Clump Point Boat Ramp: Marine Ecology, Water Quality & Sediment Sampling Report

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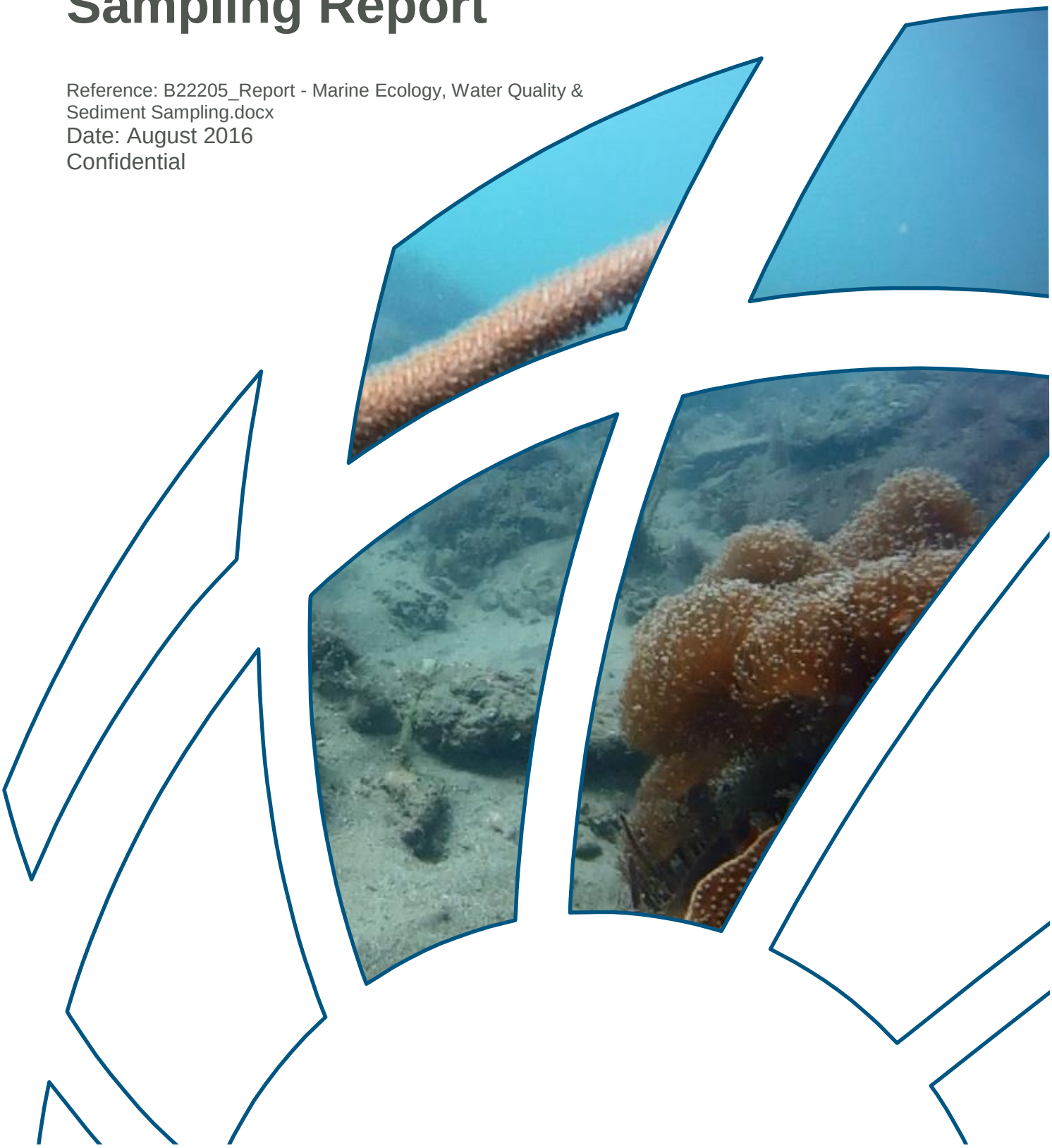

Document Control Sheet

BMT WBM Pty Ltd Level 8, 200 Creek Street Brisbane Qld 4000 Australia PO Box 203, Spring Hill 4004 Tel: +61 7 3831 6744 Fax: + 61 7 3832 3627 ABN 54 010 830 421 www.bmtwbm.com.au	**Document:**	B22205_Report - Marine Ecology, Water Quality & Sediment Sampling.docx
	Title:	Clump Point Boat Ramp: Marine Ecology, Water Quality & Sediment Sampling Report
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	Author:	Darren Richardson
	Client:	Department of State Development
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	Client Reference:	DSD-4028-16
Synopsis:	**Description of marine ecology, water quality and sediment sampling activities undertaken to inform the Clump Point Boat Ramp Development Plan and design activities**	

REVISION/CHECKING HISTORY

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1 Introduction

The Queensland Government, through the Department of State Development (DSD), plans to enhance maritime infrastructure within Boat Bay, Mission Beach, to improve boating safety. To enhance the safety and functionality of existing maritime infrastructure within Boat Bay, a combination of infrastructure solutions has been identified. Proposed infrastructure solutions (and their objectives) represent the culmination of several years of consultation, commencing in 2011.

Boat Bay and surrounding marine environs around Clump Point support a range of biodiversity values that need to be considered in the design of proposed marine and land-side works. Several marine water quality, sediment quality and marine ecological studies have been carried out in the study area to date. Those previous studies have been reviewed and further studies carried out to ensure information is current and to extend the areas assessed, given the previous limited spatial coverage of previous studies. A rapid marine environmental assessment was undertaken to ground-truth existing information regarding the characteristics of marine benthic habitats in the study area. The methodology and outcomes of this assessment are presented in this technical report, together with an updated assessment of potential values of the study area for marine megafauna species.

The specific objectives of this study are to:

- Summarise the water quality characteristics of marine waters at and adjacent to the study area
- Map key benthic habitats within the study area
- Characterise the textual characteristics of soft sediments within the study area
- Identify dominant coral and seagrass taxa within representative habitat types
- Describe the potential values of the study area for marine megafauna species.

2 Methodology and Survey Conditions

2.1 Desktop Assessments

Flora and fauna species, communities and habitats within the study area and surrounds were characterised through searches of relevant databases, a review of previous studies, and supplementary field investigations. Searches were undertaken of the EPBC Protected Matters Search Tool (18 July 2016) and Department of Environment and Heritage Protection Wildlife Online database (18 July 2016). References cited in this report are presented in Section 4.

Supplementary surveys were undertaken by BMT WBM to ground-truth existing habitat mapping. Preliminary habitat maps were initially developed based on:

- Benthic habitat mapping of the study area undertaken by Roder *et al*. (1998) in December 1998.
- Hydrographic survey data, including surveys carried out in July 2016 at the boat ramp and adjacent offshore environments, as shown in Figure 3-1. The hydrographic survey provided information on water depths (relative to lowest astronomical tide; LAT), substrate rugosity, and substrate type (based on acoustic backscatter data).
- Digitising of visible reef features from geo-rectified aerial photographs using the Mapinfo software package.

2.2 Field Surveys

Field surveys were carried out by a qualified senior marine ecologist (Dr Conor Jones) supported by two senior marine field technicians (Craig Morgan, Joe Desmond). All field staff had commercial dive qualifications (ADAS). Sampling was conducted using BMT WBM's Class C certified research vessel *Resolution 2,* skippered by a certified coxswain. Sampling was carried out under GBRMPA Research Permit number G16/37982.1, in accordance with an approved sampling and analysis plan.

Seabed habitats and benthic communities were assessed using an underwater video camera during 23-24 July 2017. The sites selected for surveys encompassed the range of habitats identified through bathymetry charts and habitat mapping from Roder *et al*. (1998). The locations of these sites are shown in Figure 2-1. Differential GPS was used on the survey vessel for position fixing and navigation to each sampling location.

At each transect, an underwater camera system was deployed by the passively drifting vessel for 4 minutes. Video footage was observed on a computer monitor in real-time and recorded to hard drive. A Van Veen grab was used to sample the seabed at selected sites to confirm sediment type and collect and identify any seagrass. Divers undertook inspections of the seafloor in each of the key habitat types, as well as large rock boulders (bommies).

Once collected, the video file for each transect was reviewed, noting the following features:

- Substrate type (e.g. soft sediment, consolidated reef)
- Approximate sediment grain size (e.g. silt, sand, rubble)

- The presence, general composition and abundance (i.e. dominant groups) of visually obvious biota, including epibenthic fauna (e.g. corals, sponges, ascidians etc.), epibenthic macroalgae and seagrass
- Other relevant features influencing seabed habitats (e.g. topography, evidence of trawling activity).

