occur all year round, whilst the calving season spans several months. However, no areas of significance and no determined migration routes have been identified for this species within waters off WA (DCCEEW, 2023b). They are typically present on the south coast of WA between January to April.
Arctocephalus forsteri	New Zealand fur seal	Listed	Other Specially Protected	Species or species habitat may occur within area. The New Zealand fur seal colony on Rottnest Island is located at Cathedral Rocks on the west end of Rottnest Island.	Present year round (ALA, 2023).
Balaenoptera acutorostrata	Minke whale	Listed	Not included	Species or species habitat may occur within area	May migrate from high latitude areas in the summer to low latitude areas in the winter. The detailed pattern of seasonal migration is generally poorly understood (ALA, 2023).
Tursiops aduncus	Indian ocean bottlenose dolphin	Listed	Not included	Species or species habitat likely to occur within area	Present year-round. Movement patterns in Australia are variable.
Tursiops truncatus s. str.	Bottlenose dolphin	Listed	Not included	Species or species habitat may occur within area	Seasonal movements are variable, and may include residency in small areas, long-range movements, and migration (DCCEEW, 2023b).
Stenella longirostris	Spinner dolphin	Not included	Priority 4, Migratory	Sighted in field survey in DBCA database data. Assumed species or species habitat may occur within area.	No seasonal differences, but mostly offshore species (ALA)

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Reptiles					
Caretta caretta	Loggerhead turtle	Endangered, Migratory	Not included	Foraging, feeding or related behaviour known to occur within area	Generally nesting in summer at nesting grounds in northern WA (not necessarily every year; ALA, 2023).
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory	Vulnerable	Species or species habitat known to occur within area	Migrates from foraging areas to nesting beaches in tropical and subtropical regions during summer (ALA, 2023; DCCEEW, 2023b).
Chelonia mydas	Green turtle	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour known to occur within area	Migrates from foraging areas to nesting beaches in tropical regions during summer, typically between November and March (DCCEEW, 2023b).
Pelamis platurus	Yellow-bellied seasnake	Listed	Not included	Species or species habitat may occur within area	Seasonal movements have not been observed in Australia hence may be present year-round.

*As listed in the PMST search results and/or Atlas of Living Australia (ala.org.au)

** Although the PMST search indicates that breeding by *E. australis* may occur within the PMST search area, a review of the online National Conservation Values Atlas indicates that this is not the case and only the migration BIA for the species overlaps Thomson Bay

Definitions: BC Act = *Biodiversity Conservation Act 2016* (WA), BIA = Biologically Important Area, DBCA = Department of Biodiversity, Conservation and Attractions (WA), EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

Priority 4 = Rare, Near Threatened and other species in need of monitoring (BC Act)

Other Specially Protected = Species otherwise in need of special protection (BC Act)

2.5.2 Non-conservation important species

The online literature review identified 440 species of fish species that are considered to have been reliably recorded within the waters surrounding Rottnest Island (Hoschke, et al., 2019). Of these species, recent surveys (2008 - 2023, RLS) and citizen science observations (2017 - 2022, iNaturalist) refined this number to 137 species that have been recorded in the vicinity of Thomson Bay and may occur or utilise habitat within the development footprint (Table 2-2). No species identified in the PMST were included in this list.

The fish listed in Table 2-2 include both cartilaginous fishes (benthic sharks and rays), as well as a broad suite of bony fishes, which encompass highly diverse habitat preferences and uses. These range from species that may occasionally pass through the bay but are unlikely to depend upon habitat within the development footprint (e.g., West Australian dhufish), to more site-attached species that are commonly found in habitat present in the development footprint (e.g., Germain's blenny). Many of the latter species are more strongly associated with hard substrate habitat such as reef which comprise only a small proportion of the Thomson Bay survey area. However, as shown in Section 3, the proposed development overlaps seagrass habitat with which 26 non-conservation important fish species are associated (Table 2-2). Of these, several utilise seagrass meadows primarily as a nursery habitat as juveniles, whilst others are associated with a broader range of habitats throughout their life history stages.

Table 2-2: Non-conservation important fish species that may occur in Thomson Bay

Name		Habitat*	Australian Distribution*
Species	Common		
Abudefduf sexfasciatus	Scissortail sergeant	Inhabit reefs, to depths of up to 15 m	Temperate to tropical waters Australia-wide
Abudefduf vaigiensis	Indo-Pacific sergeant	Inhabit reefs, to depths of up to 15 m	Temperate to tropical waters Australia-wide
Acanthaluteres brownii	Spinytail leatherjacket	Inhabit inshore reefs and adjacent seagrass beds, to depths up to 25 m	Endemic to southern Australia (Shark Bay, WA to Rapid Head, SA)
Acanthaluteres vittiger	Toothbrush leatherjacket	Inhabit shallow sheltered seagrass beds and rocky reefs, to depths up to 45 m	Endemic to southern Australia (Coffs Harbour, NSW to north of Leeman, WA)
Acanthistius serratus	Western wirrah	Inhabit reefs of coastal waters, often sheltering in caves, to depths of up to 40 m	Temperate to tropical waters (Ceduna, SA to Shark Bay, WA)
Achoerodus gouldii	Western blue groper	Inhabit coastal and offshore reefs, usually at depths of 5 to 40 m	Endemic to temperate coastal waters of southern Australia (Inverlock, VIC to Houtman Abrolhos Islands, WA)
Anampses caeruleopunctatus	Diamond wrasse	Inhabit reefs, to depths of up to 30 m	Temperate to tropical waters Australia-wide
Anampses geographicus	Scribbled wrasse	Inhabit shallow reefs	Temperate to tropical waters Australia-wide
Anampses meleagrides	Speckled wrasse	Inhabit areas of mixed coral rubble and sand on seaward reefs, to depths of up to 30 m	Temperate to tropical waters Australia-wide
Anoplocapros amygdaloides	Western smooth boxfish	Inhabit offshore reef and seagrass beds, to depths of up to 100 m	Endemic to temperate waters of southern and southwestern Australia (Shark Bay, WA to Great Australian Bight, SA)
Anoplocapros lenticularis	Whitebarred boxfish	Inhabit offshore reefs and jetty pylons, to depths of up to 250 m	Endemic to temperate waters of southern and southwestern Australia (Houtman Abrolhos Islands, WA to Western Port, VIC)
Aplodactylus westralis	Western seacarp	Inhabit rocky reefs with abundant macroalgae, to depths of up to 20 m	Temperate waters (Yorke Peninsula, SA to Rottnest Island, WA)
Apogon victoriae	Western striped cardinalfish	Nocturnal, inhabiting caves and ledges of shallow reefs	Endemic to Western Australia (Cape Leeuwin, WA to the Cobourg Peninsula, NT)
Arripis georgianus	Australian herring	Inhabit seagrass and macroalgal beds in inshore bays and estuaries, to depths of up to 50 m	Endemic to southern Australia (Forster, NSW to Swan River, WA, including Tasmania)
Aspidontus taeniatus	False cleanerfish	Inhabit reef flats and lagoons, to depths of up to 25 m	Temperate to tropical waters Australia-wide
Aulohalaelurus labiosus	Blackspotted catshark	Nocturnal, inhabiting reefs, to depths of up to 10 m	Endemic to south-western WA (Recherche Archipelago to the Houtman Abrolhos Islands)
Austrolabrus maculatus	Blackspotted wrasse	Inhabit exposed reefs, to depths of up to 40 m	Endemic to southern Australia (Fraser Island, QLD to Shark Bay, WA)

Name		Habitat*	Australian Distribution*
Bathytoshia brevicaudata	Smooth stingray	Inhabit sandy areas in coastal bays and reefs, to depths of up to 150 m	Temperate waters of southern Australia
Bodianus frenchii	Foxfish	Inhabit caves and ledges of deeper offshore reefs, to depths of up to 82 m	Temperate waters of southern Australia
Caesioscorpis theagenes	Blowhole perch	Inhabit offshore reefs, to depths of up to 30 m	Endemic to WA (Albany to Shark Bay)
Chaetodon assarius	Western butterflyfish	Inhabit reefs, to depths of up to 40 m	Endemic to WA (Israelite Bay to Northwest Shelf)
Chelmonops curiosus	Western talma	Inhabit coastal rocky reefs, to depths of up to 60 m	Endemic to south-western Australia (Victor Harbor, SA to Shark Bay, WA)
Chironemus maculosus	Silver spot	Inhabit rocky reefs, to depths of up to 10 m	Temperate waters of southern Australia (Jervis Bay, NSW to Rottnest Island, WA)
Chlorurus sordidus	Bullethead parrotfish	Inhabit reefs and lagoons, to depths of up to 50 m	Temperate to tropical waters Australia-wide
Choerodon rubescens	Baldchin groper	Inhabit coastal and offshore reefs and adjacent weedy areas, to depths of up to 30 m	Endemic to WA (Cape Leeuwin to Ningaloo Reef)
Chromis klunzingeri	Blackhead puller	Inhabit inshore and offshore reefs, to depths of up to 40 m	Endemic to southern WA (Recherche Archipelago to the Houtman Abrolhos Islands)
Chromis westAustralis	West Australian puller	Inhabit reefs, to depths of up to 75 m	Endemic to western and northern Australia (Recherche Archipelago, WA to Evans Shoal, NT)
Cirripectes hutchinsi	Hutchins' blenny	Inhabit shallow reefs, to depths of up to 22 m	Endemic to WA (Rottnest Island to North West Cape)
Cnidoglanis macrocephalus	Estuary cobbler	Nocturnal, inhabit sandy and muddy bottoms often amongst rocks, algae and wrack, to depths of up to 30 m	Endemic to temperate southern Australia (Moreton Bay, QLD to Houtman Abrolhos Islands, WA)
Cochleoceps bicolor	Western cleaner clingfish	Inhabit rocky reefs, to depths of up to 40 m	Endemic to southern Australia (Port Phillip, VIC to Lancelin, WA)
Coris auricularis	Western king wrasse	Inhabit sandy areas and seagrass beds around offshore reefs, to depths of up to 45 m	Temperate to subtropical waters of south-western Australia
Cristiceps aurantiacus	Yellow crested weedfish	Inhabit rock pools, subtidal rocky reefs, macroalgal beds and wrack on adjacent sandy areas, to depths of up to 30 m	Temperate to subtropical waters on Australia's east and west coasts
Dactylophora nigricans	Dusky morwong	Inhabit rocky reefs, seagrass beds and sandy lagoons, to depths of up to 20 m	Endemic to southern Australia (Clarence River, NSW to Houtman Abrolhos Islands, WA)
Dinolestes lewini	Longfin pike	Inhabit seagrass beds, reefs and bays, to depths of up to 65 m	Endemic to southern Australia (Newcastle, NSW to Perth region, WA)
Diodon nicthemerus	Globefish	Inhabit sheltered reefs and weedy habitats, to depths of up to 85 m	Endemic to southern Australia (Seal Rocks, NSW to Houtman Abrolhos Islands, WA)
Dotalabrus alleni	Little rainbow wrasse	Inhabit shallow rocky reefs, to depths of up to 15 m	Endemic to southern WA (Recherche Archipelago to the Houtman Abrolhos Islands)

Name		Habitat*	Australian Distribution*
Dotalabrus aurantiacus	Castelnau's wrasse	Inhabit seagrass beds, reefs and sheltered bays, to depths of up to 47 m	Endemic to southern Australia (Point Hicks, VIC to Rottnest Island, WA)
Enoplosus armatus	Old wife	Inhabit inshore reefs and macroalgal beds, to depths of up to 100 m	Endemic to southern Australia (Fraser Island, QLD to South Passage, WA)
Eocallionymus papilio	Painted stinkfish	Inhabit muddy and shelly bays, to depths of up to 50 m	Temperate and sub-tropical waters (Mudjimba Island, QLD to Kalbarri, WA)
Epinephelides armatus	Breaksea cod	Inhabit offshore reefs, to depths of up to 100 m	Endemic to WA (Recherche Archipelago to Shark Bay)
Eubalichthys cyanoura	Bluetail leatherjacket	Inhabit coastal reefs, to depths of up to 30 m	Endemic to southern Australia (York Peninsula, SA to Dongara, WA)
Eubalichthys gunnii	Gunn's leatherjacket	Inhabit bays and coastal reefs, to depths of up to 55 m	Temperate coastal waters
Eubalichthys mosaicus	Mosaic leatherjacket	Inhabit offshore and coastal reefs, to depths of up to 150 m	Endemic to southern Australia (Noosa, QLD to Dongara, WA)
Eupetrichthys angustipes	Snakeskin wrasse	Inhabit sheltered sandy areas adjacent to reefs, to depths of up to 40 m	Endemic to southern Australia (northern NSW to Houtman Abrolhos Islands, WA)
Eviota bimaculata	Twospot eviota	Inhabit rocky and coral reefs, to depths of up to 10 m	Temperate to subtropical waters of southwestern Australia (Ceduna, SA to North West Cape, WA)
Girella tephraeops	Western rock blackfish	Inhabit coastal reefs, to depths of up to 20 m	Endemic to WA (Israelite Bay to north of Shark Bay)
Girella zebra	Zebrafish	Inhabit bays and coastal reefs, to depths of up to 20 m	Endemic to southern Australia (Clarence River, NSW to Port Denison, WA)
Glaucosoma hebraicum	West Australian dhufish	Inhabit rocky outcrops and ledges, to depths of up to 200 m	Endemic to WA (Esperance to Shark Bay)
Goniistius gibbosus	Magpie morwong	Inhabit shallow protected reefs and sandy areas, to depths of up to 20 m	Endemic to WA (Recherche Archipelago to Shark Bay)
Goniistius rubrolabiatus	Redlip morwong	Inhabit inshore rocky reefs, to depths of up to 30 m	Endemic to WA (Recherche Archipelago to Coral Bay)
Halichoeres brownfieldi	Brownfield's wrasse	Inhabit macroalgal reefs and adjacent seagrass beds, to depths of up to 30 m	Endemic to WA (Israelite Bay to Exmouth Gulf)
Halichoeres nigrescens	Bubblefin wrasse	Inhabit shallow reefs, to depths of up to 10 m	Tropical waters (Dampier Archipelago, WA to Hervey Bay, QLD)
Helcogramma decurrens	Blackthroat threefin	Inhabit intertidal and subtidal macroalgal rocky reefs, to depths of up to 13 m	Temperate coastal waters of southern Australia
Heteroscarus acroptilus	Rainbow cale	Inhabit exposed rocky reefs and seagrass beds, to depths of up to 60 m	Endemic to southern Australia (Seal Rocks, NSW to Point Gregory, WA)
Hyperlophus vittatus	Sandy sprat	Inhabit shallow sandy areas and seagrass beds, to depths of up to 29 m	Temperate waters of southern Australia (Moreton Bay, QLD to Kalbarri, WA)