2.3 Survey Conditions

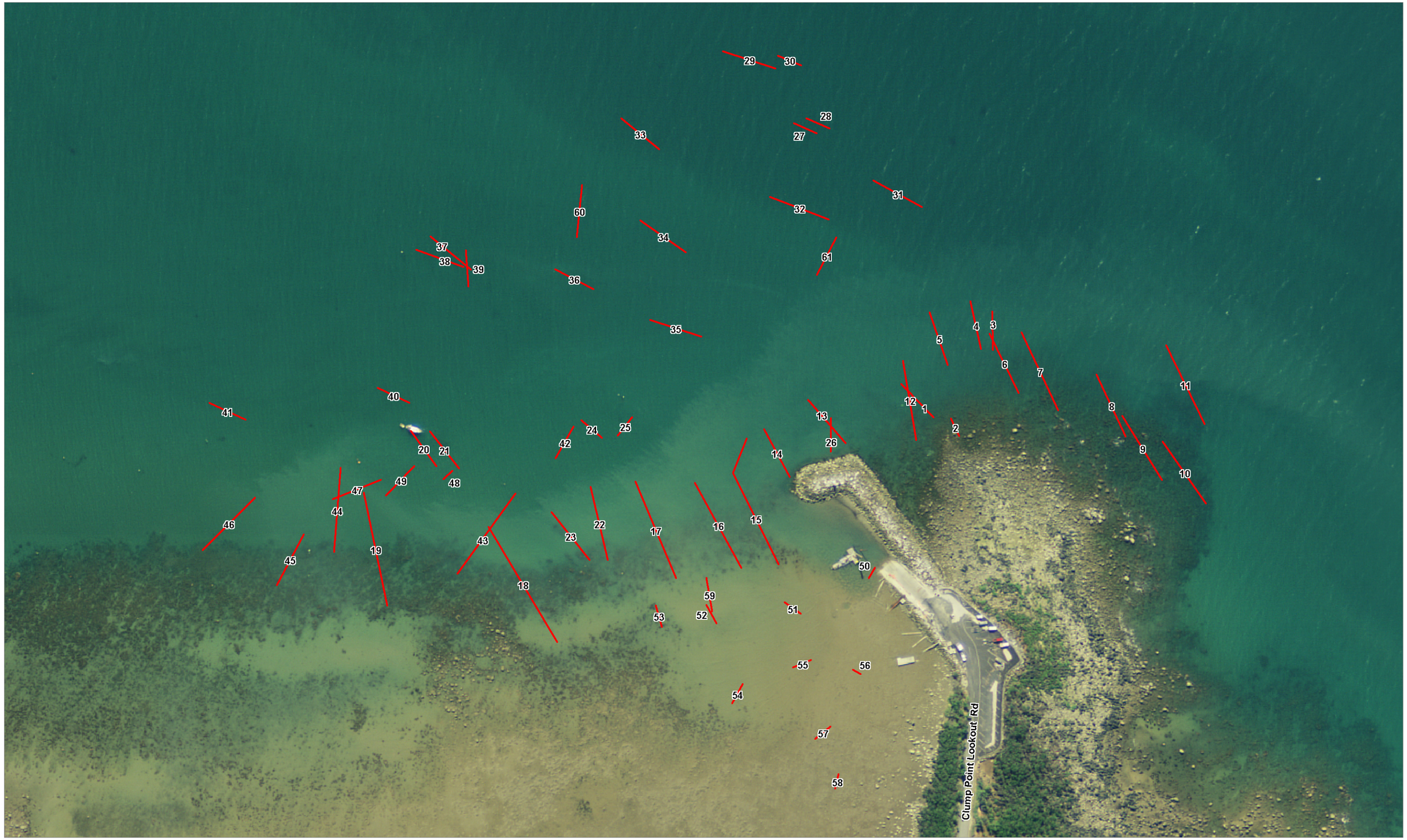
Table 2-1 shows rainfall and wind conditions recorded at the South Johnstone Bureau of Meteorology station[1] in the period leading to and including surveys on the 23-24 July 2016. High rainfall (142 mm) was recorded in this period, but major flood plumes were not observed. Water visibility at Boat Bay was <0.5 m in the week prior to surveys, as a result of wave-induced sediment resuspension. Winds abated immediately prior to and during surveys, and water visibility improved to >1-2 m, providing suitable conditions for underwater video and diver based benthic surveys.

Table 2-1 Weather conditions in the 10 day period prior to surveys in July 2016 (Bureau of Meteorology station at South Johnstone – Station 032037)

Date	Rain (mm)	Max wind gust			9:00 AM			3:00 PM		
		Dir	Speed (km/h)	Time	Dir	Speed (km/hr)	MSLP (hPa)	Dir	Speed (km/hr)	MSLP (hPa)
15/7	8	SW	17	16:44	Calm		1016.7	SW	7	1013.1
16/7	1	NE	20	13:27	ENE	4	1014.8	E	11	1011.6
17/7	0	SSE	26	14:37	Calm		1015.3	SE	13	1012.6
18/7	15.8	ENE	37	7:50	E	19	1017.1	NNW	2	1014.3
19/7	82.8	NE	37	6:55	ESE	9	1016.9	ESE	17	1015
20/7	21.6	SSE	30	13:00	SE	9	1017.8	ESE	13	1015.4
21/7	10.2	SSE	26	13:57	Calm		1017.3	SE	9	1014.6
22/7	3	SSE	20	10:18	Calm		1017.2	SE	9	1013.9
23/7	0	ENE	46	14:30	WSW	6	1015.9	ESE	11	1012.6
24/7	0.2	SSE	20	14:03	Calm		1016.6			

*Yellow – survey period

[1] Closest BoM station to study area (located ~30 km away)



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Transect

Title:

Location of Sampling Sites

Figure **2-1**

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3 Results and Discussion

3.1 Water Quality

3.1.1 Environmental Values and Water Quality Objectives

Schedule 1 of Environmental Protection Policy (Water) (EPP Water) defines water types, environmental values and water quality objectives for the Wet Tropics Region. The waters of the study area are within the Tully River basin. Two water types are represented in the study area:

- Enclosed coastal waters –includes all of Boat Bay
- Open coastal waters –includes all waters east of Clump Point and north of Boat Bay.

The study area is classified as slightly disturbed waters. Environmental values (EVs) for these waters include aquatic ecosystems, human consumption, primary, secondary and visual recreation, and cultural and spiritual values. Water quality objectives (WQOs) for aquatic ecosystem EVs include the parameters listed in Table 3-1 below.

Table 3-1 WQOs for study area waters

Parameter	WQOs for Boat Bay*	WQOs for open coastal waters*
Dissolved oxygen	85-105% saturation	95-100-105% saturation
pH	6.5-7.3-8.4	8.1-8.3-8.4
Ammonia nitrogen	<15 µg/L	1-3-7 µg/L
Oxidised nitrogen	nd	0-0-1 µg/L
Particulate nitrogen	nd	≤20 µg/L
Organic nitrogen	135 µg/L	nd
Total nitrogen	160 µg/L	76-105-140 µg/L
Filterable reactive phosphorus	5 µg/L	0-2-3 µg/L
Particulate phosphorus	nd	≤2.8 µg/L
Total phosphorus	20 µg/L	8-14-22 µg/L
Chlorophyll-a	2.0 µg/L	<0.45 µg/L
Turbidity	10 NTU	0.6-0.9-1.8 NTU
Secchi depth	1.0m	≥10m
Total suspended sediment (TSS)	nd	≤2 mg/L

*where three WQOs are provided, this represents the 20th, 50th and 80th percentiles

3.1.2 Water and Sediment Quality Characteristics

There is limited available site-specific water and sediment quality data. Single surveys were carried out by Aurecon (2014) in dry season 2013 and wet season in February 2014, and identified the following ambient water and sediment quality characteristics at sites near the existing boat ramp (i.e. enclosed coastal waters):

3.1.2.1 Physio-chemical properties of waters

The dry season sampling event had higher TSS (14-16 mg/l) and turbidity (0.6 to 5.3 NTU) than the wet season event TSS (<5 mg/l) and turbidity (0.6 to 1.8 NTU). Turbidity increased with increasing depth on both occasions, likely due to resuspension of bed sediments at depth. Turbidity was less than the WQO of 10 NTU on the two sampling occasions.

It is important to note that turbidity can show great variability over time, and these results would not capture this variability. Wind driven resuspension of sediments is a key driver of turbidity in nearshore environments of the broader region, and turbidity would likely significantly exceed the WQO for periods measured in days to weeks during windy periods. Álvarez-Romero *et al*. (2013) mapped exposure gradients to flood plume water in the Wet Tropics region, and found the study area is only infrequently affected by secondary flood plumes (<33% of wet season days). Major flood events from the Tully River and small local coastal drainages would periodically affect turbidity in the study area.

pH was between 8.07 to 8.14, and salinity was ~35-36 ppt, with no major differences between survey events. These pH and salinity values are typical of nearshore marine waters during non-flood periods. It is expected that during flood events salinity and pH would decline, depending on discharge volumes.

Nutrient concentrations during the dry season sampling event were less than laboratory detection limits for total nitrogen and nitrogen species, however detection limits were above WQOs and therefore cannot be assessed. Total phosphorus (0.08-0.1 mg/l) exceeded the WQO of 0.014 mg/l during the dry season. Detection limits for nutrients in wet season samples were again above WQOs, so it is not possible to determine compliance.

3.1.2.2 Contaminants

Arsenic concentrations in the water column exceeded the ANZECC/ARMCANZ (2000) toxicant trigger value for 95% protection of species. Other metals tested in water samples had concentrations that were less than detection limit and/or relevant toxicant trigger value for 95% protection of species. Pesticides were not detected in any water samples. Zinc, ammonia, total Kjeldahl nitrogen, total nitrogen, total phosphorus were detected in rinsate and/or field blank samples, indicating cross-contamination of samples during sampling or analysis. Holding times were also breached for many of the parameters (nitrite, reactive phosphorus, chlorophyll a, phenoxyacetic acid herbicides and the multi-residue pesticide residue screen) and therefore results for these parameters should be treated with caution.

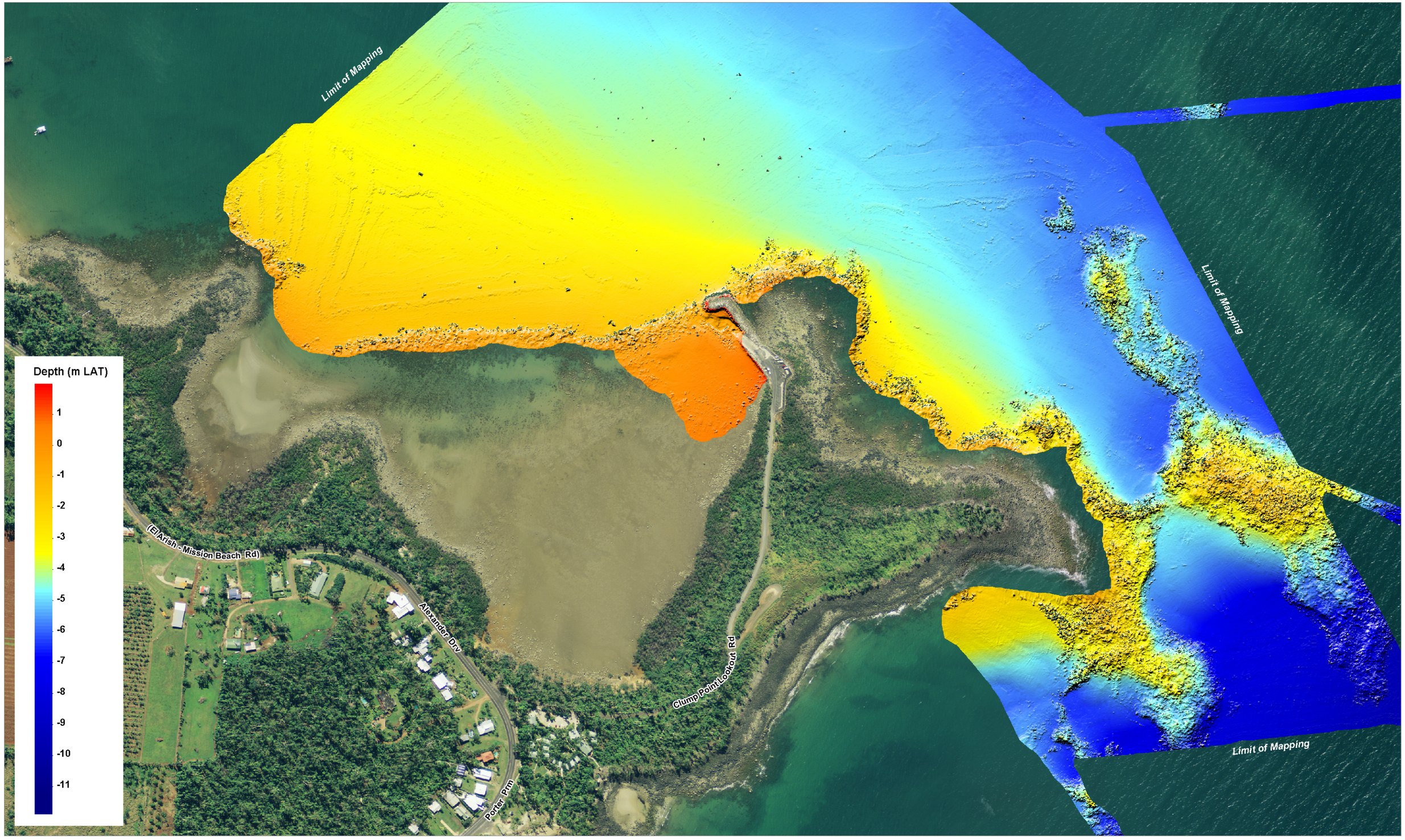
One sediment sample was analysed for contaminants. Metals/metalloids, organotins, phenols, Polycyclic Aromatic Hydrocarbons, Polychorinated Biphenyl, Total Petroleum Hydrocarbons (TPH), and organchlorine and organophosphate pesticides had concentrations less than the national assessment guidelines for dredged material. TPHs (>C15 fraction), naphthalene and most metals/metalloids were detected in samples, but not at levels of concern and/or no guidelines were available to assess potential risk. On the basis of this limited sampling, sediments were not found that have elevated sediment contaminant concentrations.

3.2 Benthic Habitats and Assemblages

3.2.1 Bathymetry and Seabed Topography

Water depth is a key control on physical and biological processes that together affect the character of benthic habitats and communities. Figure 3-1 is a map of bathymetry in parts of the study area based on surveys carried out in July 2016 by Navigation Management Systems on behalf of DSD.

Boat Bay consists of a gently sloping tidal flat with (<1 m LAT). An area of slightly deeper water (-0.5 m LAT) occurs at the existing boat ramp. A band of complex terrain (boulder field – see Section B.3.2.2) extends along most of the northern perimeter of the bay to a depth of approximately -1.2 m LAT. The shoreline east of Clump Point boat ramp was fringed by a topographically complex intertidal rocky shore and subtidal reef system, which extends down to approximately -4.2 m LAT, but in places only extends to approximately -2 to -3 m LAT. Beyond the reef/boulder field the seabed was gently sloping and largely featureless, except for occasional reef patches, small scale features (bommies) and a wreck located near the boulder field at the entrance to Boat Bay.



Title:

Bathymetry of the Study Area Based on Surveys Carried Out for DSD in July 2016 (DSD unpublished data)

Figure **3-1**

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3.2.2 Benthic Primary Producer Habitat

Seagrass, mangroves, saltmarsh, benthic algae, together with corals (see Section B.3.3.2), represent benthic primary producer habitat (BPPH). BPPH play an important role in maintaining coastal ecosystems and associated ecological services, including the provision of food and habitat resources for species of fisheries and conservation significance. BPPH is also sensitive to disturbance and in the case of seagrass and algae, water quality degradation, particularly light limitation due to high turbidity. Marine plants are protected under the *Fisheries Act 1994*, and a permit is required for their disturbance/removal.

3.2.2.1 Mangroves, Saltmarsh and Saltpan

Mangrove communities in the study area are mapped as Regional Ecosystem (RE) 7.1.1 (Least Concern) which is described as mangrove closed scrub to open forest of sheltered coastlines, estuaries, and deep swales between dunes, on fine anaerobic silts, inundated with saline water at high tide (Figure 3-2).

Based on current RE mapping (V9.0), mangrove forest covered an area of 9 ha within the study area. Figure 3-2 also shows mangrove extent and type mapped at the local-scale based on interpretation of 2016 aerial imagery and field observations. Approximately 0.15 ha of *Avicennia marina* mangroves and 7.2 ha of *Rhizophora* spp. mangroves were mapped in the study area.

The western and eastern shorelines of Boat Bay and the eastern shoreline of Clump Point had a narrow (averaging 20-60 m wide) fringe of mangrove forest occurring landward of sand/mud shoals and boulder fields (Figure 3-3). The mangrove forest on the western shoreline of Boat Bay was numerically dominated by *Rhizophora stylosa, Avicennia marina* was sub-dominant, and *Aegiceras corniculatum* formed an under-storey canopy in places. *Rhizophora apiculata* was more abundant in the mangrove forest on the eastern shoreline of Boat Bay, and the landward margin of this forest also contained *Osbornia octodonta*, *Ceriops tagal* and *Aegiceras corniculatum*. Only isolated mangroves, dominated by *A. marina*, occurred directly adjacent to the existing boat ramp (refer Figure 3-2). No saltmarsh or saltpan have been recorded in the study area.

The distribution and community structure of mangroves is controlled by four primary environmental factors: salinity, tidal range, degree of wave and current action, and the physical nature of the substrate (King 1981; Odum *et al*. 1985). Mangroves grow in the intertidal zone, typically within quiescent (calm) environments. North-facing embayments such as Boat Bay are sheltered from prevailing south-easterly waves and the intertidal banks here provide suitable mangrove habitat. The open coastal environments on the eastern shoreline of Clump Point and the existing boat ramp do not have well developed intertidal flats and associated mangrove forests.

LEGEND

- Remnant RE 7.1.1 (Least concern) Mangrove closed scrub to open forest (Based on Remnant Regional Ecosystem Mapping, V9.0, DSITI)
- Avicennia marina dominated mangroves (Based on 2016 Aerial Photo Interpretation)
- Mixed mangroves dominated by Rhizophora spp. (Based on 2016 Aerial Photo Interpretation)

Title:

Mangrove Vegetation

Figure **3-2**

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A *Rhizophora* species and boulder field; **B** *Rhizophora* species and sedimentary habitat; **C** = nudibranch in boulder habitat; **D** sand shoals; **E** rock pool with *Holothuria leucospilota*; **F** Heavily worked intertidal sand/mud shoals

Figure 3-3 Photographs of mangroves and foreshore habitats in the study area

The structure of mangrove forests (i.e. dominant species, forest structure, zonation patterns) in the study area is considered generally representative of those in north-facing coastal embayments within the wider region. No mangrove species are listed as threatened under Commonwealth or Queensland legislation. Haines' orange mangrove (*Bruguiera hainesii*), listed as Critically Endangered under the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species, which has only been recorded at Trinity Inlet within Australia (James Cook University, 2016), has not been recorded in the study area. RE 7.1.1 is listed as Least Concern at present under the *Vegetation Management Act 1999* (VM Act) with approximately 12, 826 ha of mangroves mapped in the Wet Tropics bioregion (Queensland Herbarium, 2015). This RE type is recognised as potential habitat for threatened species including *Myrmecodia beccarii* (ant plant) and *Hypochrysops apollo apollo* (apollo jewel butterfly). All mangroves are protected as marine plants under the *Fisheries Act 1994*.

3.2.2.2 Seagrass

Surveys conducted in July 2016 recorded one seagrass species: *Halodule uninervis.* Two mono-specific meadows were recorded (Figure 3-4):

- Meadow 1 was located on the seaward edge of the basalt boulder field on the northern edge of Boat Bay, at approximately -1 to -1.7 m below LAT. This meadow had a total area of 0.34 ha and had sparse (<1%) cover.
- Meadow 2 was located immediately landward of the edge of the basalt boulder field on the northern edge of Boat Bay, at approximately -0.2 m below LAT. This meadow had a total area of 0.12 ha and had sparse (<1%) cover.