Name		Habitat*	Australian Distribution*
Hypoplectrodes nigroruber	Banded seaperch	Inhabit rocky reefs, to depths of up to 30 m	Endemic to southern Australia (Solitary Islands, NSW to Houtman Abrolhos Islands, WA)
Kyphosus cornelii	Western buffalo bream	Inhabit coral and rocky reefs, to depths of up to 20 m	Endemic to WA (Cape Naturaliste to Shark Bay)
Kyphosus gladius	Gladius drummer	Inhabit rocky substrates, to depths of up to 20 m	Endemic to temperate WA (Albany to Houtman Abrolhos Islands)
Kyphosus sydneyanus	Silver drummer	Inhabit exposed rocky reefs, to depths of up to 30 m	Temperate waters of southern Australia (Fraser Island, QLD to Houtman Abrolhos Islands, WA)
Labroides dimidiatus	Common cleanerfish	Inhabit coral reefs, to depths of up to 40 m	Temperate to tropical waters across northern Australia (Perth, WA to Sydney, NSW)
Latropiscis purpurissatus	Sergeant baker	Inhabit soft bottom habitats, rocky and coral reefs, to depths of up to 250 m	Endemic to southern Australia (Double Island Point, QLD to Shark Bay, WA)
Lethrinus genivittatus	Threadfin emperor	Inhabit outer reef slopes and shallow sandy and seagrass bed areas, to depths of up to 25 m	Temperate to tropical waters across northern Australia
Leviprora inops	Longhead flathead	Inhabit rocky reefs with abundant vegetation, to depths of up to 20 m	Southern Australia (Gulf St. Vincent, SA to Swan River, WA)
Lotella rhacina	Largetooth beardie	Nocturnal, inhabiting bays, harbours and exposed reefs, to depths of up to 90 m	Temperate waters of southern Australia (Coolangatta, QLD to Houtman Abrolhos Islands, WA)
Meuschenia flavolineata	Yellowstriped leatherjacket	Inhabit macroalgal reefs, to depths of up to 50 m	Endemic to southern Australia (Broughton Island, NSW to Dongara, WA)
Meuschenia freycineti	Sixspine leatherjacket	Inhabit reefs and seagrass beds, to depths of up to 45 m	Endemic to southern Australia (Coffs Harbour, NSW to Jurien Bay, WA)
Meuschenia galii	Bluelined leatherjacket	Inhabit coastal reefs, to depths of up to 30 m	Temperate waters of southern Australia (Inverloch, VIC to Shark Bay, WA)
Meuschenia hippocrepis	Horseshoe leatherjacket	Inhabit macroalgal rocky reefs, to depths of up to 120 m	Endemic to southern Australia (Wilsons Promontory, VIC to Shark Bay, WA)
Neatypus obliquus	Footballer sweep	Inhabit rocky reefs, to depths of up to 30 m	Endemic to southern Australia (Flinders Island, SA to Shark Bay, WA)
Notolabrus parilus	Brownspotted wrasse	Inhabit shallow algal-covered rocky reefs and seagrass beds, to depths of up to 20 m	Endemic to southern Australia (Port Phillip, VIC to Dirk Hartog Island, WA)
Olisthops cyanomelas	Herring cale	Inhabit rocky reefs and seagrass beds, to depths of up to 30 m	Temperate waters of southern Australia (Angourie Point, NSW to Houtman Abrolhos Islands, WA)
Omobranchus germaini	Germain's blenny	Inhabit shallow reefs and tide pools, to depths of up to 3 m	Temperate to tropical waters across northern Australia (One Tree Island, QLD to Rockingham, WA)
Ophthalmolepis lineolata	Southern maori wrasse	Inhabit exposed rocky reefs, to depths of up to 60 m	Endemic to southern Australia (Sunshine Coast, QLD to Houtman Abrolhos Islands, WA)

Name		Habitat*	Australian Distribution*
Ostorhinchus cookii	Cook's cardinalfish	Nocturnal, inhabiting rocky and coral reefs, to depths of up to 10 m	Temperate to tropical waters across northern Australia (Solitary Islands, NSW to Houtman Abrolhos Islands, WA)
Ostorhinchus doederleini	Fourline cardinalfish	Inhabit lagoons and reef slopes, to depths of up to 20 m	Temperate to tropical waters across northern Australia (Sydney, NSW to Perth, WA)
Ostorhinchus rueppellii	Western gobbleguts	Inhabit estuaries, inshore reefs and weedy areas, to depths of up to 10 m	Temperate to tropical waters across north-western Australia (Torres Strait, QLD to Albany, WA)
Othos dentex	Harlequin fish	Inhabit exposed reefs, drop-offs and caves, to depths of up to 30 m. Site-attached with relatively small home range	Southern Australia (Port Phillip Bay, VIC to Houtman Abrolhos Islands, WA)
Pagrus auratus	Snapper	Inhabit bays, inlets (juveniles) and offshore rocky reefs (adults), to depths of up to 200 m. Exhibit strong site fidelity	Temperate to tropical waters Australia across southern Australia (Townsville, QLD to Cape Cuvier, WA)
Parablennius postoculomaculatus	False Tasmanian blenny	Inhabit hard substrates in rocky regions and bays, including jetty pylons, to depths of up to 10 m	Endemic to WA (Two Peoples Bay to Muiron Islands)
Parapercis haackei	Wavy grubfish	Inhabit protected soft bottomed habitats near reefs, outcrops and jetties, to depths of up to 35 m	Endemic to south-western Australia (Kangaroo Island, SA to Shark Bay, WA)
Paraplesiops meleagris	Southern blue devil	Inhabit reefs and drop-offs, to depths of up to 45 m	Endemic to southern Australia (Port Phillip, VIC to Exmouth, WA)
Parapriacanthus elongatus	Elongate bullseye	Inhabit rocky reefs and jetties, to depths of up to 60 m	Endemic to southern Australia (Disaster Bay, NSW to Houtman Abrolhos Islands, WA)
Parascyllium variolatum	Varied carpetshark	Inhabit rocky reefs, seagrass beds and sandy areas, to depths of up to 180 m	Endemic to southern Australia (East Sister Island, VIC to Dongara, WA)
Parma bicolor	Bicolor scalyfin	Inhabit rocky reefs, to depths of up to 40 m	Temperate south-western WA (Recherche Archipelago to Rottnest Island)
Parma mccullochi	McCulloch's scalyfin	Inhabit rocky reefs, to depths of up to 25 m	Temperate south-western WA (Recherche Archipelago to Kalbarri)
Parma occidentalis	Western scalyfin	Inhabit rocky reefs, to depths of up to 15 m	Temperate WA (Cape Leeuwin to Coral Bay)
Parupeneus chrysopleuron	Rosy goatfish	Inhabit soft bottom habitats adjacent to reefs, to depths of up to 200 m	Temperate to tropical waters across western Australia
Parupeneus spilurus	Blacksaddle goatfish	Inhabit sandy habitats and rocky reefs, to depths of up to 80 m	Temperate to tropical waters Australia-wide
Pempheris klunzingeri	Rough bullseye	Inhabit rocky reefs, to depths of up to 40 m	Endemic to south-western Australia (Kangaroo Island, SA to Shark Bay, WA)
Pempheris multiradiata	Bigscale bullseye	Inhabit rocky reefs, to depths of up to 70 m	Temperate waters of southern Australia (Newcastle, NSW to Jurien Bay, WA)
Pictilabrus laticlavius	Senator wrasse	Inhabit coastal reefs and algal beds, to depths of up to 40 m	Endemic to southern Australia (Byron Bay, NSW to Houtman Abrolhos Islands, WA)

Name		Habitat*	Australian Distribution*
Pictilabrus viridis	False senator wrasse	Inhabit rocky reefs, to depths of up to 15 m	Endemic to southern WA (Recherche Archipelago to Jurien Bay)
Plagiotremus rhinorhynchos	Bluestriped fangblenny	Inhabit coral and rocky reefs, to depths of up to 40 m	Temperate to tropical waters across northern Australia (southern NSW to Albany, WA)
Plectorhinchus flavomaculatus	Goldspotted sweetlips	Inhabit sheltered reefs and lagoons, to depths of up to 25 m	Temperate to tropical waters across northern Australia (southern NSW to Perth, WA)
Pomacentrus coelestis	Neon damsel	Inhabit reefs and lagoons, to depths of up to 20 m	Temperate to tropical waters across northern Australia (Merimbula, NSW to Rottnest Island, WA)
Pomacentrus milleri	Miller's damsel	Inhabit shallow inshore reefs, to depths of up to 6 m	Temperate to tropical waters across northern Australia (Gulf of Carpentaria, QLD to Rottnest Island, WA)
Psammoperca waigiensis	Black sand bass	Inhabit coral reefs and vegetated rocky reefs, to depths of up to 12 m	Temperate to tropical waters across northern Australia (Moreton Bay, QLD to Busselton, WA)
Pseudocaranx georgianus	Silver trevally	Pelagic species. School over reefs and adjacent sandy areas. Juveniles more reef-associated. To depths of up to 240 m	Temperate southern Australia (north of Sydney, NSW to north of Perth, WA)
Pseudodax moluccanus	Chiseltooth wrasse	Inhabit coral reefs, to depths of up to 60 m	Temperate to tropical waters across northern Australia
Pseudolabrus biserialis	Redband wrasse	Inhabit macroalgal rocky reefs, to depths of up to 20 m	Temperate southern Australia (Port Lincoln, SA to Houtman Abrolhos Islands, WA)
Ptereleotris evides	Arrow dartgoby	Inhabit outer reef slopes and lagoons, to depths of up to 15 m	Temperate to tropical waters across northern Australia (Sydney, NSW to Rottnest Island, WA)
Rhabdosargus sarba	Tarwhine	Inhabit coastal waters, to depths of up to 60 m	Temperate to tropical waters on Australia's east and west coasts
Scarus ghobban	Bluebarred parrotfish	Inhabit lagoon reefs and sandy areas, to depths of up to 30 m	Temperate to tropical waters across northern Australia (Jervis Bay, NSW to Rottnest Island, WA)
Scarus prasiognathos	Greencheek parrotfish	Inhabit reefs and lagoons, to depths of up to 25 m	Temperate to tropical waters across northern Australia
Scarus schlegeli	Schlegel's parrotfish	Inhabit reefs and lagoons, to depths of up to 50 m	Temperate to tropical waters across northern Australia (southern Great Barrier Reef, QLD to Rottnest Island, WA)
Schuettea woodwardi	Western pomfred	Inhabit rocky reefs, to depths of up to 30 m	Endemic to southwestern Australia (Victor Harbor, SA to Shark Bay, WA)
Scobinichthys granulatus	Rough leatherjacket	Inhabit seagrass beds, to depths of up to 30 m	Temperate southern Australia (Maroochydore, QLD to Shark Bay, WA)
Scorpaena sumptuosa	Western red scorpionfish	Inhabit coastal reefs, to depths of up to 60 m	Endemic to WA (Albany to North West Cape)
Scorpis aequipinnis	Sea sweep	Inhabit rocky reefs, to depths of up to 25 m	Endemic to southern Australia (Currarong, NSW to Shark Bay, WA)

Name		Habitat*	Australian Distribution*
Scorpis georgiana	Banded sweep	Inhabit rocky reefs, to depths of up to 35 m	Temperate southern Australia (Kangaroo Island, SA to Kalbarri, WA)
Seriola lalandi	Yellowtail kingfish	Pelagic/benthopelagic species. Inhabit reefs and adjacent sandy areas, rocky outcrops, bays and around jetties. Usually to depths of up to 50 m.	Temperate to subtropical waters across southern Australia (Capricorn Group, QLD to Shark Bay, WA)
Siganus fuscescens	Black rabbitfish	Inhabit lagoons, rocky reefs and algal and seagrass flats, to depths of up to 50 m	Temperate to tropical waters across northern Australia (Nadgee, NSW to Busselton, WA)
Sillaginodes punctatus	King George whiting	Inhabit sandy habitats, algal areas and seagrass beds, to depths of up to 200 m	Endemic to southern Australia (Sydney, NSW to north of Rottnest Island, WA)
Siphamia cephalotes	Wood's siphonfish	Inhabit shallow coastal reefs and seagrass and algal beds, to depths of up to 30 m	Temperate to subtropical waters across southern Australia (Byron Bay, NSW to Exmouth Gulf, WA)
Siphonognathus attenuatus	Slender weed whiting	Inhabit rocky reefs and sandy areas adjacent to macroalgal and seagrass beds, to depths of up to 45 m	Endemic to southern Australia (Cape Conran, VIC to Rottnest Island, WA)
Siphonognathus beddomei	Pencil weed whiting	Inhabit kelp beds, to depths of up to 20 m	Endemic to southern Australia (Gippsland Lakes region, VIC to Rottnest Island, WA)
Siphonognathus caninis	Sharpnose weed whiting	Inhabit rocky reefs and algal-covered areas, to depths of up to 35 m	Endemic to southern Australia (Bass Strait, VIC to Port Denison, WA)
Siphonognathus radiatus	Long-rayed weed whiting	Inhabit seagrass and macroalgal beds, to depths of up to 18 m	Endemic to southern Australia (Port Phillip, VIC to Green Head, WA)
Sphyraena obtusata	Striped barracuda	Inhabit seagrass beds (juveniles), rocky reefs and bays, to depths of up to 200 m	Temperate to tropical waters across northern Australia.
Spratelloides gracilis	Slender sprat	Inhabit coastal reefs and lagoons, to depths of up to 40 m	Temperate to tropical waters across northern Australia.
Stegastes lacrymatus	Whitespotted damsel	Inhabit coastal reefs and lagoons, to depths of up to 40 m	Temperate to tropical waters across northern Australia
Stegastes obreptus	Western gregory	Inhabit coastal reefs, to depths of up to 10 m	Temperate to tropical waters across northern Australia (Bountiful Island, QLD to Rottnest Island, WA)
Stethojulis bandanensis	Redspot wrasse	Inhabit reefs and lagoons, to depths of up to 30 m	Temperate to tropical waters across northern Australia (Merimbula, NSW to Rottnest Island, WA)
Stethojulis strigiventer	Silverstreak wrasse	Inhabit seagrass beds, inner reefs and lagoons, to depths of up to 20 m	Temperate to tropical waters across northern Australia
Suezichthys cyanolaemus	Bluethroat rainbow wrasse	Inhabit seagrass beds adjacent to reefs and rubble areas, to depths of up to 40 m	Endemic to WA (Albany to Ningaloo Reef)
Sutorectus tentaculatus	Cobbler wobbegong	Inhabit rocky and coral reefs, to depths of up to 35 m	Temperate to subtropical waters of southern Australia (Gulf St Vincent, SA to Houtman Abrolhos Islands, WA)
Thalassoma lunare	Moon wrasse	Inhabit reefs, to depths of up to 20 m	Temperate to tropical waters across northern Australia
Thalassoma lutescens	Green moon wrasse	Inhabit reefs and lagoons, to depths of up to 30 m	Temperate to tropical waters on Australia's east and west coasts

Name		Habitat*	Australian Distribution*
Thalassoma septemfasciatum	Sevenband wrasse	Inhabit shallow coral, rocky and macroalgal reefs, to depths of up to 20 m	Endemic to WA (Point Samson to Rottnest Island)
Tilodon sexfasciatus	Moonlighter	Inhabit rocky reefs and areas around jetties, to depths of up to 30 m	Endemic to southern Australia (Wilsons Promontory, VIC to Jurien Bay, WA)
Trachinops brauni	Bluelined hulafish	Inhabit coastal reefs, to depths of up to 10 m	Endemic to south-western WA
Trachinops noarlungae	Yellowhead hulafish	Inhabit coastal reefs, to depths of up to 30 m	Endemic to southern Australia (Gulf St Vincent, SA to Houtman Abrolhos Islands, WA)
Trachurus novaezelandiae	Yellowtail scad	Inhabit rocky reefs and shallow, soft bottom habitats, to depths up to 500 m	Temperate to subtropical waters across southern Australia
Trinorfolkia clarkei	Clark's threefin	Inhabit coastal reefs and jetty pylons, to depths of up to 30 m	Endemic to southern Australia (Minnie Waters, NSW to Rottnest Island, WA)
Trygonoptera ovalis	Striped stingaree	Inhabit seagrass beds and adjacent sandy areas, to depths up to 88 m	Endemic to WA (Eucla to Houtman Abrolhos Islands)
Trygonoptera personata	Masked stingaree	Inhabit sandy areas and seagrass beds, typically offshore, to depths of up to 115 m	Endemic to WA (Geographe Bay to Shark Bay)

*Source: Atlas of Living Australia (2023); Fishes of Australia (2023); FishBase (Froese & Pauly, 2023)

2.6 Conclusions

A desktop study was conducted to identify and describe the seasonal presence of species protected under the Commonwealth EPBC Act and WA State BC Act that may be present in the vicinity of the proposed development.

26 listed syngnathid species (seahorses, seadragons, pipefishes, and pipehorses) may occur within a 5 km radius of the proposed development. These species are not listed as threatened under the EPBC and BC Acts but occupy diverse habitats including those found in Thomson Bay. Syngnathids are small, cryptic, and site-attached species that are likely to be present in the area year-round.

Three threatened shark species may occur within a 5 km radius of the proposed development. Scalloped hammerheads (EPBC Act listed conservation dependent) and white sharks (vulnerable) are typically seasonal and use the area for foraging and/or migration; however, may be present year-round. Scalloped hammerheads aggregate in the nearby Shoalwater Islands Marine Park, peaking during January and February. White sharks are more likely to be present in the Perth region during spring and early summer, and least likely to be present during late summer and autumn. The grey nurse shark (vulnerable) is known to congregate or aggregate in the area year-round.

10 listed marine mammal species may occur within a 5 km radius of the proposed development. Seasonal migration of whales along the WA coast includes the southern right whale (endangered; migration April to October), humpback whale (migration May to November), pygmy blue whale (endangered; migration April to January), and the minke whale (may be present over winter). Orcas may be present year-round but are more common on the south coast of WA between January and April. Other listed marine mammals that may be present year-round include the Australian sea lion (endangered), New Zealand fur seal, bottlenose dolphin, Indian ocean bottlenose dolphin, and the spinner dolphin.

Four listed marine reptile species may occur within a 5 km radius of the proposed development. Turtle species that may forage in the area include the loggerhead turtle (endangered), leatherback turtle (endangered), and green turtle (vulnerable). Turtles migrate to/from their nesting grounds in northern WA during summer (typically between November and March); however, their common distribution is north of the proposed development area. The yellow-bellied sea snake may be present year-round.

A second desktop study was conducted to identify non-conservation important fish species that have been recorded within the vicinity of the proposed development. 137 species of fish, sharks and rays were identified that may use habitats within Thomson Bay year-round. Most of these species are associated with hard substrate; however, several use seagrass meadows as nursery grounds (e.g., wrasse, barracuda, pike, herring and stingaree). As Thomson Bay has extensive seagrass meadows, these species may be more vulnerable to impacts from development activities.

3 DESCRIPTION OF BENTHIC HABITAT

The Rottnest Island Marine Reserve is characterised by a unique blend of tropical and temperate species and a diverse range of habitats and communities, including coral reef and extensive seagrass meadows. Protection of this unique environment is a strategic focus area for the RIA, with particular focus on seagrass meadows within Thomson Bay (RIA, 2014, 2020).

3.1 Objectives

The main objective of the benthic marine habitat mapping scope was to review and update the benthic habitat assessment undertaken by RPS in 2019, including:

- Confirm the suitability of the Local Assessment Unit (LAU) defined by RPS (2019b) in assessment of benthic impacts from the proposed development, and its update if required.
- Confirm the suitability of benthic habitat mapping by Harvey (2009) and its suitability for LAU-scale estimates.
- Update the south Thomson Bay area benthic habitat map previously developed by RPS (2019b).
- Confirm estimates of benthic habitat loss due to the proposed development.
- Estimate cumulative loss of benthic habitat as a consequence of historic activities.

An additional objective of the study was to describe benthic habitat adjacent the area previously surveyed by RPS (2019b), extending to the shoreline in the vicinity of the main and fuel jetties.

3.2 Methods

3.2.1 Field surveys

Two surveys were completed for this scope – the main survey which replicated the survey by RPS 2019b, and a supplementary survey of adjacent benthic habitat (Figure 3-2).

The purpose of the main field survey was to describe the benthic habitat present at specific sites within an area of south Thomson Bay that encompassed the proposed development. This area, referred to as the 'Field Survey Area' (FSA) measured 2.6 x 1.0 kilometres and was the same as that surveyed by RPS (2019b; Appendix B). Data obtained from the survey were then used to ground-truth habitat identified in recent aerial images so as to develop a habitat map used to meet objectives described in Section 3.1.

The main field survey was completed between 0830 and 1630 hrs on the 24 November 2023. Weather was fine with light cloud cover with five knot northerly winds in the morning and 15 knot south-westerly winds in the afternoon. Water visibility was good, with detailed benthic habitat classification (i.e., distinguish between elements of the habitat) reliable to a depth of approximately five metres and general classification (i.e., identify dominant habitat) to approximately seven metres. Tides on the day were: low tide (0322 hrs/0.11 m) and high tide (1740 hrs/0.59 m). The survey was conducted using an RIA vessel skippered by an RIA Ranger who navigated to pre-determined survey sites within the FSA (Appendix B). These sites replicated those surveyed by RPS in 2019, except where habitat of specific interest for ground-truthing were identified in the aerial images. Note that survey activities near the main jetty were restricted by ferry and barge activities on the day.

At each site an RPS field scientist experienced in benthic habitat identification lowered a glass bottomed viewing tube into the water and made a point assessment of the habitat type vertically below the viewing location near the rear of the vessel. The assessment area was approximately two by two metres. Data recorded were percent cover of seagrass (to genus), macroalgae, bare substrate (sand or limestone reef/platform) and wrack (unattached macroalgal thalli and dead seagrass leaves) (Appendix C). Data were recorded by a second RPS field scientist along with the GPS position, time, and relevant notes. The initial eight sites were independently assessed through the viewing tube by each RPS scientist, and the results compared and discussed to ensure consistency between habitat identification and percent cover estimations (Appendix C). The survey conditions (water clarity, shallow depth, and low wind) allowed for clear viewing of the benthic habitat from the vessel.

Both scientists undertaking the two field surveys were experienced in marine benthic habitat surveys. For quality control purposes the description of habitat at specific locations was compared between scientists prior to and regularly during the survey (Appendix C).

The supplementary field survey was completed on the 29 January 2024 between 0830 and 1330 hrs. The objective of this field survey was to describe benthic habitat in the near-shore area west of the FSA where vessel moorings and jetties (including the main jetty) are located (Figure 3-2; referred to as the 'Main Jetty Survey Area'). The additional field survey area was assessed in the same way as the FSA. The tides on the day were: low tides (0623 hrs/ 0.56 m and 1554 hrs/ 0.75 m) and high tide (1330 hrs/ 0.76 m). Independent assessment of habitat at the first site was again undertaken by the two RPS field scientists for quality control purposes. Snorkelling was used for this purpose and for assessment of sites close to the shoreline which were too shallow to be accessed via the RIA vessel. The benthic assessment followed the same protocols as outlined above for the November 2023 survey.

3.2.2 Data processing

Sampling locations recorded during the field survey were downloaded into GIS and correlated with habitat classes. These classes were derived from percent cover of biota and bare substrate obtained during the field survey, as described in Section 3.2.1. A map of benthic communities and habitat was subsequently developed using methods described in Section 3.2.2.1.

3.2.2.1 Habitat classification

The classification scheme used in the field component of this study was based on that developed for Seamap Australia (Butler et al., 2017). This is a dominance-based scheme, i.e., the classes are defined based on the dominant biota, or a mixture of one or more dominant species (Table 3-1). In this study the criterion for dominance is >50% cover. A mixed class is identified where the percentage cover of the two or more dominant classes are separated by ≤ 30% (relative to the percentage cover of the most dominant class). For example, a sampling location consisting of 25% macroalgae and 60% *Posidonia* spp., would be classed as *Posidonia*-dominated, whereas a location consisting of 40% macroalgae and 60% *Posidonia* spp., would be classed as mixed *Posidonia* / macroalgae habitat. The classification scheme was also designed to be compatible with the hierarchical scheme developed by Harvey (2009) for classifying marine benthic habitats of Rottnest Island, to enable extrapolation to broader spatial scales.

Table 3-1: Classification scheme used in analysis of benthic habitat

Habitat Class	Description
Sand	71 – 100% bare sand
Sand with seagrass	20 - 50% seagrass
Sand with wrack	> 30% wrack (note: wrack present with other biota is not classified)
Halophila dominated	> 50% *Halophila* (note: *Halophila* morphology allows for a high percentage of sand)
Posidonia dominated	> 50% *Posidonia*
Amphibolis dominated	> 50% *Amphibolis*
Macroalgae dominated	> 50% macroalgae
Mixed seagrass	% cover of dominant seagrasses separated by ≤ 30%
Mixed algae / seagrass	% cover of dominant seagrass/algae separated by ≤ 30%
Limestone reef / pavement	Limestone reef or platform with minor (< 30%) attached seagrass/macroalgae

3.2.2.2 Development of the benthic habitat map

Habitat mapping was undertaken using Esri's ArcGIS Pro to create a digitised image in vector shapefile format using select Landgate Web Map Service aerial photographs. For this purpose the February 2023 photograph was selected as the 'base map' due to its superior clarity of seabed features compared to other images available since August 2022 (Appendix D, Figure 3). Note that August would have been a preferred option for compatibility with the previous habitat mapping process by RPS (2019b), however whilst the August 2022 photograph provided good clarity of offshore seabed features compared to other recent aerial photographs the nearshore areas of this photograph were largely hidden by a plume (Appendix D, Figure 4). The August 2022 photograph nevertheless provided good comparison against the 'base map' for

identification of areas of wrack in these offshore areas (i.e., areas of dark seabed not common between the two images), so that these could be removed from the benthic habitat map, with other photographs used for comparison of nearshore areas. Noting also that the August 2023 aerial photograph was not available for initial mapping of the habitat within the FSA but subsequently became available for use during the mapping of habitat for the Main Jetty Survey Area. This photograph was therefore used to confirm the accuracy of the habitat map developed earlier for the FSA (Appendix D, Figure 5).

After completion of the habitat digitisation process and removal of wrack as described above, areas of habitat on the digitised image were classified into habitat classes (Table 3-1) using data from the RPS field surveys that was pooled where necessary to provide a more reliable description of habitat across the FSA. Note that isolated areas of habitat less than a few metres in diameter were generally too small for effective digitisation and mapping. It is also possible that minor errors in habitat description have been made due to limitations posed by photograph clarity, habitat complexity (for example mixing of wrack with live seagrass) and vessel/barge traffic near the main wharf (i.e., restricting site surveys). These are not expected to have meaningful effect on the results and conclusions, however.

3.3 Results and Discussion

3.3.1 Review of the Local Assessment Unit and habitat mapping by Harvey (2009)

A local assessment unit (LAU) is a geographical area that establishes the spatial context for the calculation and assessment of recoverable impacts and cumulative losses. LAUs are location specific and should reflect local physical, ecological, administrative and jurisdictional considerations. There is no standard size or shape to a LAU, and they need to be defined on a situation-specific basis (EPA 2016). Guidance on LAU size by the EPA (2016) indicates that they are typically defined as a ten kilometre stretch of coastline extending five kilometres offshore (i.e., 50 km^2), although other size LAUs will be considered if justified.

RPS (2019b) previously suggested that the most appropriate LAU for the proposed development in Thomson Bay is the area mapped by Harvey (2009) because this area:

- Comprises 2,746 ha of described habitat in which historic habitat loss from anthropogenic impacts have been estimated (Oceanica 2013; as explained further in RPS (2019b))
- Represents a complete island ecosystem
- Is consistent with EPA (2016) guidance on the size of an LAU.

Furthermore, there have been no further updates to the benthic habitat map of Rottnest Island by Harvey (2009; Figure 3-1). This map was developed using hyperspectral imagery obtained in 2004 and based on spectral signatures of the dominant habitat components. At the broadest scale, areas of bio-substrate were separated from bare substrates in the image with an overall accuracy of 95%, whereas at the finest scale, bare substrates and dominant species or genera were separated with an accuracy of 70% (Harvey 2009). In their comparison of benthic habitat modelling techniques, Davis (2011) concluded that the habitat modelling used by Harvey (2009) had the highest accuracy (84%; validated in field) and was able to identify small patches of habitats, providing additional technical review to support using the habitat map by Harvey (2009) to define the LAU for the proposed development.

In developing their habitat map, Harvey (2009), noted that a reason for the decrease in accuracy at the finer scale was the inherent spatial inaccuracy of the geo-location of both the image and the validation data collected in the field. Similarly, when comparing the benthic habitat map by Harvey (2009) to aerial images taken in August 2014/2018 and observations from the site visit, RPS (2019b) identified discrepancies in areas of seagrass and sand habitat, considered most likely to be due to fine-scale misclassification of habitats by Harvey (2009). In particular, RPS (2019b) observed that misclassification of mobile wrack as seagrass by Harvey (2009) would result in an overestimate of the amount of seagrass loss within the planned development footprint. Because of the potential for fine-scale misclassification of habitat, additional sites were added to the 2023 survey to further clarify high risk wrack accumulation areas, such as the shallows and habitat edges where misclassification is more likely, and supplementary observations were noted detailing when wrack was present, and if it occurred at the edge of a benthic habitat. This information assisted in the aerial footage comparisons (Section 3.3.2) to predict areas of benthic habitat and calculate benthic habitat losses more accurately.