No seagrass was recorded immediately north of the existing break-water (i.e. the Project footprint). Water depths and wave action are likely to restrict seagrass establishment in this area.

The results of the present study are largely consistent with previous studies. Aurecon (2014) undertook surveys of seagrass (and other benthic habitats) on transects located directly adjacent to the existing boat ramp during dry season (November 2013) and wet season (February 2014), and recorded only small (<2 m^2) sparse patches of *Halodule* sp. (most likely *H. uninervis*) and *Halophila* sp. (species not specified) on transects, varying inconsistently over time among transects. This indicates that seagrass patches in the surveyed area were ephemeral and did not occur in the same place on both sampling occasions. This is typical of nearshore seagrass meadows in the region, which are greatly affected by seasonal variations in turbidity (Collier and Waycott, 2012; Rasheed *et al.* 2013).

Roder *et al*. (1998) undertook an assessment of benthic habitats, including seagrass, at Clump Point and Boat Bay in December 1997. Five seagrass species were recorded: *Cymodocea serrulata, Enhalus acoroides, Halodule uninervis, Halophila decipiens* and *Halophila ovalis,* but patterns in species dominance and community structure were not described. Most seagrass occurred on the outer edge of Boat Bay in the same location as Meadow 1, with smaller patches occurring near Meadow 2, and on the fringing reef east of the break-water (Figure 3-4). Approximately 2.8 ha of seagrass in eight separate meadows were recorded, none of which occurred in the Project footprint.

Species richness and meadow extent was lower in July 2016 than recorded by Roder *et al.* (1998). Several processes are likely to drive these temporal patterns, most notably:

- Cyclone disturbance - Major declines in seagrass meadow distribution and extent occurred in the wider region as a result of disturbance by tropical cyclones in 2006 (TC Larry) and 2011 (Yasi) (e.g. Rasheed *et al*. 2014). It is likely that seagrass meadows in the study area are in a recovery phase following these events.
- Seasonal changes in seagrass meadows – Roder *et al*. (1998) undertook surveys in December, which is the typical seagrass growing season in central and north Queensland (Rasheed *et al.* 2013), whereas the present study was conducted in July, when seagrass biomass and growth is typically low.

In time, it is expected that seagrass will continue to recover, potentially occupying similar areas as observed by Roder *et al.* (1998) as shown in Figure 3-4.

Different species vary in their tolerances and capacity to recover from disturbance (Table 3-2). *Halophila* and *Halodule* are ephemeral species with rapid turnover and reproductive rates, which enable them to rapidly recover following disturbance, whereas *Cymodocea* is considered an 'intermediate' genus that can survive a moderate level of disturbance, and recovery rates are slower (Carruthers *et al*. 2003). *Enhalus acoroides* is the most sensitive to disturbance; while it is a persistent species that has adaptations that allow it survive periodic burial and disturbance, it is a slow growing species, and it is predicted that removal of a 1m^2 area from a meadow would take more than 10 years for full recovery (Rollon *et al*. 1998).

No seagrass species are listed as threatened under Commonwealth or Queensland legislation. The five seagrass species recorded at Clump Point to date are widespread and abundant throughout the wet tropics region (Coles *et al*. 2015).

Table 3-2 Seagrass species found in the study area

Species	Habitat and occurrence	Sensitivity to disturbance [a]
Cymodocea serrulata	• Within GBR region, typically co-dominant in lower intertidal, shallow subtidal environments, but can occur in deep water [b]	• High light requirement • Large growing species = large stores of energy reserves and capacity to endure short-term changes in turbidity • Low to moderate growth & reproductive output c.f. *Halophila*, high rhizome persistence • Recovery longer than *Halophila* • Classified as an intermediate taxa that can tolerate moderate levels of disturbance and is able to rapidly recover following disturbance [b]
Enhalus acoroides	• Often dominant species in estuaries in FNQ [a] • Typically found <2 m[a] • Roder *et al*. (1998) recorded a small patch recorded in Boat Bay near mangroves	• High light requirement • Large growing species = large stores of energy reserves and capacity to endure short-term changes in turbidity • Low growth & reproductive output c.f. *Halophila* and *Cymodocea* • Recovery longer than *Halophila* • Can tolerate moderate levels of disturbance, but takes a long time (up to 10 years) to fully recover [b]
Halodule uninervis	• Co-dominant in intertidal and shallow subtidal waters along mainland coast in FNQ [a] • Dominant seagrass species in study area	• Small stores of energy reserves • Rapidly decline when conditions become unfavourable for growth • Seed and vegetative, but asexual dominant process in region • Fast growth & high reproductive output • Classified as an ephemeral genera that can tolerate high levels of disturbance [b]
Halophila ovalis	• Co-dominant in intertidal and shallow subtidal waters along mainland coast in FNQ [a] • Dominant seagrass species in study area	• Small stores of energy reserves • Rapidly decline when conditions become unfavourable for seagrass growth • Seeds and vegetative • Colonising growth strategy • Fast growth & high reproductive output • Classified as an ephemeral genera that can tolerate high levels of disturbance [b]
Halophila decipiens	• Subdominant in places on the mainland coast, and dominant (but sparse) in deep-water environments in GBR region [a]	• See *H. ovalis*

a = Collier and Waycott (2009); b = Carruthers *et al*. (2002)

3.3 Reefs and Rocky Shores

Figure 3-4 is a map of the distribution of rocky shores, rock walls and reef environments in the study area. Figure 3-13 is a map of benthic habitat features immediately seaward of the existing rock wall, which further sub-divides reef and rocky habitats into sub-classes. Photographs of representative taxa and features are shown in Figure 3-5, Figure 3-6 and Figure 3-7. The following reef/rocky shore habitat types occur in the study area.

3.3.1.1 Rock Walls

Constructed rock walls at the existing Clump Point boat ramp provide habitat for intertidal and subtidal biota. Turfing algae and brown algae *Sargassum* tended to dominate in the lower intertidal and upper subtidal zone. The base of the wall directly northwest of the end of break-water was sandy with occasional gorgonians (*Menella, Junceella*) attached to rocks. The rock walls would provide localised habitat values for reef associated fish.

3.3.1.2 Boat Bay Intertidal Boulders and Cobble

An intertidal fringe of isolated basaltic boulders and cobble on soft sediment occurred along the shoreline of Boat Bay and Clump Point (Figure 3-7). The boulder field to the east of Clump Point consisted of sand and coral rubble amongst the boulders. West of Clump Point the sediment between the boulder field was a mixture of mud, coral rubble and sand.

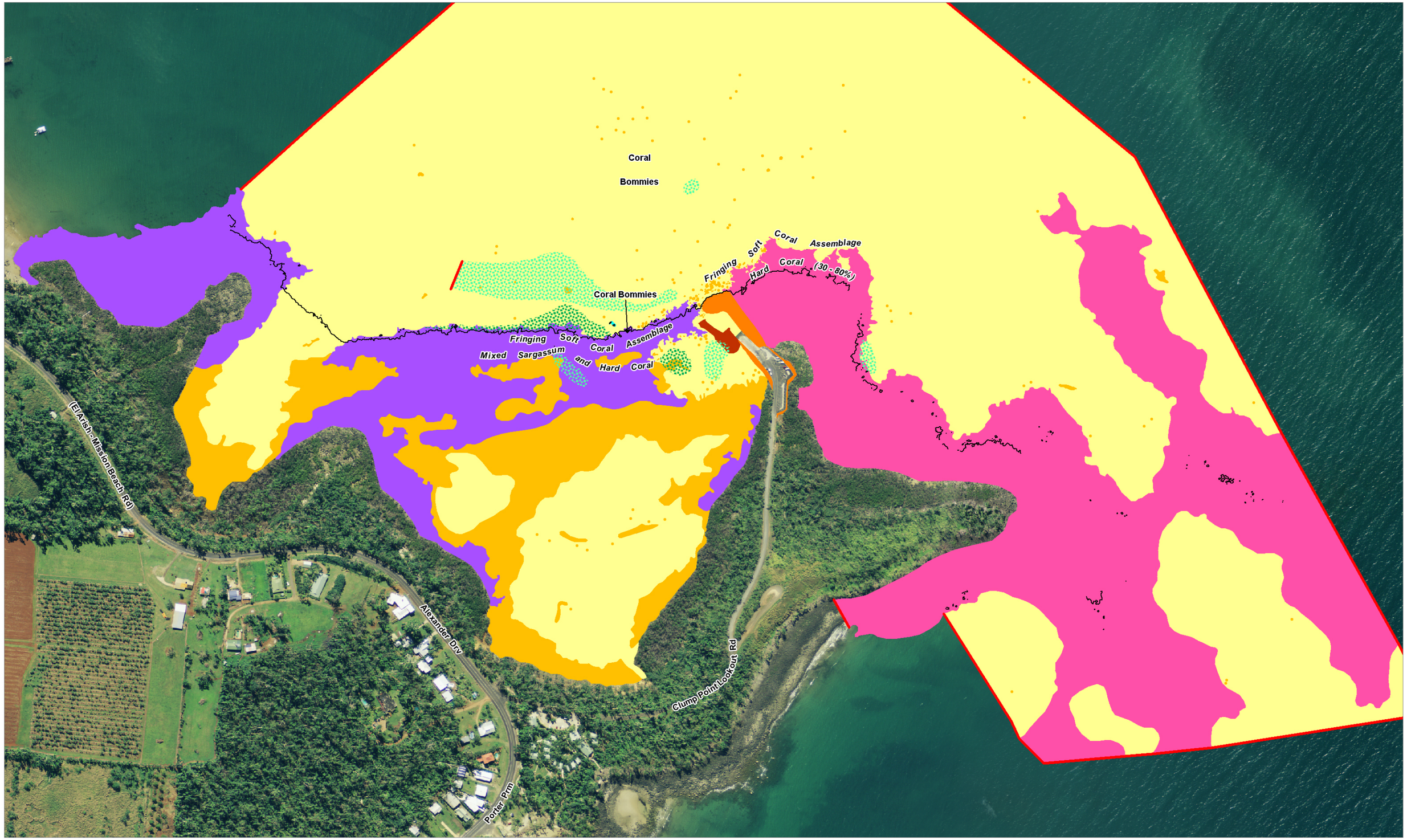
The cobbles and boulders provide habitat for a range of intertidal invertebrate and algae species. Dominant taxa varied with depths and spatially within depth zones, with oysters (*Saccostrea*) and a range of common gastropod snails tending to numerically dominate in the upper/middle intertidal, and macroalgae and small hard coral colonies (including *Porites*) around and below low water and in rock pools. The black sea cucumber *Holothuria leucospilota* (see Figure 3-3) was abundant in rock pools, and small faviid corals were also common east of Clump Point.