The spatial scale of analysis is therefore critical in determining the accuracy of habitat maps - and in assessing the impacts associated with the proposed development. Table 3-2 highlights broad similarities

between the habitat map developed in 2019 and in this study for the FSA, and the Level 2 habitat map developed by Harvey (2009) for the same area. However, it also indicates that the map by Harvey (2009) underestimates the amount of seagrass in south Thomson Bay and overestimates the macroalgae dominated habitat, particularly in the area identified during the current study as comprising a mix of algae and seagrass (see Section 3.2). The map by Harvey (2009) also indicates more areas of sand than the current study. These findings remained true when comparing the Harvey (2009) habitat map to the 2023 survey. The two RPS surveys results (2019b and current) were more similar to each other than Harvey (2009), however there was an increase in macroalgae/ limestone pavement and an increase in seagrass and sand/ sand with wrack observed. These were relatively small differences though and may be accounted for with the alteration of site locations (and the additional sites) in the 2023 survey. Further, variation between images in the clarity of seabed features (e.g. Appendix D) is another source of discrepancy between habitat maps.

Based on the above and considering the guidance by EPA (2016) that the understanding of benthic communities and their habitats should be proportional to the scale of the proposed development, it is considered reasonable that the habitat map developed by Harvey (2009) is satisfactory for description of habitat within the LAU defined for the proposed development. However, because the Harvey (2009) map underestimates the amount of seagrass habitat within the FSA it is more appropriate to base assessment of seagrass habitat loss due to the proposed development on the habitat map developed during the current study (described in following sections).

Table 3-2: Comparison of habitat area estimates within the FSA by RPS (2019 and current) and Harvey (2009), using habitat types described by Harvey (2009)

Harvey (2009) category	RPS category	Harvey (2009) hectares	RPS (2019) hectares	Difference (Harvey & RPS 2019)	RPS hectares (2023)	Difference (Harvey & RPS 2023)	Difference RPS 2019 & 2023
Macroalgae / intertidal	Limestone reef / pavement & Macroalgae dominated	16.04	7.09	8.95	12.59	3.45	5.5
Seagrass	Mixed seagrass	91.69	110.28	-18.59	108.10	-16.41	-2.18
Sand	Sand / sand with wrack	55.12	46.09	9.03	42.43	12.69	-3.66
Unclassified	NA	0.56	NA	0.56	NA	NA	NA

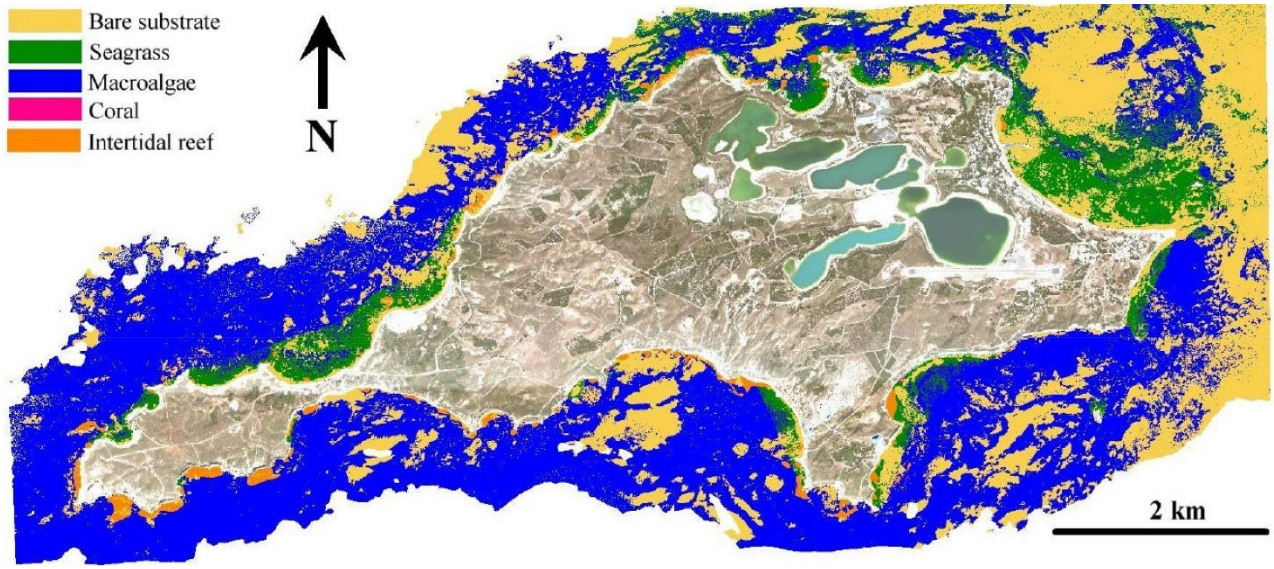

Figure 3-1: Habitat map of Rottnest Island by Harvey (2009)

3.3.2 Development of a benthic habitat map within the FSA

A benthic habitat map is required for estimating historic habitat loss and predicting additional losses from planned developments (EPA, 2016). The benthic habitats of Rottnest Island were mapped by Harvey (2009) using a combination of *in situ* observation and aerial hyperspectral imagery. Benthic habitats were classified at four levels by Harvey (2009), where Level 2 identified seagrass, macroalgae, coral, intertidal reef, sand and unclassified (typically beach). Approximately 399 ha or 14.5 % of the total mapped area of Rottnest Island (2,746 ha) was classified as seagrass meadows, with 119 ha located within Thomson Bay.

The benthic habitat map developed by RPS in 2023 for assessment of the south Thomson Bay development shows the distribution of seagrass in the vicinity of the proposed development and more broadly across southern Thomson Bay (Figure 3-2, Figure 3-3). The relative cover of the different habitat types shown in Table 3-2 and Table 3-3 confirms the dominance of seagrass, in particular *Posidonia* spp. which comprise the priority ecological community *Posidonia australis* complex meadows (DBCA 2023a). 'Bare' sand habitat (15% of sites; approximately 26 % of the FSA) also occupies a substantial part of the FSA, followed by macroalgae dominated habitat/ limestone reef/pavement recorded at 13 % of the sampling sites and covering 8 % of the FSA. Areas of mobile wrack over sand that might otherwise have been classified as seagrass or other habitat were identified by comparison of the August 2022 and February 2023 aerial images. These areas can be seen as darker areas of sand in aerial photos (Appendix D) and are common across the FSA, particularly around habitat edges and along the shoreline as confirmed by in-field ground-truthing in 2023. Areas of wrack are also evidenced in Figure 3-2 by its accumulation into parallel lines visible on the aerial image (Appendix C).

The Harvey (2009) benthic habitat map shown in Figure 3-1 also indicates an area dominated by macroalgae in the southeast part of the FSA. This was verified by several of the survey locations and the habitat edges were confirmed using the February 2023 aerial image, which was particularly clear (Appendix D). Similarly, a broad area in the northern part of the FSA appears to comprise a mix of seagrass and algae that could not be clearly defined from the aerial images.

There were some notable differences in the percentage of habitat cover identified between the 2019 and 2023 surveys, in particular an 8 % decrease in the number of sites classified as "Sand with wrack" and an 8 % increase in "Macroalgae dominated" habitat classification. However, because the location of additional sites of interest differed between surveys a difference in habitat percentages recorded at sites is to be expected. Nevertheless, as shown in Table 3-2 these differences at the site level are not reflected in the broader benthic habitat classification. The proportion of the FSA that was classified as Seagrass dominated decreased by 2.18 % from 2019 to 2023, Macroalgae dominated increased by 5.5 % and Sand/Sand with Wrack decreased by 3.66 % indicating that the FSA benthic habitat has remained relatively stable since the 2019 survey.

Table 3-3: Habitat class across sites in FSA and expressed as a percentage from the 2023 and 2019 surveys (RPS, 2019b) and the percentage difference between the two surveys.

Habitat class	Number of sites (2023)	Percentage of total sites (2023)	Percentage of total sites (2019)	Percentage difference (2019 to 2023)
Amphibolis dominated	8	5%	3%	+2%
Halophila dominated	1	1%	NA	+1
Limestone reef / pavement	3	2%	4%	-2%
Macroalgae dominated	17	11%	3%	+8%
Mixed algae / seagrass	7	4%	2%	+2%
Mixed seagrass	4	3%	6%	-3%
Posidonia dominated	76	48%	54%	-6%
Sand	24	15%	14%	+1%
Sand with seagrass	8	5%	2%	+3%
Sand with wrack	9	6%	14%	-8%
Grand Total	**157**	**100%**	**100%**	

3.3.3 Development of a benthic habitat map within the Main Jetty Survey Area

Thirty-two sites in a 10 ha area west of the FSA were assessed for the development of a benthic habitat map. The sites spanned the main ferry terminal and fuel jetty within Thomson Bay (Figure 3-2). *Posidonia* seagrass dominated 50 % of the survey sites and 57 % of the area (5.71 ha). The remaining sites and area were bare sand patches, and sand patches with wrack accumulations (4.27 ha; Figure 3-4, Table 3-4).

A significant amount of wrack was present along the shoreline and within the adjacent shallow waters (22 %, Table 3-4). There was a very low tide recorded the previous week (e.g., Friday 26 January 2024: low tide at 0632 hrs/0.46 m) and seagrass showed signs of stress (sunburn) including brown leaves with green (living) leaf near the thallus. There were also areas of live seagrass present underneath wrack e.g., *Posidonia* at site Extra 13 surrounded by wrack at sites Extra 11 and Extra 12 (Appendix B). Closer to the shoreline, small sand patches exist within the seagrass meadows (e.g., S13); however, the area of these sand patches was generally too small for effective digitisation and mapping (Appendix B). Observations near the ferry terminal (e.g., S10) were challenging due to high vessel traffic resuspending sediments and reducing water clarity. Visual confirmation of the edge of the seagrass meadow was attained near S11, and observations at site Extra 07 indicate there is not a substantial seagrass meadow located immediately south of the ferry terminal (Appendix B).

Table 3-4: Habitat class across sites in the area west of the FSA and expressed as a percentage from the 2024 survey.

Habitat class	Number of sites (2024)	Percentage of total sites (2024)
Amphibolis dominated	0	0%
Halophila dominated	0	0%
Limestone reef / pavement	0	0%
Macroalgae dominated	0	0%
Mixed algae / seagrass	0	0%
Mixed seagrass	0	0%
Posidonia dominated	16	50%
Sand	7	22%
Sand with seagrass	2	6%
Sand with wrack	7	22%
Grand Total	**32**	**100%**

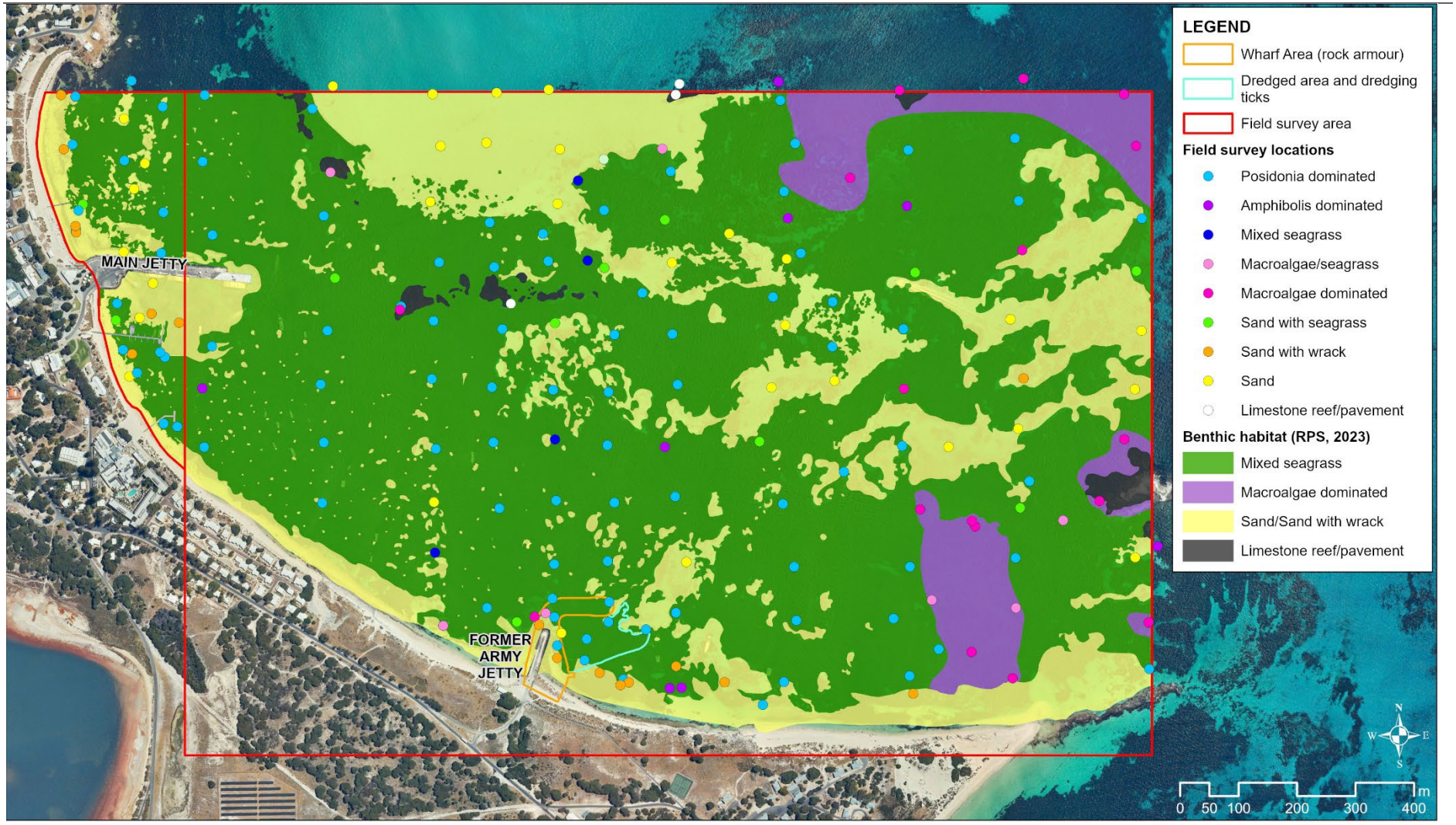

Figure 3-2: Benthic habitat map of the Field Survey Area and Main Jetty Survey Area within Thomson Bay, Rottnest Island

Figure 3-3: Detail of the benthic habitat map within the proposed development area

Figure 3-4: Benthic habitat map within the Main Jetty Survey Area, west of the FSA

3.3.4 Habitat loss due to the proposed development

Overlay of the proposed South Thomson Bay Maritime Facilities Redevelopment (Figure 1-1) on the benthic habitat map shown in Figure 3-2 indicates that installation of the wharf may result in the loss of 0.34 hectares (2,900 m^2) of *Posidonia* dominated seagrass (Table 3-5). Associated dredging of seabed may result in the loss of a further 0.96 hectares (9,200 m^2) of *Posidonia* dominated seagrass. As noted by the EPA (2016) assessment of direct impacts from activities such as dredging is relatively straightforward as these impacts are generally closely linked to the dredge area and immediate surrounding area. A five-metre buffer is notionally considered a reasonable estimate of the area surrounding the wharf and dredged area footprints that may be subject to events causing additional habitat loss, including localised erosion, slumping of dredged area walls and backwash. Addition of this buffer to the overall footprint (wharf and dredged areas combined) indicates that a total of 1.55 hectares (14,200 m^2) of *Posidonia* dominated seagrass may be directly lost by the proposed development (Table 3-5). The only other habitat lost by construction of the proposed development would be sand or sand with wrack (Table 3-5).

Table 3-5: Area of habitats within development-related footprints using data collected by RPS in 2023

Area	Habitat (hectares)			
	Mixed seagrass	Macroalgae dominated	Sand/Sand with wrack	Limestone reef/pavement
Field survey area	108.10	10.80	42.43	1.79
Wharf area	0.34	0	0.18	0
Dredged area	0.96	0	0.06	0
Development footprint (wharf area plus dredged area)	1.30	0	0.24	0
Development footprint + 5 m buffer	1.55	0	0.44	0
Total habitat remaining (field survey area minus development footprint)	106.80	10.80	42.19	1.79
Total habitat remaining inc. buffer (field survey area minus development footprint with 5 m buffer)	106.55	10.80	41.99	1.79

3.3.5 Cumulative habitat loss

Calculation of cumulative benthic habitat loss within a defined LAU requires estimates of the extent of benthic habitat (EPA, 2016):

- prior to all human-induced disturbance
- at the time of the proposed development
- remaining after the development is completed.

Oceanica (2013) provided estimates for the first two points above through calculations of historic benthic habitat loss within the defined LAU for Rottnest Island. These are reviewed below (Section 3.3.5.1). Preliminary estimates for the third point above (habitat loss due to the proposed development) are described in Section 3.3.5, with a combined calculation of cumulative benthic habitat (seagrass) loss described below.

3.3.5.1 Historic benthic habitat loss

Oceanica (2013) estimated historic benthic habitat loss associated with vessel moorings (mooring scars) and jetties from a review of aerial imagery taken in March 2008. These estimates are only for seagrass because there was insufficient data for other habitat types such as coral and macroalgae, and because seagrass meadows typically occur within sheltered, shallow bays where this marine infrastructure is located. This is acceptable for the current study because seagrass is the key impacted habitat. The estimates by Oceanica (2013) did not consider other potential sources of anthropogenic stressors such as eutrophication, propeller scour and sedimentation, and assumed that areas of bare sand around marine infrastructure and moorings were previously 100% seagrass. The latter may result in an over-estimate of seagrass loss as some areas may have historically been bare sand (RPS, 2019b). Further, there appears to have been some recovery of cleared seagrass due to the change to environmentally friendly mooring designs which has allowed some

seagrass regrowth (Oceanica 2013). RPS (2019b) found evidence of both degradation and regrowth of seagrass habitat to the east and west of Main Jetty in Thomson Bay, respectively, and noted that regrowth may be associated with a change in the species composition of seagrass. The 2023 survey also noted potential seagrass regrowth in the northwest of the FSA (Plate 3-1). Ultimately, estimations of historic anthropogenic losses are inherently difficult due to a lack of reliable baseline data and lack of understanding of loss due to natural events such as storms and alongshore sediment transport (RPS, 2019b). A conservative approach is therefore taken in this report by not accounting for areas of regrowth.

In considering the above, the estimate of seagrass loss around Rottnest Island by Oceanica (2013) is acceptable for LAU-scale calculations. These estimates use the data by Harvey (2009) to estimate the 'current' extent of seagrass habitat as 398.70 hectares which, when combined with the amount lost due to human-induced disturbance (7.95 hectares) results in an estimated 406.65 hectares of seagrass habitat within the LAU prior to impacts due to human activities. This represents a 1.95% loss of seagrass habitat within the LAU prior to the proposed development.

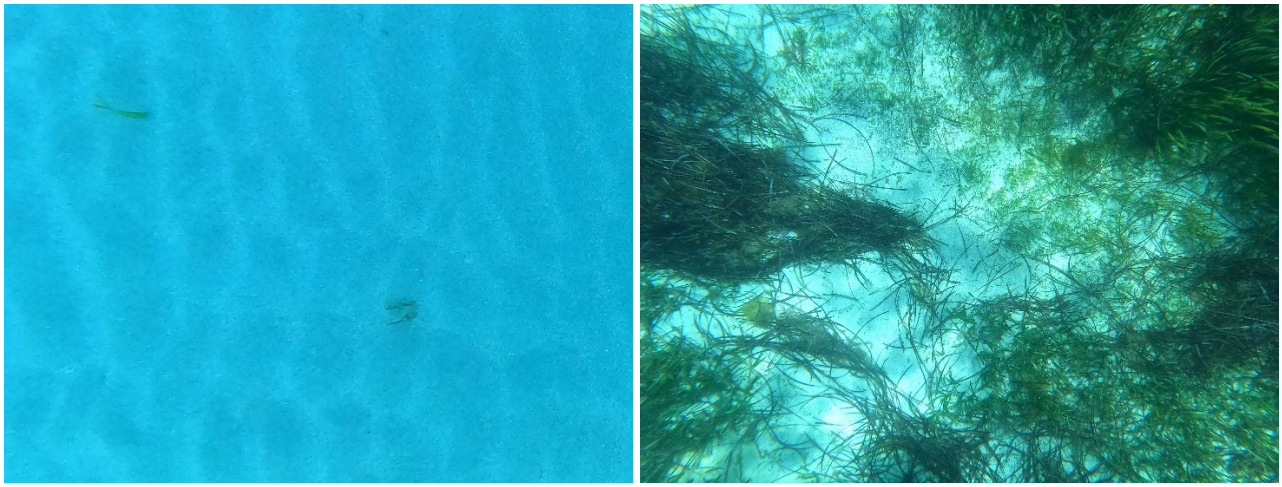

Plate 3-1: Individual living *Posidonia* shoots (site number T10A) (left); accumulation of *Posidonia* wrack and new growth of seagrass at edge of *Posidonia* meadow (site number T10D) (right) in the northwest of the FSA

3.3.5.2 Increase in cumulative benthic habitat loss due to the proposed development

Based on calculations described in Section 3.3.4 the loss of seagrass habitat as a consequence of the proposed development (1.55 ha) represents a 1.22 % loss of this habitat from the FSA (Table 3-5). In terms of the broader LAU, the development (wharf and dredged areas plus five m buffer) may decrease the amount of seagrass habitat estimated to be within the LAU (398.7 ha) by a further 0.39 %, resulting in a cumulative (projected plus historical) loss of 2.34 % seagrass habitat across the LAU.

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Appendix A
PMST and DBCA database search results

Appendix Table 1: EPBC Act (PMST) and BC Act (DBCA database) listed threatened, marine or migratory marine species in the search radius around Thomson Bay

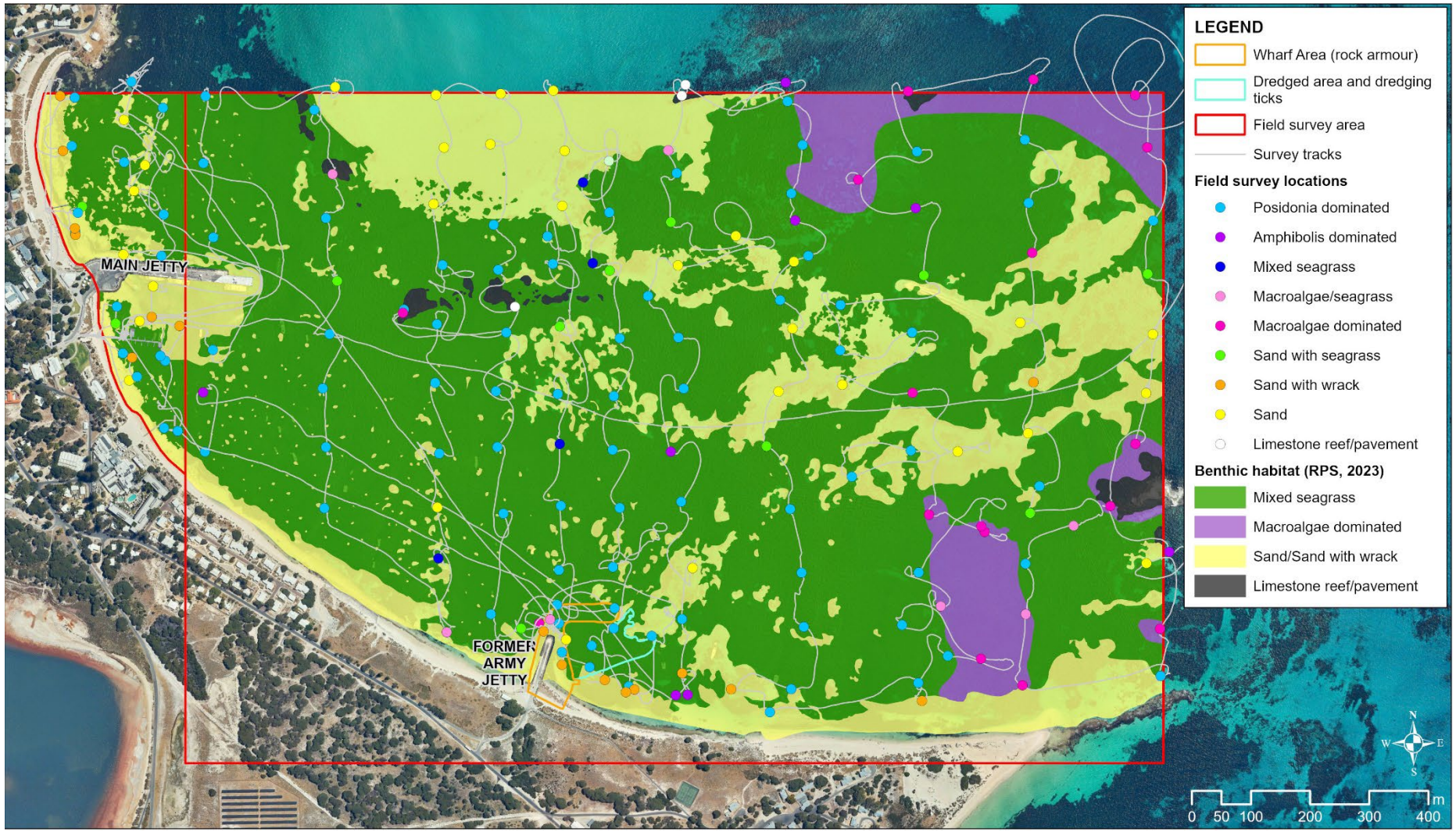
Name		Conservation status	
Species	**Common**	**EPBC Act**	**BC Act**
Birds			
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	Critically Endangered	Not included
Calidris ferruginea	Curlew sandpiper	Critically Endangered, Migratory	Critically Endangered
Calidris tenuirostris	Great knot	Critically Endangered, Migratory	Critically Endangered
Numenius madagascariensis	Eastern curlew	Critically Endangered, Migratory	Not included
Rostratula Australis	Australian painted snipe	Endangered	Not included
Calidris canutus	Red knot	Endangered, Migratory	Endangered
Charadrius mongolus	Lesser sand plover	Endangered, Migratory	Endangered
Diomedea amsterdamensis	Amsterdam albatross	Endangered, Migratory	Not included
Diomedea dabbenena	Tristan albatross	Endangered, Migratory	Not included
Diomedea sanfordi	Northern royal albatross	Endangered, Migratory	Not included
Macronectes giganteus	Southern giant-petrel	Endangered, Migratory	Not included
Thalassarche cauta	Shy albatross	Endangered, Migratory	Not included
Anous tenuirostris melanops	Australian lesser noddy	Vulnerable	Not included
Halobaena caerulea	Blue petrel	Vulnerable	Not included
Pachyptila turtur subantarctica	Fairy prion (southern)	Vulnerable	Not included
Pterodroma mollis	Soft-plumaged petrel	Vulnerable	Not included
Sternula nereis	Fairy tern	Vulnerable	Vulnerable
Sternula nereis nereis	Australian fairy tern	Vulnerable	Vulnerable
Charadrius leschenaultii	Greater sand plover	Vulnerable, Migratory	Vulnerable
Diomedea epomophora	Southern royal albatross	Vulnerable, Migratory	Not included
Diomedea exulans	Wandering albatross	Vulnerable, Migratory	Vulnerable
Macronectes halli	Northern giant petrel	Vulnerable, Migratory	Not included
Phoebetria fusca	Sooty albatross	Vulnerable, Migratory	Not included
Thalassarche carteri	Indian yellow-nosed albatross	Vulnerable, Migratory	Not included
Thalassarche impavida	Campbell albatross	Vulnerable, Migratory	Not included
Thalassarche melanophris	Black-browed albatross	Vulnerable, Migratory	Not included
Thalassarche steadi	White-capped albatross	Vulnerable, Migratory	Not included
Anous stolidus	Common noddy	Migratory	Migratory
Ardenna carneipes	Flesh-footed shearwater	Migratory	Not included
Ardenna grisea	Sooty shearwater	Migratory	Not included
Ardenna pacifica	Wedge-tailed shearwater	Migratory	Migratory
Arenaria interpres	Ruddy turnstone	Migratory	Migratory
Calidris acuminata	Sharp-tailed sandpiper	Migratory	Migratory
Calidris alba	Sanderling	Migratory	Migratory
Calidris melanotos	Pectoral sandpiper	Migratory	Migratory
Calidris ruficollis	Red-necked stint	Migratory	Migratory
Hydroprogne caspia	Caspian tern	Migratory	Migratory
Limosa lapponica	Bar-tailed godwit	Migratory	Migratory