3.3.1.3 Boat Bay Subtidal Boulder Fields and Bommies

A subtidal basalt boulder field extended from the entrance to Boat Bay to the northern tip of Clump Point. Hydrographic surveys indicate that the boulder field occurred at depths of approximately -0.2 to -1 m LAT.

The landward margin of the boulder field had a high cover of brown algae (particularly *Sargassum* species), which is typical of shallow nearshore reef environments in the region. Small micro-atolls and soft corals were also abundant in places among *Sargassum*.

The deeper sections of the bounlder field had a low cover of brown algae, and were dominated by soft corals (typically 25-60% cover) and hard corals (<10% cover). Common hard coral included *Acropora, Montastrea, Porites* and *Turbinaria,* consistent with the findings of Aurecon (2014). Hydroids, sponges, oysters and a range of other reef-associated biota occurred in low abundance.



LEGEND

- Limit of Mapping
- Contour: -1m LAT Depth
- Rock Walls
- Shipwreck
- Class 1a - Clump Point Reef
- Class 1b - Boat Bay Boulder Field (>20% cover)
- Class 2a - Soft Sediments with Isolated, Low Density (<20% cover) Boulders
- Class 2b - Soft Sediments (sandy)
- Class 2c - Soft Sediments (mud)
- Class 3a - Seagrass (historical)
- Class 3b - Seagrass (existing)

Title:

Reef and Soft Sediment Habitats in the Study Area

Figure 3-4

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Approx. Scale

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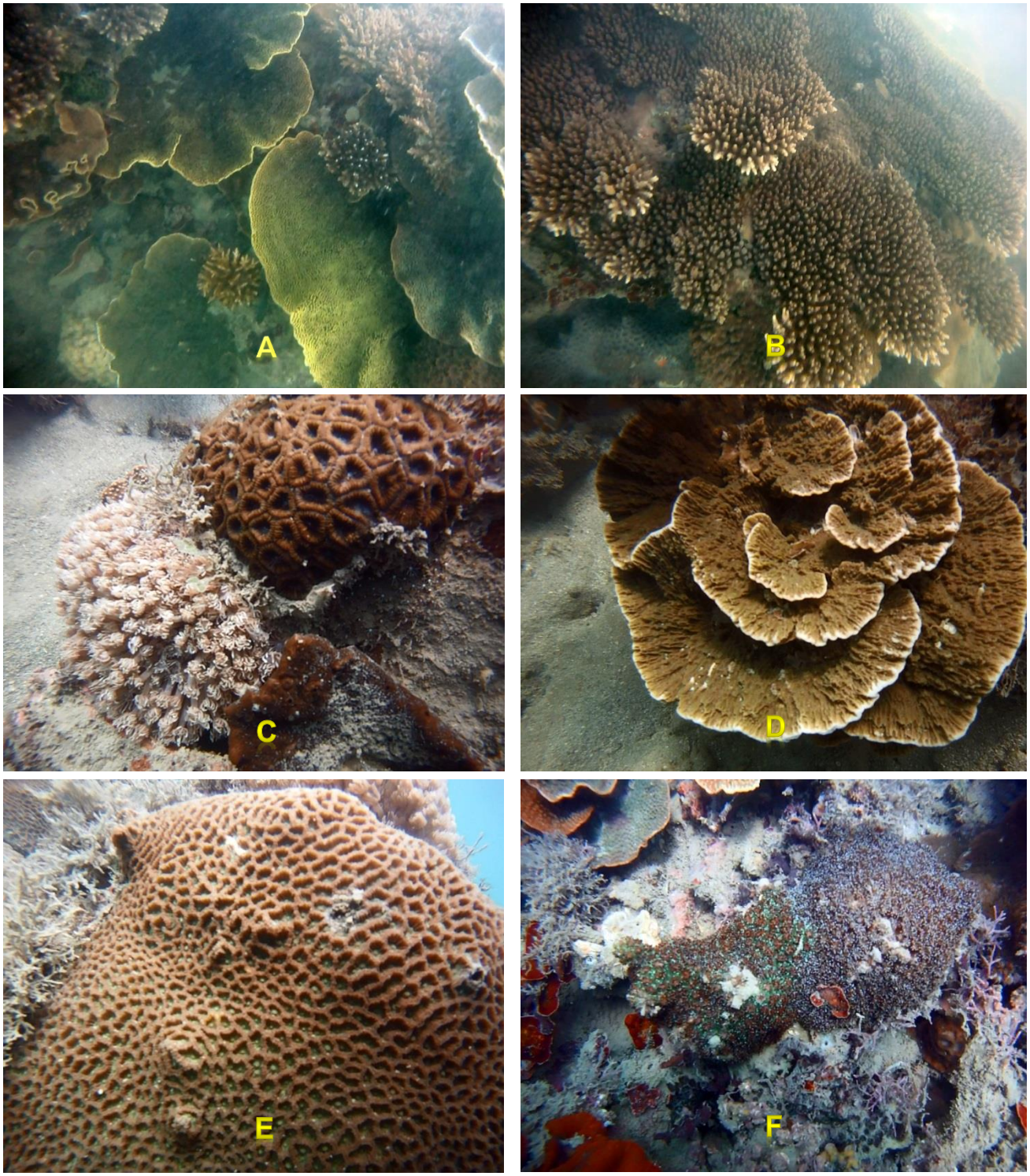
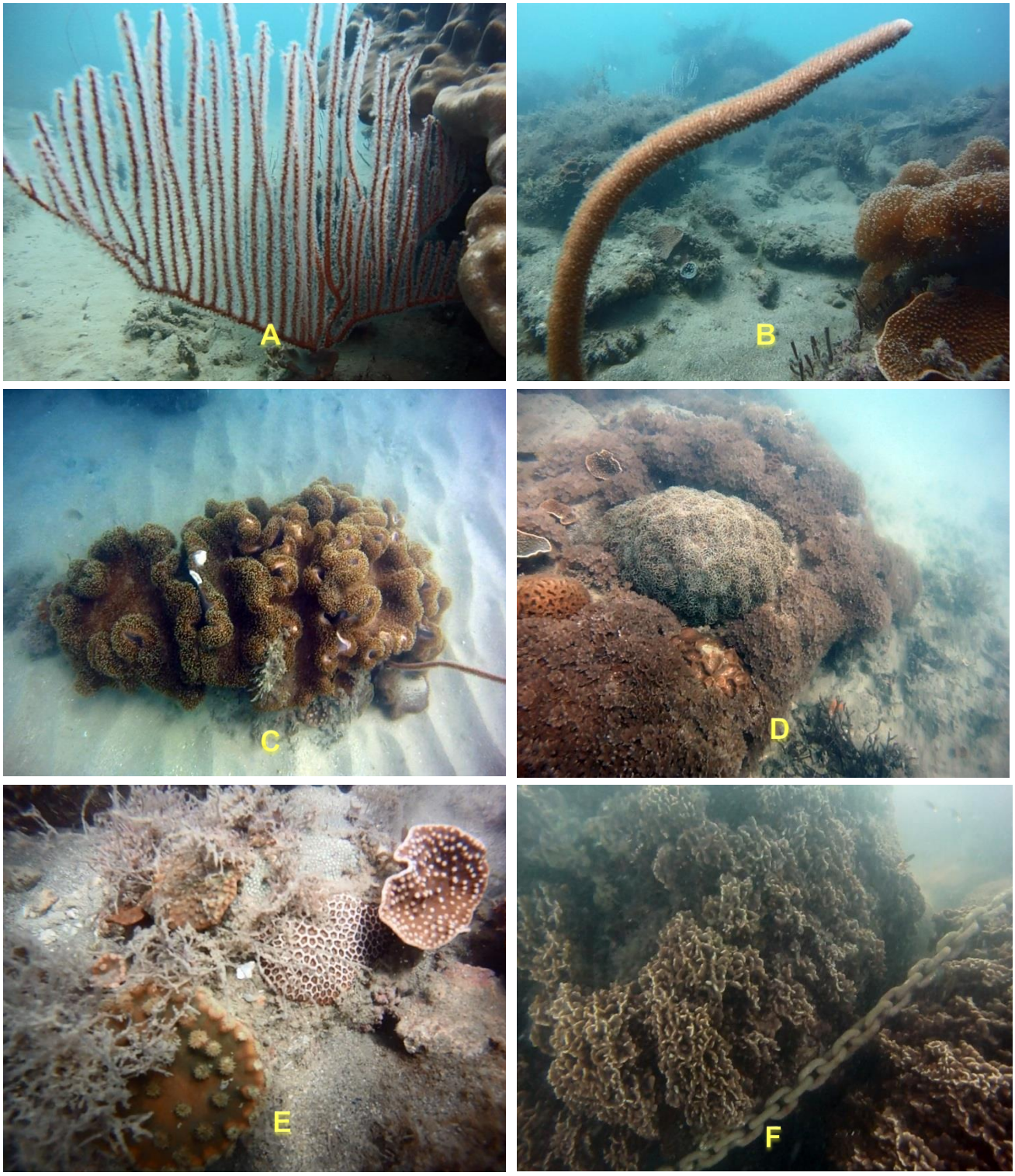