Numenius phaeopus	Whimbrel	Migratory	Migratory
Onychoprion anaethetus	Bridled tern	Migratory	Not included
Phaethon rubricauda	Red-tailed tropicbird	Migratory	Priority 4, Migratory
Phalaropus lobatus	Red-necked phalarope	Migratory	Migratory
Pluvialis fulva	Pacific golden plover	Migratory	Migratory
Pluvialis squatarola	Grey plover	Migratory	Migratory
Sterna dougallii	Roseate tern	Migratory	Migratory
Thalasseus bergii as Sterna bergii	Crested tern, Greater crested tern	Migratory	Migratory
Tringa nebularia	Common greenshank	Migratory	Migratory
Tringa stagnatilis	Marsh sandpiper	Migratory	Migratory
Actitis hypoleucos	Common sandpiper	Listed	Not included
Charadrius bicinctus	Double-banded plover	Listed	Not included
Charadrius ruficapillus	Red-capped plover	Listed	Not included
Chroicocephalus novaehollandiae as Larus novaehollandiae	Silver gull	Listed	Not included
Eudyptula minor	Little penguin	Listed	Not included
Gallinago megala	Swinhoe's snipe	Listed	Not included
Gallinago stenura	Pin-tailed snipe	Listed	Not included
Haliaeetus leucogaster	White-bellied sea-eagle	Listed	Not included
Halobaena caerulea	Pied stilt	Listed	Not included
Larus pacificus	Pacific gull	Listed	Not included
Limosa limosa	Black-tailed godwit	Listed	Not included
Motacilla cinerea	Grey wagtail	Listed	Not included
Numenius minutus	Little curlew	Listed	Not included
Onychoprion fuscatus as Sterna fuscata	Sooty tern	Listed	Not included
Pachyptila turtur	Fairy prion	Listed	Not included
Pandion haliaetus	Osprey	Listed	Not included
Puffinus assimilis	Little shearwater	Listed	Not included
Recurvirostra novaehollandiae	Red-necked avocet	Listed	Not included
Stercorarius antarcticus as Catharacta skua	Brown suka	Listed	Not included
Thinornis cucullatus	Hooded plover	Listed	Priority 4
Tringa brevipes as Heteroscelus brevipes	Grey-tailed tattler	Listed	Not included
Tringa totanus	Common redshank	Listed	Not included
Xenus cinereus	Terek sandpiper	Listed	Not included
Apus pacificus	Fork-tailed swift	Not included	Migratory
Charadrius dubius	Little ringed plover	Not included	Migratory
Fish			
Thunnus maccoyii	Southern bluefin tuna	Conservation Dependent	Not included
Mobula alfredi as Manta alfredi	Reef manta ray	Migratory	Not included
Mobula birostris as Manta birostris	Giant manta ray	Migratory	Not included
Acentronura australe	Southern pygmy pipehorse	Listed	Not included
Campichthys galei	Gale's pipefish	Listed	Not included
Choeroichthys suillus	Pig-snouted pipefish	Listed	Not included
Halicampus brocki	Brock's pipefish	Listed	Not included

Heraldia nocturna	Upside-down pipefish	Listed	Not included
Hippocampus angustus	Western spiny seahorse	Listed	Not included
Hippocampus breviceps	Short-head seahorse	Listed	Not included
Hippocampus subelongatus	West Australian seahorse	Listed	Not included
Histiogamphelus cristatus	Rhino pipefish	Listed	Not included
Lissocampus caudalis	Australian smooth pipefish	Listed	Not included
Lissocampus fatiloquus	Prophet's pipefish	Listed	Not included
Lissocampus runa	Javelin pipefish	Listed	Not included
Maroubra perserrata	Sawtooth pipefish	Listed	Not included
Mitotichthys meraculus	Western crested pipefish	Listed	Not included
Nannocampus subosseus	Bonyhead pipefish	Listed	Not included
Phycodurus eques	Leafy seadragon	Listed	Not included
Phyllopteryx taeniolatus	Common seadragon	Listed	Not included
Pugnaso curtirostris	Pugnose pipefish	Listed	Not included
Solegnathus lettiensis	Gunther's pipefish	Listed	Not included
Stigmatopora argus	Spotted pipefish	Listed	Not included
Stigmatopora nigra	Widebody pipefish	Listed	Not included
Syngnathoides biaculeatus	Double-end pipefish	Listed	Not included
Urocampus carinirostris	Hairy pipefish	Listed	Not included
Vanacampus margaritifer	Mother-of-pearl pipefish	Listed	Not included
Vanacampus phillipi	Port Phillip pipefish	Listed	Not included
Vanacampus poecilolaemus	Longsnout pipefish	Listed	Not included
Sharks			
Galeorhinus galeus	School shark	Conservation Dependent	Not included
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	Not included
Carcharias taurus (west coast population)	Grey nurse shark (west coast population)	Vulnerable	Not included
Carcharodon carcharias	White shark	Vulnerable, Migratory	Vulnerable
Pristis pristis	Freshwater sawfish	Vulnerable, Migratory	Not included
Rhincodon typus	Whale shark	Vulnerable, Migratory	Not included
Carcharhinus longimanus	Oceanic whitetip shark	Migratory	Not included
Lamna nasus	Porbeagle, Mackerel shark	Migratory	Not included
Mammals			
Neophoca cinerea	Australian sea lion	Endangered	Endangered
Balaenoptera musculus	Blue whale	Endangered, Migratory	Endangered, Migratory
Eubalaena Australis as Balaena glacialis Australis	Southern right whale	Endangered, Migratory	Vulnerable
Balaenoptera musculus brevicauda	Pygmy blue whale	Endangered	Not included
Balaenoptera edeni	Bryde’s whale	Migratory	Not included
Caperea marginata	Pygmy right whale	Migratory	Not included
Megaptera novaeangliae	Humpback whale	Migratory	Conservation Dependent, Migratory
Orcinus orca	Killer whale, Orca	Migratory	Not included
Arctocephalus forsteri	New Zealand fur seal	Listed	Other Specially Protected
Balaenoptera acutorostrata	Minke whale	Listed	Not included
Delphinus delphis	Common dolphin	Listed	Not included
Grampus griseus	Risso’s dolphin	Listed	Not included

Stenella attenuata	Spotted dolphin	Listed	Not included
Tursiops aduncus	Indian ocean bottlenose dolphin	Listed	Not included
Tursiops truncatus s. str.	Bottlenose dolphin	Listed	Not included
Stenella longirostris	Spinner dolphin	Not included	Priority 4, Migratory
Reptiles			
Caretta caretta	Loggerhead turtle	Endangered, Migratory	Not included
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory	Vulnerable
Chelonia mydas	Green turtle	Vulnerable, Migratory	Vulnerable
Natator depressus	Flatback turtle	Vulnerable, Migratory	Not included
Aipysurus pooleorum	Shark Bay seasnake	Listed	Not included
Disteira kingii	Spectacled seasnake	Listed	Not included
Pelamis platurus	Yellow-bellied seasnake	Listed	Not included

Appendix B
Field survey sites and GPS tracks



Appendix Figure 1: Field survey sites and GPS tracks within the two survey areas

Appendix Figure 2: Field survey sites within the Main Jetty Survey Area west of the FSA

Appendix C
Field survey data

Appendix Table 2: Field survey data 24th November 2023 (FSA)

Site ID	Wpt	Lat	Long	Time	Depth (m)	Observer	Benthic Habitat Description	Notes	Classification
T11C	1671	-31.99674499	115.543965	8:56	2.9	JB/RM	JB - 80% Posidonia australis, 20% Sargassum RM - 80% Posidonia australis, 20% Sargassum	QAQC check	Posidonia dominated
T11D	1672	-31.99502897	115.544003	9:07	1.4	JB/RM	JB - 100% Posidonia sinuosa RM - 100% Posidonia sinuosa	QAQC	Posidonia dominated
T11E	1673	-31.99389397	115.54384	9:12	1.4	JB/RM	JB - 100% Posidonia sinuosa RM - 100% Posidonia sinuosa	QAQC	Posidonia dominated
T11F	1674	-31.99287096	115.543895	9:15	1.7	JB/RM	JB - 90% Posidonia sinuosa, 10% Sargassum RM - 90% Posidonia sinuosa, 10% Sargassum	QAQC	Posidonia dominated
T10A	1675	-31.99275898	115.546217	9:20	2.7	JB/RM	JB - 100% sand RM - 100% sand	QAQC Individual shoots of Posidonia	Sand
S01	1676	-31.99310197	115.545841	9:24	3.3	JB/RM	JB - 100% Posidonia sinuosa RM - 100% Posidonia sinuosa	QAQC No visible wrack	Posidonia dominated
T10B	1677	-31.99408801	115.546151	9:27	2.6	JB/RM	JB - 40% limestone, 40% Posidonia sinuosa, 20% Sargassum RM - 40% limestone, 40% Posidonia sinuosa, 20% Sargassum	QAQC Drifted for photo	Mixed algae / seagrass
T10C	1678	-31.99475798	115.546023	9:30	2.1	JB/RM	JB - 100% Posidonia sinuosa RM - 100% Posidonia sinuosa	QAQC	Posidonia dominated
T10D	1679	-31.99571997	115.54621	9:34	2.5	JB/RM	JB - 20% Posidonia sinuosa, 20% wrack, 10% brown algae, 50% sand RM - 20% Posidonia sinuosa, 20% wrack, 10% brown algae, 50% sand	QAQC	Sand with seagrass
T10E	1680	-31.99652798	115.546061	9:39	2.1	RM	95% Posidonia sinuosa, 5% Brown algae		Posidonia dominated
T10F	1681	-31.99735503	115.545924	9:41	2.5	JB	100% Posidonia sinuosa		Posidonia dominated

T10G	1682	-31.99825298	115.545968	9:43	2	JB	20% Amphibolis, 80% Posidonia sinuosa		Posidonia dominated
T10H	1683	-31.99918396	115.545924	9:46	1.6	RM	20% sand, 80% Posidonia sinuosa		Posidonia dominated
T9A	1684	-32.00110199	115.548084	9:50	1.7	RM	20% sand, 30% wrack, 30% Posidonia australis, 20% brown algae (likely Sargassum)		Mixed algae / seagrass
T9B	1685	-31.99997404	115.547952	9:54	2.3	RM	50% Posidonia australis/sinuosa, 20% Amphibolis, 20% sand, 10% brown algae	Photo reassessed. In field estimation: 30% Posidonia australis/sinuosa, 20% Amphibolis, 30% sand, 20% brown algae	Mixed seagrass
T9C	1686	-31.99919502	115.547946	9:57	2.6	RM	98% sand, 2% wrack		Sand
T9D	1687	-31.99837402	115.547992	9:59	2.7	RM	100% Posidonia sinuosa		Posidonia dominated
T9E	1688	-31.99729401	115.547939	10:01	2.5	JB	100% Posidonia sinuosa		Posidonia dominated
T9F	1689	-31.99639899	115.547983	10:03	2.8	JB	100% Posidonia sinuosa	Near reef	Posidonia dominated
T9G	1690	-31.99549701	115.548096	10:07	3.8	JB	100% Posidonia sinuosa	Only 2 photos	Posidonia dominated
T9H	1691	-31.99456402	115.547953	10:11	4.3	JB	100% sand		Sand
T9I	1692	-31.99370404	115.548152	10:12	4.4	RM	100% sand		Sand
T9J	1693	-31.99290097	115.548021	10:13	3	JB	100% sand		Sand
T1J	1694	-31.99289502	115.549179	10:15	3.3	RM	100% sand		Sand

T1I	1695	-31.99366297	115.548982	10:17	4.7	JB	100% sand	Sand
T1H	1696	-31.99489502	115.549022	10:20	4.1	JB	70% Posidonia sinuosa/australis, 30% brown algae	Posidonia dominated
T1G	1697	-31.995581	115.549095	10:23	4.1	JB	100% Posidonia sinuosa	Posidonia dominated
S02	1698	-31.99614996	115.549387	10:25	4	RM	50% Posidonia sinuosa/australis, 50% limestone	Photo may show 100% Posidonia ** edge of habitat** have marked as limestone to pick up that reef area.	Limestone reef / pavement
A06	1699	-31.99616999	115.547395	10:29	2.8	JB	100% Posidonia sinuosa	Posidonia dominated
Extra	1700	-31.99621802	115.547378			RM	100% Sargassum on limestone reef	Macroalgae dominated
T1F	1701	-31.99653997	115.549226	10:32	3.7	RM	100% Posidonia sinuosa	Posidonia dominated
T1E	1702	-31.99743398	115.549022	10:35	2.6	RM	95% Posidonia sinuosa, 5% brown algae	Posidonia dominated
T1D	1703	-31.99828601	115.549036	10:36	2.6	JB	90% Posidonia sinuosa, 10% Amphibolis	Posidonia dominated
T1B	1704	-31.99930298	115.549127	10:40	2.7	RM	100% Posidonia sinuosa	Posidonia dominated
T1A	1705	-32.00083603	115.548879	10:42	2.2	JB	100% Posidonia sinuosa	Posidonia dominated
A19	1706	-32.00077099	115.551096	10:46	3.6	RM	95% Posidonia sinuosa, 5% Amphibolis	Posidonia dominated
A20	1707	-32.00070502	115.550068	10:49	2.6	RM	5% Amphibolis, 95% Posidonia sinuosa	Wrack present around sand edges	Posidonia dominated
A21	1708	-32.00098397	115.549743	10:52	3.3	RM	95% brown algae (80% Sargassum, 15% Ecklonia), 5% Posidonia sinuosa	Macroalgae dominated

A22	1709	-32.00105899	115.549419	10:55	2.6	RM	50% sand, 40% Posidonia australis, 10% wrack		Sand with seagrass
A26	1710	-32.00162301	115.550139	10:58	1.2	RM	100% wrack	Mix seagrass and brown algae **sand under wrack**	Sand with wrack
A25	1711	-32.001665	115.550635	11:00	1.5	JB	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
A24	1712	-32.00133802	115.550678	11:03	2.5	RM	100% Posidonia sinuosa		Posidonia dominated
A27	1713	-32.001967	115.551334	11:05	1.9	JB	100% Posidonia sinuosa		Posidonia dominated
Extra	1714	-32.00201503	115.551429			RM	50% wrack, 50% sand		Sand with wrack
A23	1715	-32.00120299	115.551755	11:09	3.1	JB	80% Posidonia sinuosa, 20% mixed algae		Posidonia dominated
T2J	1716	-32.00099302	115.550099	11:20	2	RM	100% Posidonia sinuosa		Posidonia dominated
T2I	1717	-32.00017797	115.550109	11:23	2.7	RM	100% Posidonia sinuosa		Posidonia dominated
T2H	1718	-31.99919703	115.550157	11:25	2.9	RM	100% Posidonia sinuosa		Posidonia dominated
T2G	1719	-31.99825298	115.550154	11:26	2.7	JB	60% Posidonia sinuosa, 30% Amphibolis, 10% brown algae		Mixed seagrass
T2F	1720	-31.99748998	115.550132	11:30	4	RM	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
T2E	1721	-31.996458	115.55018	11:30	4.7	RM	20% Halophila ovalis, 10% Posidonia sinuosa, 10% mixed seagrass, 30% wrack, 30% sand		Sand with seagrass
T2D	1722	-31.99550296	115.550072	11:38	3.9	RM	80% Posidonia sinuosa, 20% Amphibolis	Camera changed - GoPro 3	Posidonia dominated

A04	1723	-31.99508102	115.549986	11:41	3.8	RM	90% Posidonia sinuosa/australis, 5% Amphibolis, 5% mixed seagrass		Posidonia dominated
T2C	1724	-31.99462102	115.550255	11:43	5.3	RM	100% sand	Individual shoots of Posidonia	Sand
T2B	1725	-31.99377897	115.55031	11:46	5	RM	80% sand, 15% wrack, 5% Halophila ovalis		Sand
T2A	1726	-31.99285696	115.550124	11:48	3.4	RM	80% sand, 20% Sargassum	Mostly bare sediment with algae patch	Sand
T3J	1727	-31.99394301	115.551103	11:51	5.4	RM	80% Halophila ovalis, 20% brown algae	Posidonia wrack floating around photo not useful. Sand with seagrass due to Halophila morphology	Halophila dominated
A02	1728	-31.99426504	115.550633	11:54	4.7	RM	60% Posidonia sinuosa, 40% Amphibolis		Mixed seagrass
T3I	1729	-31.99472898	115.551097	11:57	4.9	JB	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
A05	1730	-31.99550003	115.550789	11:59	3.5	JB	90% mixed seagrass, 10% sand		Mixed seagrass
T3H	1731	-31.99561704	115.551089	12:01	4.6	JB	40% sand, 40% Posidonia sinuosa, 10% Halophila ovalis, 10% mixed seagrass		Sand with seagrass
T3G	1732	-31.99665103	115.551255	12:05	3.4	JB	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
T3F	1733	-31.99753398	115.551133	12:07	3.3	JB	80% Posidonia sinuosa, 20% Amphibolis		Posidonia dominated
T3E	1734	-31.99835298	115.551099	12:09	2.9	JB	100% Posidonia sinuosa		Posidonia dominated
T3D	1735	-31.99924104	115.551212	12:11	3.6	JB	100% Posidonia sinuosa		Posidonia dominated
T3C	1736	-32.00014201	115.551075	12:13	3.4	JB	95% Posidonia sinuosa, 5% sand	Slight drift for photo	Posidonia dominated

	1737	-32.00017897	115.551114					Additional waypoint taken at T3C - unnecessary can ignore	
T3B	1738	-32.00108003	115.551078	12:23	3.1	JB	70% Posidonia sinuosa, 30% Posidonia australis	Bare sand next to meadow with wrack. Australis on edge of meadow.	Posidonia dominated
T3A	1739	-32.00205401	115.551278	12:27	1.8	RM	70% sand, 30% wrack		Sand with wrack
T11B	1740	-31.99739199	115.543782	12:34	1.5	RM	80% Amphibolis, 20% sand	Bits of wrack throughout	Amphibolis dominated
T11A	1741	-31.998299	115.5438	12:37	0.8	RM	100% Posidonia sinuosa		Posidonia dominated
T8A	1742	-31.99304497	115.56054	13:45	6.2	RM	20% Posidonia, 10% sand, 70% brown algae		Macroalgae dominated
T8B	1743	-31.99384603	115.560744	13:48	6.4	RM	70% brown algae, 20% Posidonia, 10% sand		Macroalgae dominated
T8C	1744	-31.99496602	115.56083	13:50	6.2	RM	100% Posidonia sinuosa		Posidonia dominated
T8D	1745	-31.99577697	115.56072	13:51	8.2	RM	80% sand, 20% Posidonia	Patches of Posidonia wrack	Sand with seagrass
T8E	1746	-31.99669898	115.560799	13:53	9.1	RM	10% wrack, 90% sand		Sand
T8F	1747	-31.99759802	115.560664	13:54	9.6	RM	10% Posidonia, 20% Posidonia wrack, 70% sand		Sand
T8G	1748	-31.99836899	115.56046	13:57	5.9	RM	80% Sargassum, 10% Posidonia sinuosa, 10% sand		Macroalgae dominated
A13	1749	-31.99931304	115.559995	13:59	4.6	RM	40% Sargassum, 20% Ecklonia, 40% wrack		Macroalgae dominated
S20	1750	-32.000025	115.561038	14:02	2.2	RM	100% Amphibolis		Amphibolis dominated

T8H	1751	-32.00019297	115.560629	14:04	3.1	RM	100% sand		Sand
T8I	1752	-32.00119603	115.560857	14:06	5.8	RM	10% sand, 70% brown algae, 20% Posidonia	Edge of Posidonia meadow	Macroalgae dominated
T8J	1753	-32.00191604	115.560858	14:08	2.4	RM	100% Posidonia		Posidonia dominated
T7A	1754	-32.00203104	115.55838	14:10	3.9	RM	60% brown algae (5% is Ecklonia), 40% Posidonia wrack	Edge of Posidonia meadow	Macroalgae dominated
T7B	1755	-32.00094701	115.558457	14:12	3.8	RM	50% Posidonia sinuosa, 30% wrack, 20% brown algae		Mixed algae / seagrass
T7C	1756	-32.00017604	115.558462	14:13	3.8	RM	90% Posidonia, 5% sand, 5% brown algae		Posidonia dominated
A15	1757	-31.99960599	115.559334	14:15	4	RM	10% Sargassum on limestone, 40% Posidonia, 50% brown algae (50% Ecklonia, 50% Sargassum)		Mixed algae / seagrass
T7D	1758	-31.99940398	115.55856	14:19	4.7	RM	30% Amphibolis, 20% Posidonia, 50% sand with wrack		Sand with seagrass
S19	1759	-31.99899402	115.558731	14:21	4.9	RM	100% Posidonia sinuosa		Posidonia dominated
T7E	1760	-31.998185	115.558541	14:23	6.6	RM	100% sand	Posidonia wrack outside quadrat	Sand
T7F	1761	-31.99740901	115.558648	14:24	7.3	RM	50% sand, 50% wrack (Posidonia and Ecklonia)		Sand with wrack
T7G	1762	-31.99649496	115.558428	14:26	6.3	RM	90% sand, 10% Halophila ovalis		Sand
T7H	1763	-31.99543096	115.558657	14:28	7	RM	100% Sargassum		Macroalgae dominated
T7I	1764	-31.99466896	115.558607	14:29	5.3	RM	100% Posidonia	Edge of meadow	Posidonia dominated

T7J	1765	-31.99370404	115.558555	14:31	4.4	RM	100% Posidonia		Posidonia dominated
T7K	1766	-31.99278496	115.558722	14:32	3.8	RM	70% Sargassum, 20% sand, 10% Posidonia		Macroalgae dominated
T6A	1767	-31.99294103	115.556474	14:35	2.7	RM	80% Sargassum, 10% limestone, 10% sand		Macroalgae dominated
T6B	1768	-31.99386296	115.556619	14:37	3.4	RM	100% Posidonia sinuosa		Posidonia dominated
A01	1769	-31.99428096	115.555559	14:39	2.3	RM	10% Posidonia, 70% Sargassum, 20% sand		Macroalgae dominated
T6C	1770	-31.99472596	115.556583	14:40	3.9	RM	100% Amphibolis	Posidonia wrack accumulated around Amphibolis meadow	Amphibolis dominated
T6D	1771	-31.995754	115.556711	14:42	4.5	RM	50% Posidonia, 50% sand with wrack		Sand with seagrass
A08	1772	-31.99618701	115.555212	14:45	4	RM	80% Posidonia, 20% Amphibolis	Not much wrack accumulated at edge of meadow	Posidonia dominated
A09	1773	-31.99688103	115.555194	14:46	4.7	RM	80% Posidonia, 20% Sargassum		Posidonia dominated
T6E	1774	-31.99662002	115.556488	14:48	4.3	RM	95% Posidonia sinuosa, 5% Amphibolis		Posidonia dominated
A10	1775	-31.99740498	115.555229	14:50	5	RM	100% sand		Sand
T6F	1776	-31.99754404	115.556483	14:52	4.7	RM	95% Sargassum, 5% Posidonia		Macroalgae dominated
A11	1777	-31.99844903	115.557278	14:54	8.3	RM	100% sand	Minor bits of Ecklonia and Posidonia wrack	Sand
A12	1778	-31.99881096	115.555377	14:57	5.9	RM	100% Posidonia	Edge of meadow - Posidonia wrack around edge of meadow	Posidonia dominated

T6G	1779	-31.99842598	115.556438	14:59	7.4	RM	100% Posidonia	Edge of meadow - minimal wrack	Posidonia dominated
T6H	1780	-31.999406	115.556746	15:02	3.9	RM	80% Sargassum, 10% Posidonia, 10% sand		Macroalgae dominated
S16	1781	-31.99968201	115.557738	15:04	4.1	RM	80% Sargassum, 20% Posidonia		Macroalgae dominated
A16	1782	-31.99959601	115.557681	15:05	2.9	RM	80% Sargassum on limestone reef, 20% limestone	Corals present	Macroalgae dominated
T6I	1783	-32.00028903	115.556549	15:08	3.9	RM	100% Posidonia		Posidonia dominated
A17	1784	-32.00080703	115.556935	15:10	3.7	RM	60% Posidonia, 30% brown algae, 10% sand	Some wrack	Mixed algae / seagrass
T6J	1785	-32.00108497	115.556239	15:13	3.9	RM	100% Posidonia		Posidonia dominated
A18	1786	-32.00161697	115.557645	15:15	3.8	RM	70% brown algae, 30% sand	Patchy	Macroalgae dominated
S17	1787	-32.00156702	115.557051	15:17	3.4	RM	70% Posidonia, 20% Sargassum, 10% sand		Posidonia dominated
T6K	1788	-32.00197203	115.556517	15:19	2.8	RM	100% Posidonia		Posidonia dominated
Extra	1789	-32.00224604	115.556578	15:20	2.8	RM	100% wrack - Posidonia & Ecklonia		Sand with wrack
A28	1790	-32.00238903	115.55385	15:24	3.2	RM	90% Posidonia australis, 10% Amphibolis	Sandy edge has Posidonia wrack	Posidonia dominated
S11	1791	-32.00203196	115.553163	15:26	2.7	RM	90% wrack (Posidonia & Ecklonia), 10% sand		Sand with wrack
T5A	1792	-32.00204101	115.554239	15:28	2.5	RM	100% Posidonia		Posidonia dominated

T5B	1793	-32.00109403	115.55448	15:29	3.5	RM	100% Posidonia		Posidonia dominated
T5C	1794	-32.00026799	115.554453	15:32	3.9	RM	100% Posidonia		Posidonia dominated
T5D	1795	-31.99929401	115.554263	15:33	3.6	RM	70% Posidonia, 30% Amphibolis		Posidonia dominated
T5E	1796	-31.998329	115.553854	15:35	4.1	RM	60% Posidonia, 40% sand with Posidonia wrack		Sand with seagrass
T5F	1797	-31.997495	115.554083	15:36	5.8	RM	100% sand	Around Posidonia meadow is Posidonia wrack	Sand
T5G	1798	-31.99653796	115.55435	15:37	4.9	RM	95% sand, 5% Posidonia	No wrack	Sand
S12	1799	-31.99610302	115.554135	15:39	3.1	RM	95% Posidonia, 5% Amphibolis		Posidonia dominated
T5H	1800	-31.99551797	115.554389	15:40	3.1	RM	100% sand		Sand
Extra	1801	-31.99543197	115.554649				100% Posidonia	No wrack on edge	Posidonia dominated
T5I	1802	-31.99488798	115.554422	15:41	2.3	RM	90% Amphibolis, 10% sand with minor Amphibolis wrack		Amphibolis dominated
S13	1803	-31.99447601	115.554359	15:43	2.3	RM	90% Posidonia, 10% Amphibolis		Posidonia dominated
T5J	1804	-31.99373798	115.554572	15:44	3.2	RM	100% Posidonia		Posidonia dominated
T5K	1805	-31.99307003	115.554314	15:45	3.9	RM	100% Posidonia	No wrack on edge of meadow	Posidonia dominated
S14	1806	-31.99278203	115.554286	15:47	3.6	RM	80% Amphibolis, 10% sand, 10% Sargassum		Amphibolis dominated

S09	1807	-31.99279502	115.55249	15:49	3.9	RM	40% limestone reef, 40% sand, 20% brown algae		Limestone reef / pavement
T4A	1808	-31.99296199	115.552423	15:51	3.2	RM	20% Amphobolis, 80% rubble with brown turf algae	Rubble is limestone reef	Limestone reef / pavement
T4B	1809	-31.99379297	115.552165	15:52	4.1	RM	50% Amphibolis, 40% brown algae, 10% sand		Mixed algae / seagrass
S10	1810	-31.994143	115.552313	15:53	4	RM	70% Posidonia, 30% Amphibolis		Posidonia dominated
T4C	1811	-31.99488899	115.552197	15:55	4	RM	50% Posidonia, 30% sand, 20% brown algae		Sand with seagrass
A3	1812	-31.99511496	115.553358	15:57	3.9	RM	100% sand with brown turf algae & wrack	100% Posidonia surrounding	Sand
T4D	1813	-31.995552	115.552314	15:59	4.8	RM	100% sand		Sand
A7	1814	-31.99601199	115.55177	16:01	3.2	RM	90% Posidonia, 10% Amphibolis		Posidonia dominated
T4E	1815	-31.99665296	115.552304	16:02	3.2	RM	100% Posidonia		Posidonia dominated
T4F	1816	-31.99743298	115.552387	16:03	3.4	RM	100% Posidonia		Posidonia dominated
T4G	1817	-31.99839296	115.552139	16:05	3.2	RM	80% Amphibolis, 20% Posidonia		Amphibolis dominated
T4H	1818	-31.99915898	115.552314	16:06	4	RM	90% Posidonia, 10% Amphibolis		Posidonia dominated
T4I	1819	-32.00017302	115.552504	16:08	5	RM	90% sand, 10% Posidonia wrack		Sand
T4J	1820	-32.00095103	115.5523	16:09	5.8	RM	100% Posidonia meadow	Minor Posidonia wrack on edge; photo shows edge	Posidonia dominated