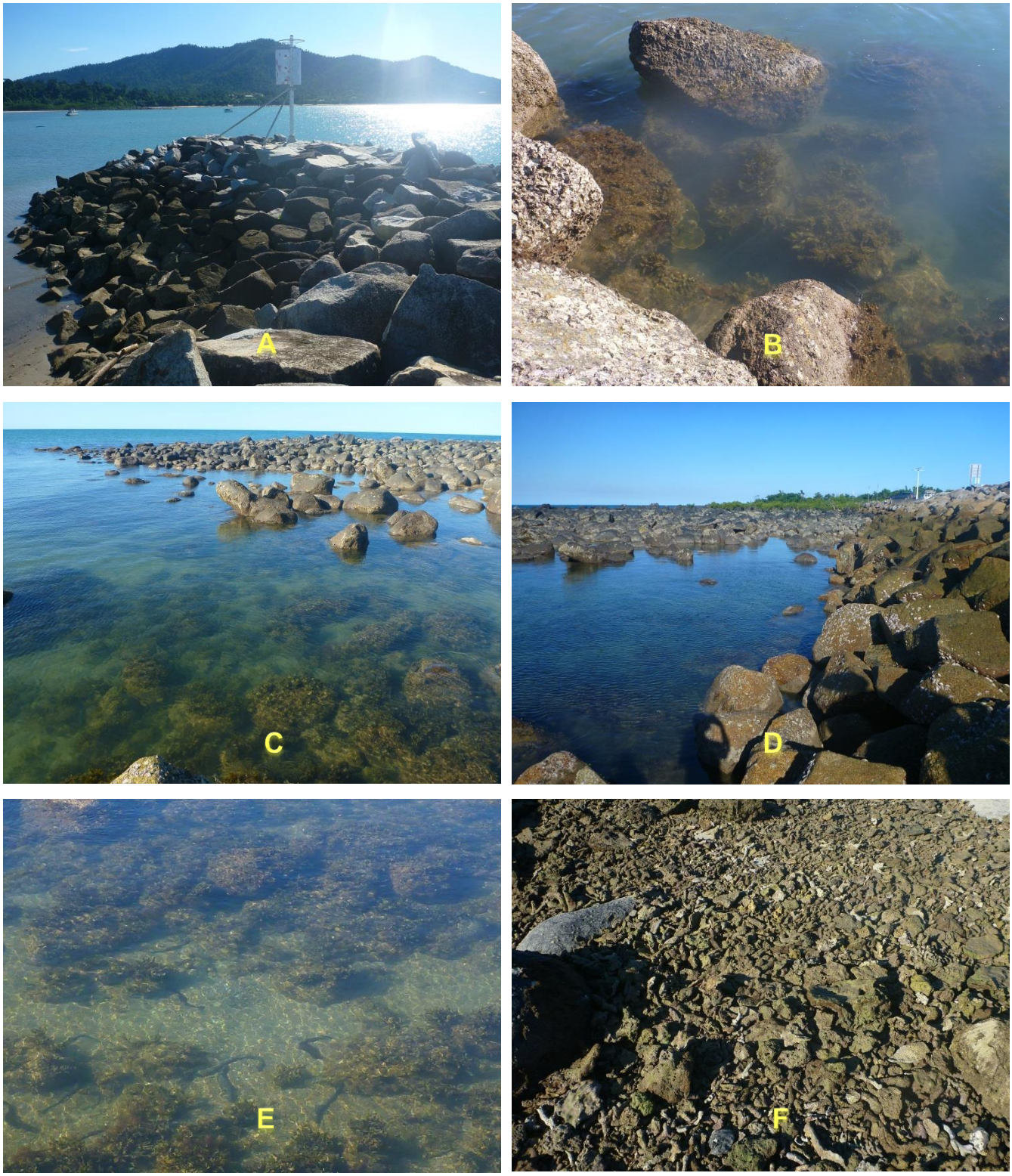
A Mixed assemblage of plating *Montipora* and *Acropora* hard corals; **B** plating *Acropora*; **C** *Alveopora* and *Favia* ; **D** *Merulina*; **E** *Favia*; **F** *Galaxea* and *Turbinaria* hard corals with sponges and coralline algae

Figure 3-5 Photographs of subtidal reef features (hard corals) on Clump Point reef



A Gorgonian (*Ctenocella*); **B** Sea whip (*Juncella*) and soft coral (*Sarcophyton*) ; **C** *Sarcophyton*; **D** Soft coral assemblage on the seaward margin of the Boat Bay boulder field habitat; **E** Mixed benthic assemblage; **F** anchor chain on coral head at Boat Bay boulder fioeld

Figure 3-6 Photographs of subtidal features in Boat Bay boulder fields and Clump Point reef



A Rock wall in Boat Bay; **B** Intertidal zone of the rock wall within Boat Bay ; **C and D** Intertidal boulder field and rock pools on the east side of rock wall adjacent to car park; **E** Rock pool adjacent to car park; **F** Coral rubble on reef flat

Figure 3-7 Intertidal habitats adjacent to the existing rock wall and car park

Large isolated submerged bommies occur throughout the study area, typically within the subtidal basalt boulder field but also in deeper areas further offshore. Consistent with Aurecon (2014), these bommies were found to support a range of macroalgae (particularly the green algae *Bryopsis* and a range of brown, red and other green algae species) and epibenthic fauna including hard corals (*Porites, Favia, Acropora, Montipora*) and other taxa (*Xenia*, colonial zooanthids, bryozoans etc.). Large living coral bommies (*Pavona frondifera, Porites*) were recorded near a ship wreck located seaward of the boulder field.

3.3.1.4 Boulders and Soft Sediment Habitat Immediately North of the Existing Break-water

Benthic habitats located immediately north of the existing break-water (in the potential Project footprint and immediate surrounds) consisted of isolated, patchy low profile boulders and rubble on soft (sandy) sediment. The boulders contained mixed assemblages of hard and soft corals, as well as encrusting reef fauna. While these boulders contained a diverse range of biota, they did not contain large, complex hard and soft coral assemblages as occurs on the adjacent Clump Point fringing reef.

Representative photographs from three transect located to the north of the wall are shown in Figure 3-8 (Transect 4, located perpendicular to the western tip of the existing break-water), Figure 3-9 and Figure 3-10 (Transect 13, located the north east of the rock wall) and Figure 3-11 and Figure 3-12 (starting on the north east base of the rock wall and then following the centreline of rock wall).

3.3.1.5 Clump Point Fringing Reef and Rocky Shores

Clump Point to the east of the existing boat ramp and car park contained a broad reef flat, which extended from above high water to approximately -5 m LAT. Basaltic boulders and cobble occurred across the reef flat and in subtidal areas, providing a high degree of micro-habitat complexity. Immediately seaward of the low *A. marina* mangrove forest adjacent to the existing carpark a zone approximately 10-30 m in width of dead coral rubble occurred in the upper intertidal zone.

In the lower intertidal and upper photic zone of subtidal (~2-3m below MSL), the reef supported a high cover of *Sargassum flavicans* and other macroalgae, including *Padina* spp., *Halimeda opuntia, Galaxaura* spp., *Codium* sp. (cf. *Codium geppii*) and geniculate red coralline algae), intermingled with occasional hard coral colonies (mostly *Goniastrea, Turbinaria,* and small *Acropora*) and soft corals (*Sarcophyton, Lobophytum*, and *Sinularia*).

Below approximately -3m MSL, macroalgae cover was lower and benthic assemblages were numerically dominated by hard corals and turfing algae. The outer reef margin had high (approximately 40% to 80% cover) cover of hard corals. Most of the hard coral was observed growing directly on boulders or dead coral skeletons. Most coral colonies were 0.2 to 0.3 m diameter, although large coral colonies (approximately 0.5 to 1 m in diameter) were also present but in moderate abundance. Few massive hard coral (e.g. *Porites*) bommies greater than 1 m in diameter were recorded.

Immediately adjacent to break-water: sand, rubble and algae

Transect continues mostly over sand, occasional boulders with soft coral and hydroids present ~15m from break-water

Figure 3-8 Soft sediment and rubble habitat on Transect 14 on the northern margin of the rock wall

Base of the break-water: *Efflatournia* soft coral and *Turbinaria* and *Acropora* hard coral, with rubble and algae

Bommies covered in *Efflatournia* soft coral and Faviidae hard coral also present immediately offshore of break-water (within ~10 m)

Figure 3-9 Boulders, rubble and soft habitat adjacent to the northern margin of the rock wall (Transect 13)

Mostly sandy substrates >10-15 m from break-water, with occasional clusters of soft coral, small faviids and macroalgae

Figure 3-10 Boulders, rubble and soft habitat >20 m from the northern margin of the rock wall (Transect 13 cont'd)

Immediately adjacent to rock wall: mostly rubble at base of wall with some small hard corals (1-5%) and mostly algae

Mostly rubble within 10 m of wall

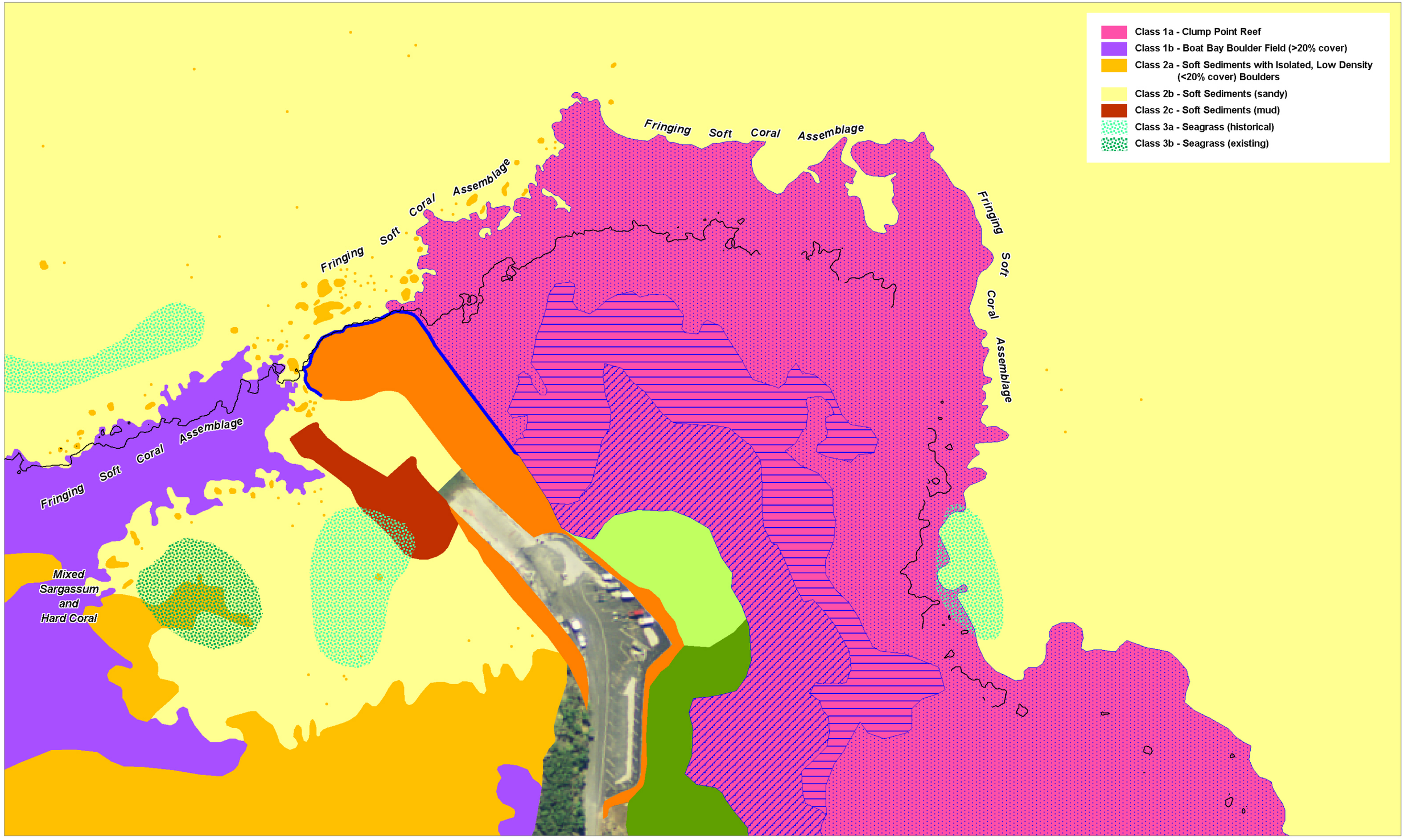
At end of rubble, isolated boulders with *Turbinaria* hard coral colony and occasional soft coral

Figure 3-11 Boulders, rubble and soft habitat adjacent to the northern margin of the rock wall (Transect 26)

Transect continues through sand before passing one large living *Porites* coral ~20 m from break-water

Continues over sand , some low relief boulders with hard and soft corals

Figure 3-12 Boulders, rubble and soft habitat >20 m from the northern margin of the rock wall (Transect 26 cont'd)



LEGEND

Contour: -1m LAT Depth

Rock Walls

Submerged Hard Coral (~30-80% cover) +/- Macroalgae

Basalt Boulders, Hard Corals and Rock Pools Within Intertidal Zone

Basalt Boulders/Coral Rubble Above Regular Tidal Inundation

Permanently Inundated Dense Macroalgae and Sparse Coral on Sea Wall

Mangroves Dominated by Low *Avicennia marina* on Basalt Boulders

Mangroves Dominated by *Rhizophora stylosa* Forest on Basalt Boulders and Intertidal Flats

Title:

Benthic Habitats Immediately Adjacent to Existing Rock Wall

Figure 3-13

Rev: A

N

0m 30 60

Approx. Scale

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Hard coral assemblages were typically numerically dominated by foliose/encrusting *Turbinaria* and *Montipora* spp., but varied greatly with depth and in different parts of the reef. There were also some large branching and corymbose *Acropora* spp. colonies, particularly in shallow water. The remaining hard coral genera had variable (but individually low) cover, and included *Favia, Favites, Montipora, Goniastrea, Galaxea, Moseleya, Lobophyllia, Porites, Echinophyllia, Echinopora, Pocillopora, Pectinia, Platygyra, Tubastrea, Caulastrea,* and *Coeloseris*. Zooanthids covered large boulders and cobble in places. Sea whips (*Juncella, Anella, Menella*) and several species of *Dendronephthya* were common along the base of the reef in sandy sediments, and soft corals (particularly *Efflatounaria*) were common in places.

3.3.1.6 Coral Condition

The following was noted regarding coral condition:

- Coral health – coral was observed to be in good health with no evidence of extensive bleaching or significant disease. This is in contrast to other parts of north Queensland (particularly north of Port Douglas), where extensive coral bleaching and mortality occurred during the summer of 2015-16, as a result of heat stress from ocean warming and a major El Niño event.
- Observations of juvenile coral colonies indicate that coral recruitment has been occurring in study area reefs.
- A wide range of coral colony size classes were observed, but most were 0.2 to 0.3 m diameter. This likely suggests that reefs are in a state of recovery following disturbance.
- Anchor chains were observed to result in localised damage to coral colonies (Figure 3-6).
- Fishing lines were also observed around some coral heads, particularly those within casting distance from the break-water.

3.3.1.7 Biodiversity Values

The reefs and subtidal boulder fields are features of high biodiversity values. In this regard:

- High levels of species richness – Aurecon (2014) suggested that hard substrates of the study area supported a (qualitatively) higher diversity of biota than adjacent soft sediments. This would be the case for most (but not all) taxonomic groups, most notably fish, hard and soft corals, other sessile invertebrates, and macroalgae.
- Fish habitat – the reefs and boulder fields represent structurally complex habitats and feeding areas for reef-associated fish. In the present study, the fringing reef at Clump Point and boulder field were observed to support schools of yellow tail pike (*Sphyraena obtusata*), as well as large numbers of yellow tail demoiselle (*Neopomacentrus azysron*). Other common reef fish observed included reef flathead (*Platycephalus* sp.), wire netting cod (*Epinephelus merra*), Venus tusk fish (*Choerodon venustus*), sailfin tang (*Zebrasoma veliferum*), goatfish (Mullidae), small lutjanid snapper (e.g. *Lutjanus carponotatus*), and a wide range of damselfish (Pomacentridae spp.).
- Turtle feeding areas – the reefs represent suitable feeding habitat for a range of turtle species, as discussed in Section 3.4 below.

The fringing reefs to the east of Clump Point boat ramp, and the large coral bommies near the shipwreck at the entrance to Boat Bay, have high coral cover and are considered to have high local-scale biodiversity values. The rubble and boulder habitat immediately offshore of the northern margin of the rock wall had high cover of reef benthos, including small hard and soft coral colonies, but were not as structurally complex as those occurring on Clump Point reef to the east, and are considered to have lower biodiversity values.

3.3.2 Soft Sediments

Unconsolidated sediment types represented in the study area include:

- A narrow sandy beach occurred directly adjacent to mangroves within the southern section of Boat Bay, but was not well represented elsewhere.
- Most of Boat Bay consisted of broad intertidal/shallow subtidal sand/mud flat, with mud content decreasing and sand and rubble increasing with distance seaward (see also Roder *et al*. 1998). Bathymetry survey data identified several isolated boulders (bommies) on the sand/mud flats within Boat Bay. A broad band of coral rubble was also mapped by Roder *et al*. (1998) along the eastern half of Boat Bay, and while not mapped in detail in the present study, coral rubble was observed in this location in the present study.
- Large sand flats occurred seaward of the basaltic boulder zone at the entrance to Boat Bay (see also Roder *et al*. 1998). Bathymetry survey data identifies several isolated high features, but otherwise this area was flat and featureless, and epibenthic assemblages were sparse.
- A mud bank occurred immediately west of the existing boat ramp. Bathymetry data shows that this mud bank had large bed forms (ripples) suggesting active working by currents. Underwater video inspections identified active biological working (yabby burrows) of sediment at this location. High yabby burrow densities occur elsewhere throughout Boat Bay, and this and other tidal flat locations within the bay are likely to provide some localised values as fish foraging habitat.