T4K	1821	-32.00177698	115.552292	16:11	3	RM	100% wrack (Posidonia & Ecklonia)		Sand with wrack
Extra	1822	-32.00210698	115.552384	16:12	3	RM	80% Amphibolis, 20% Posidonia	Surrounded by Posidonia wrack	Amphibolis dominated
Extra	1823	-32.00211201	115.552172	16:15	2	RM	100% Amphibolis meadow onto sand	Patches of Posidonia	Amphibolis dominated
Extra	1824	-32.00186298	115.550902	16:17	1.5	RM	100% wrack (Posidonia & Sargassum)		Sand with wrack

Definitions: JB = James Brightmore, RM = Rosh McCallum, QAQC = Quality assurance and quality control

Appendix Table 3: Field survey data 29th January 2024 (Main Jetty Survey Area with several sites also in the FSA)

Site ID	Wpt	Lat	Long	Time	Depth (m)	Observer	Benthic Habitat Description	Notes	Classification
S01	1825	-31.99263501	115.54257402	9:15	0.8	JB/RM	100% Posidonia australis	Snorkel QA/QC. Halophila ovalis & zostera present, Posidonia wrack accumulated in sandy gaps	Posidonia dominated
S03	1826	-31.99304002	115.54312999	9:30	1.2	JB/RM	100% Posidonia (95% sinuosa, 5% australis)	QA/QC	Posidonia dominated
S05	1827	-31.99386296	115.54242197	9:35	0.8	JB/RM	100% Posidonia sinuosa	QA/QC. Posidonia wrack accumulated in the patches	Posidonia dominated
S07	1828	-31.99466896	115.54311901	9:37	1.3	JB/RM	100% Posidonia sinuosa	QA/QC	Posidonia dominated
S09	1829	-31.99530104	115.54306897	9:39	1	JB/RM	100% Posidonia (10% australis, 90% sinuosa)	QA/QC. High level of epiphytes	Posidonia dominated
S08	1830	-31.99527204	115.54238702	9:42	0.7	JB/RM	100% sand	Wrack accumulation along edge of sand patch	Sand
S10	1831	-31.99576297	115.54291299	9:47	4.9	JB/RM	Probable 100% sand (visibility low)		Sand
Extra01	1832	-31.99623001	115.54287904	9:49	1.6	JB/RM	100% Posidonia wrack with sand patches		Sand with wrack
S12	1833	-31.99637401	115.543376	9:52	2.3	JB/RM	50% sand, 50% wrack		Sand with wrack
S14	1834	-31.99690299	115.54310996	9:55	1.1	JB/RM	100% Posidonia sinuosa	Small sand patches	Posidonia dominated
Extra02	1835	-31.99682596	115.54302304	9:57	1.1	JB/RM	80% Posidonia mix, 20% sand	Sand patch, drifting along patchy bits	Posidonia dominated
S16	1837	-31.99792801	115.54307501	10:00	0.8	JB/RM	90% Posidonia australis, 10% brown algae (brown algae may be epiphytes)	High level of epiphytes	Posidonia dominated
S17	1838	-31.99797596	115.54331699	10:02	0.6	JB/RM	100% Posidonia australis, with epiphytes	Boundary appears living seagrass from distance	Posidonia dominated
DA01	1839, 1840	-32.00092999	115.54994004	10:09	2.8	JB/RM	40% mixed algae, 40% wrack, 20% Posidonia	Development area site	Mixed algae / seagrass
DA02	1841, 1842	-32.00111004	115.54982001	10:14	2.6	JB/RM	10% brown algae, 10% Posidonia, 80% wrack	Development area site	Sand with wrack

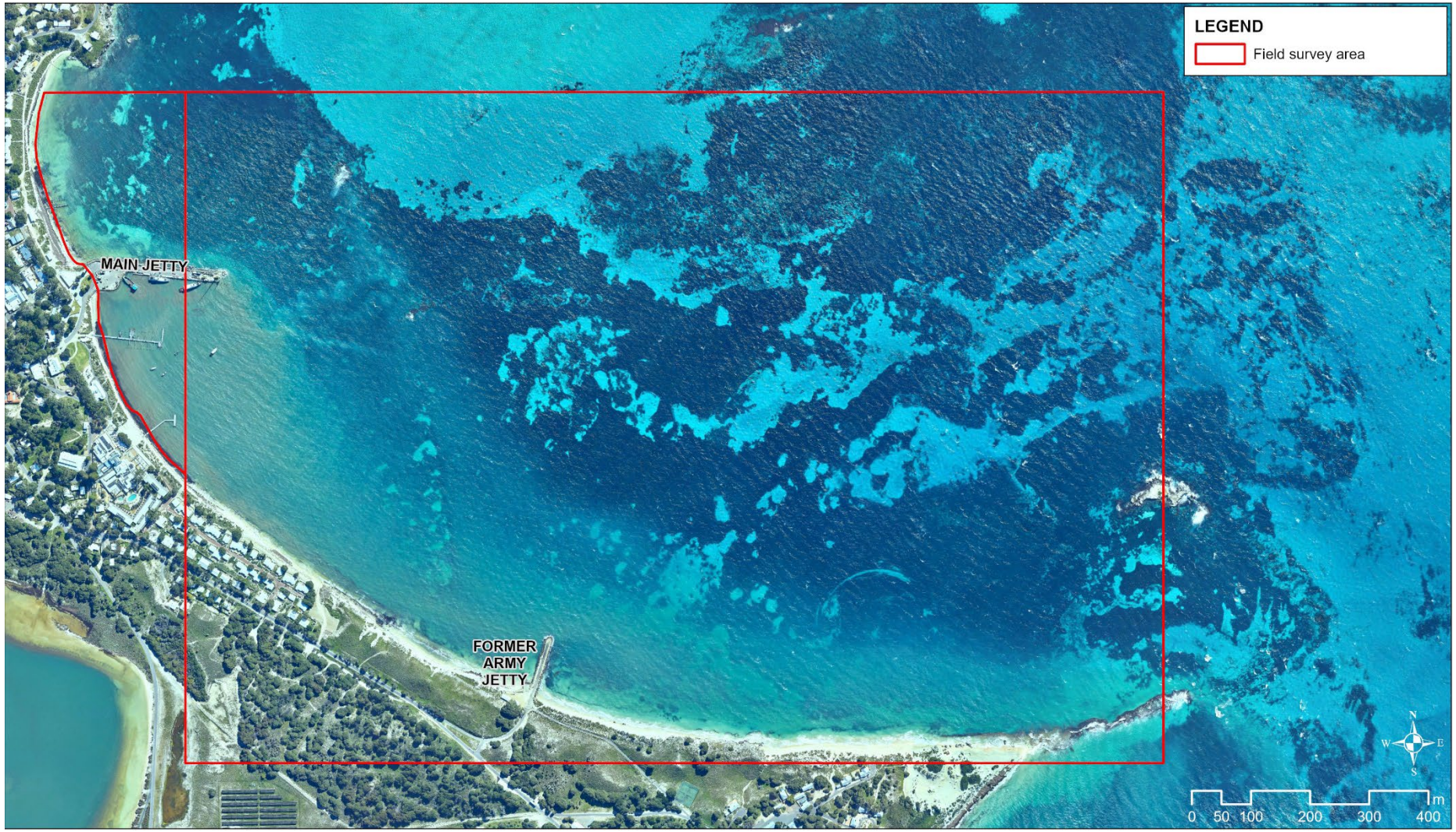
DA03	1844	-32.00143098	115.55014498	10:19	1.4	JB/RM	10% brown algae, 90% Posidoinia (90% sinuosa, 10% australis)	Development area site. Lots of wrack on nearby beach	Posidonia dominated
Extra03	1845	-32.00124197	115.55022301	10:22	1.9	JB/RM	100% sand	Wrack accumulated along edges	Sand
Extra04	1846	-31.99430301	115.54259196	10:32	0.8	JB/RM	Sand patch with Posidonia wrack around edges. Meadow is Posidonia australis		Sand
Extra05	1847	-31.99391199	115.54279304	10:36	1.9	JB/RM	Sand patch with Posidonia wrack on edges, 20% wrack in sand patches, 2% Halophila ovalis		Sand
Extra06	1848	-31.99321504	115.54243002	10:41	1.3	JB/RM	100% sand, 5% wrack (95% sand with 5% wrack)	Edges 50% wrack, 50% Posidonia australis	Sand
Extra07	1849	-31.99629002	115.54266103	10:46	1.4	JB/RM	100% sand	Posidonia australis meadow with wrack accumulated at edge	Sand
S02	1850	-31.99283802	115.54129503		1	RM	100% wrack	First wading/snorkelling site. All wrack on way out. Wrack on top of sparse meadow. 26th Jan = very low tide that likely exposed shallow sites - RIA.	Sand with wrack
Extra08	1851	-31.99286501	115.54155403		0.2 - 1	RM	100% Posidonia, small patches of Halophila	Wpt 1851 = boundary of seagrass	Posidonia dominated
S04	1852	-31.99367596	115.54132998		1	RM	100% wrack		Sand with wrack
Extra09	1853	-31.99360496	115.541491		1	RM	100% Posidonia, lots of epiphytes	Wpt 1852 = boundary of seagrass	Posidonia dominated
S06	1854	-31.99452999	115.54166199		1-1.5	RM	50% Posidonia australis, 50% sand		Sand with seagrass
Extra10	1855	-31.99462504	115.54158202		1-1.5	RM	100% Posidonia australis		Posidonia dominated
Extra11	1856	-31.99491204	115.54153098		1	RM	100% Posidonia australis	Surrounded by 100% wrack all around	Posidonia dominated
Extra12	1857	-31.99496099	115.54153299		1	RM	100% wrack		Sand with wrack
Extra13	1858	-31.99486099	115.54152402		1	RM	100% wrack		Sand with wrack
S11	1859	-31.99606497	115.54225802		1	RM	100% Posidonia australis, mixed with wrack	Green seagrass underneath wrack	Posidonia dominated

Extra14	1860	-31.99632296	115.54223296		1	RM	50% Posidonia australis, 50% sand	Edge of meadow	Sand with seagrass
S15	1861	-31.997193	115.54246296		1	RM	100% sand		Sand
Extra15	1862	-31.99713903	115.54260101		1	RM	100% Posidonia australis	Edge of meadow	Posidonia dominated
S13	1863	-31.99684599	115.54251602		1.5	RM	10% Posidonia australis, 10% sand, 80% wrack		Sand with wrack
Extra16	1864	-31.99677902	115.542354	12:15 (end)	0.8	RM	70% Posidonia (mixed), 30% sand	Edge of meadow	Posidonia dominated

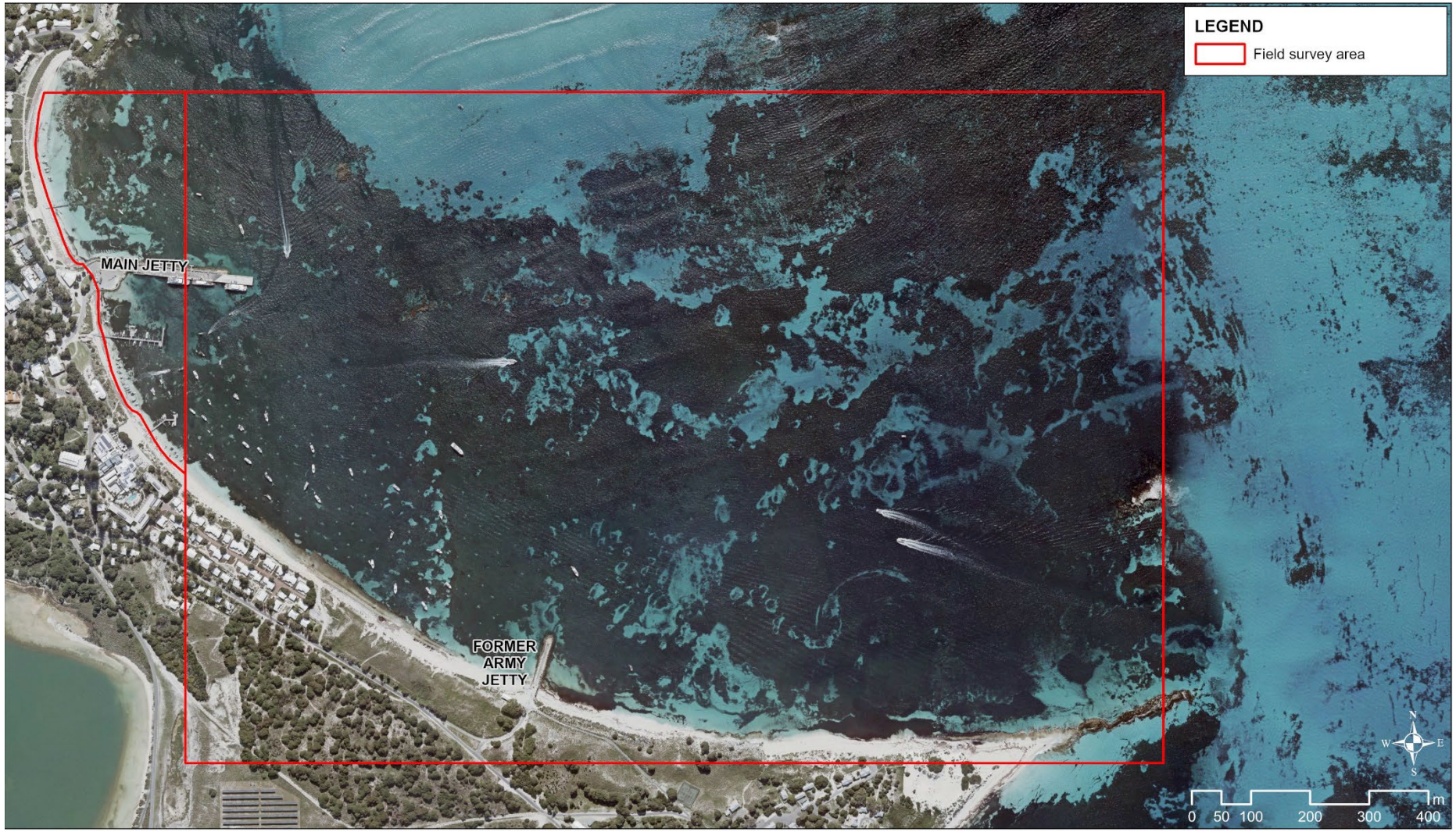
Definitions: JB = James Brightmore, RM = Rosh McCallum, QAQC = Quality assurance and quality control

Appendix D
Thomson Bay aerial images

Appendix Figure 3: Thomson Bay aerial image, February 2023 (source: Landgate)



Appendix Figure 4: Thomson Bay aerial image, August 2022 (source: Landgate)



Appendix Figure 5: Thomson Bay aerial image, August 2023 (source: Landgate)