No quantitative surveys of soft sediment benthic communities have been carried out in the study area to date. Site inspections by Clayton *et al*. (in Aurecon, 2014) noted that assemblages on shallow sections of the sand/mud flats within Boat Bay consisted of yabbies (Callianassidae), fiddler crabs (*Uca* spp.), cockles (*Gafrarium* sp.), moon snail (*Nassarius dorsatus*), soldier crab (*Mictyris longicarpus*), bivalve (*Placuna placenta)*, horn snails (*Cerithidea* sp.), sea skater (*Halobates* sp.) and mudskippers (*Periophthalmus* sp.). The shallow subtidal sand/mud flats had high burrow densities (probably Callianassidae), as well as a variety of hermit crabs (Paguridae) and Portunidae swimming crabs. Roder *et al*. (1998) noted that most of the intertidal and the sub-tidal areas surveyed were predominantly bare sediment with occasional epibenthic taxa such as hydroids, soft coral, clam shells and/or green algae. It is likely that benthic microalgae represent a key energy source in shallow soft sediment habitats within the study area.

The soft sediment substrates of the study area provide suitable habitat for a wide range of fish and shellfish (prawns, crabs) species. Nearshore soft sediment habitat in the wider region (Cairns to Bowen), particularly those supporting seagrass meadows, support abundant demersal fish, prawn and crab assemblages. In particular, soft sediment habitats provide suitable habitats for Penaeidae

prawns, but are likely less productive than other areas containing large seagrass meadows (e.g. Coles *et al*. 1992).

3.4 Listed Threatened and Migratory Species

The EPBC Protected Matters Search Tool was used to identify threatened, migratory and marine species, and threatened ecological communities, that occur or could occur within the study area. In summary, the following were identified:

- Threatened sharks: three species
- Threatened marine mammals: two species
- Threatened marine reptiles: six species
- No threatened ecological communities.

An additional seven species were listed as protected migratory species, including five mammals, one reptile and one shark.

Further to the threatened and migratory species, numerous species were listed only as 'listed marine species' (i.e. non-threatened, non-migratory).[2] These other *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed marine species included 50 sygnathid species (i.e. seahorses, pipehorses, pipefish), 15 sea snake species, and six mammal species (minke whale and five dolphins).

The listed threatened and migratory species can be collectively described as marine megafauna species. There are few quantitative survey data describing marine megafauna distribution and abundance within the study area and broader region more generally. The values of the study area to marine megafauna were inferred through assessments of habitat types and characteristics.

The usage of the study area to listed threatened and migratory species will vary among habitat types, and is expected to include the following:[3]

- *Feeding habitat for turtles*. The fringing reef on the eastern side of Clump Point and boulder fields at the entrance to Boat Bay are expected to provide suitable feeding habitat for green turtle (*Chelonia mydas*: V/V), and possibly other species including loggerhead turtle (*Caretta caretta*: E/E), hawksbill turtles (*Eretmochelys imbricata*: V/V) and flatback turtles (*Natator depressus*: V/V). Boat Bay is not expected to represent a high quality feeding habitat for green turtles due to its shallow depths (i.e. accessible only during certain tidal stages) and lack of significant seagrass meadows (the preferred food resource of green turtles).
- *Nesting habitat for turtles*. Turtles nest on sandy beaches, a habitat type that is not well developed in the study area. Sandy beaches occur to the south (Mission Beach) and north of the study area, and would provide suitable turtle nesting habitats.

[2] Listed marine species are protected under the *Environment Protection and Biodiversity Conservation Act 1999* in that a specific licence is required for the taking of species. However, they are not considered to be threatened or internationally important, unless also listed as a 'threatened' or 'migratory' species.
[3] Listing status for each marine megafauna species has been included in the following format: Commonwealth/State. Commonwealth listing is provided under the EPBC Act: CE (critically endangered), E (endangered), V (vulnerable), Mi (migratory), Ma (marine). State listing is provided under the *Nature Conservation Act 1992*: E (endangered), V (vulnerable), NT (near threatened) and LC (least concern)

- *Feeding habitat for dugong*. Dugong (*Dugong dugon*: Mi,Ma/V) are principally herbivores that have a preference for *Halophila* spp.; the dominant seagrass species within the study area. The sparsity of seagrass within the study area limits its values of as a dugong feeding habitat. Due to their shallow depth, seagrass meadows within most of Boat Bay are only accessible at certain stages of the tide, whereas fringing seagrass meadows along the entrance would be accessible at all tidal stages and likely have higher feeding habitat values. The closest important dugong feeding habitats occur at Hinchinbrook/Missionary Bay[4] (Grech *et al*. 2011), located >40 km from the study area.
- *Feeding habitat for nearshore dolphin species*. Two dolphin species could occur in the study area, both listed as a migratory marine mammal under the EPBC Act and near threatened under the *Nature Conservation Act 1992* (NC Act): snubfin dolphin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphin (*Sousa chinensis*). Both species generally occurs in waters less than 15 m deep, within 10 km of the coast and within 20 km of a river mouth (Parra *et al*.2004). The species is an opportunistic generalist, feeding on fish and cephalopods from coastal, estuarine and nearshore reef habitats (Parra, 2006, Parra *et al*.2006b). The study area is unlikely to support high quality habitat for this species due to: (i) the shallow water depths in Boat Bay, which would restrict access; (ii) the absence of river mouth habitat; (iii) the limited seagrass habitat. Both species have large home ranges and it is possible that they could undertake opportunistic feeding in the study area from time to time.
- *Feeding habitat for sharks*. Three threatened shark species were identified as potentially occurring in the study area using EPBC Protected Matters search tool: whale shark (*Rhincodon typus*: V,Mi/LC), dwarf sawfish (*Pristis clavata*: V,Mi/LC) and green sawfish (*Pristis zijsron*: V,Mi/LC). The whale shark is a pelagic species that tends to prefer offshore tropical waters, and is unlikely to occur in the study area. Green sawfish and dwarf sawfish may occur in the study area from time to time, with Cairns representing the present day southern extent of their geographic distribution along the Queensland coast. Stevens *et al*. (2005) report that green sawfish has been recorded in the Cairns area in recent decades (i.e. since 1990). However, long term data from the Queensland Shark Control Program indicate a major population decline has occurred since the 1970's, largely due to fishing pressure (targeted and bycatch) and net entanglement. While both green and dwarf sawfish may occur within the study area from time to time, it is likely that the local population is very small and/or transient. Dwarf sawfish are typically considered to be the more common *Pristis* species throughout northern Australia (Stevens *et al*. 2005), although there are no known recent records from east of Cape York (GBRMPA 2012).
- *Feeding habitat for crocodiles*. Saltwater crocodile (*Crocodylus porosus*: Mi,Ma/V) is likely to occur in the study area and surrounds. This species typically prefers mangrove lined estuaries, but may occur across a range of aquatic habitat types, including coastal embayments such as those found in the study area.
- *Whales*. The offshore sections of the study area could support habitat for large, oceanic species such as humpback whale (*Megaptera novaeangliae*: V/V). Humpback whales calve in the protected waters of the GBR between July and August then travel along the Australian coast to

[4] Hinchinbrook and Taylors Beach Dugong Sanctuaries, which are Declared Dugong Protection Areas

Antarctic waters where they spend spring and summer before returning (Paterson, 1991). The waters surrounding Clump Point have been modelled to be of low environmental suitability for humpback whales compared to the highly suitable waters offshore from Mackay (Smith *et al*. 2012).

4 Summary of Biodiversity Values

Table 4-1 summarises the biodiversity values and constraint category for key marine habitats and communities in the study area.

Table 4-1 Summary of key values of marine habitats and development constraint

Feature	Marine Plant	Habitat for threatened/migratory marine species or threatened community	Other values	Constraint
Mangrove forest	Yes	None known	Limited extent and lack of deep-water refugia (estuarine channels) may reduce fisheries habitat values	Mod
Seagrass meadows	Yes	Potential feeding habitat for turtles and dugong Sparse cover and limited extent limit food resource values Low habitats values c.f. more extensive meadows regionally (e.g. Hinchinbrook)	Potential habitat for prawns and fish Sparse cover/limited extent limit fisheries resource values Low habitats values c.f. more extensive meadows regionally (e.g. Hinchinbrook)	Mod
Rock walls	Yes (macroalgae)	Potential feeding habitats for sea turtles during high tide	Limited fish feeding habitat values c.f. adjacent subtidal environs Low coral cover	Low
Intertidal/shallow subtidal rocky shores	Yes (macroalgae)	Potential feeding habitats for sea turtles during high tide	High habitat complexity Low coral cover	Mod
Boat Bay subtidal boulder field	Yes (macroalgae)	Potential feeding habitats for sea turtles during all tidal stages	Low to moderate coral cover High local values for reef associated fish and crayfish	Mod-High
Soft sediment, rubble and boulders immediately north of existing break-water (i.e. potential sea wall footprint)	Yes (limited macroalga)e	Potential feeding habitats for sea turtles during all tidal stages	Low to moderate coral cover on isolated boulders Local values for reef associated fish and crayfish	Low-Mod
Subtidal reefs Large bommies near the shipwreck	Yes (macroalgae)	Potential feeding habitats for sea turtles during all tidal stages	High coral cover and species richness High local values for reef associated fish and crayfish	High
Shallow soft sediment in Boat Bay	Yes (macroalgae)	Potential feeding habitats for sea turtles during high tide	Moderate localised values as a prawn, crab and fish habitat	Mod

Feature	Marine Plant	Habitat for threatened/migratory marine species or threatened community	Other values	Constraint
Subtidal soft sediment offshore of Boat Bay	No	Potential (low quality) feeding habitats for sea turtles and dolphins	Localised prawn habitat values	Low-Mod

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