TOWNSVILLE PORT EXPANSION PROJECT

Additional Information to the Environmental Impact Statement

APPENDIX A1

Additional Field Studies for Townsville Port Expansion Project

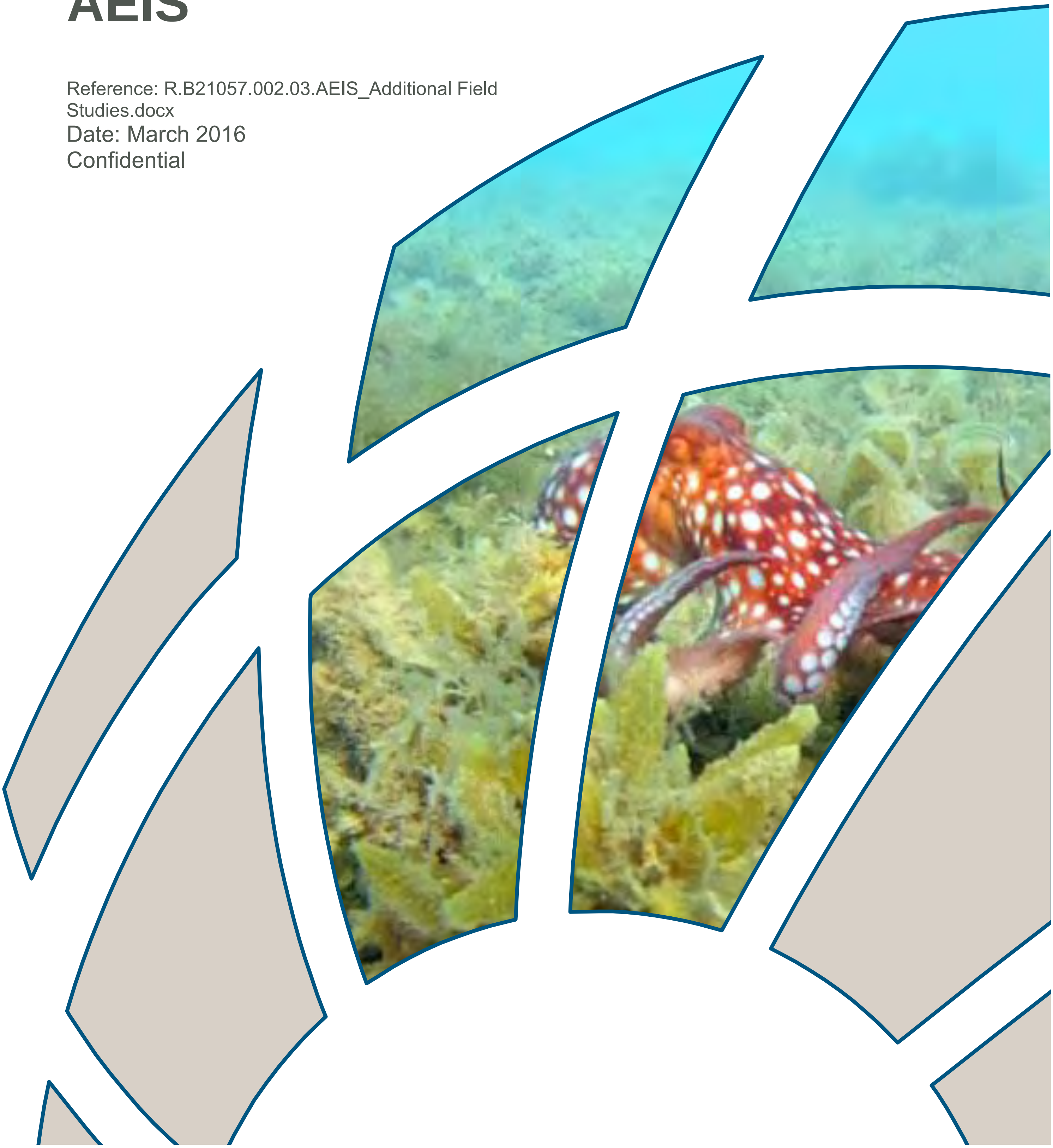
TOWNSVILLE PORT EXPANSION PROJECT

AECOM BMT WBM

A part of BMT in Energy and Environment

Additional Field Studies for Townsville Port Expansion Project AEIS

Reference: R.B21057.002.03.AEIS_Additional Field Studies.docx
Date: March 2016
Confidential



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:	R.B21057.002.03.AEIS_Additional Field Studies.docx
Title:	Additional Field Studies for Townsville Port Expansion Project AEIS
Project Manager:	Brad Grant
Author:	Brad Grant, Conor Jones
Client:	AECOM
Client Contact:	Rouven Lau
Client Reference:	60161996
Synopsis:	This report presents the findings of additional field investigations to inform the Port Expansion Project Additional Environmental Impact Statement.

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	12th January 2015	DLR		BG	
1	30th January 2015	DLR		BG	
2	29th March 2016	DLR		BG	
3	30th March 2016	DLR		BG	

DISTRIBUTION

Destination	Revision										
	0	1	2	3	4	5	6	7	8	9	10
AECOM	PDF	PDF	PDF	PDF							
BMT WBM File	PDF	PDF	PDF	PDF							
BMT WBM Library	PDF	PDF	PDF	PDF							

Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

The Port of Townsville Port Expansion Project (PEP) involves dredging of the sea bed to provide for larger shipping vessel access, manoeuvring and berthing. It is proposed that dredge material will be placed in a near shore reclamation area to provide land requirements for operation of the port expansion.

The Environmental Impact Statement (EIS) for the PEP was submitted in late 2012. The EIS committed to undertaking further marine environmental data collection programs to develop an improved understanding of existing (baseline) conditions within Cleveland Bay. Submissions received on the EIS also highlighted the need for further data to address data gaps, particularly with respect to reef benthic communities.

Subsequent to the EIS, the project design was revised in an effort to reduce the potential for adverse impacts to sensitive ecological receptors, namely seagrass and corals. The design refinement included widening of the channel, and a larger reclamation to accept all dredge material on land. As a result of this design refinement, additional field studies were required to investigate areas previously not included in the design footprint.

1.2 Aims and Objectives

The aim of this study is to characterise baseline conditions in marine water quality, reef benthic communities and benthic habitats within and adjacent to areas potentially affected by the proposed PEP. This information is intended to inform the PEP Additional Environmental Impact Statement (AEIS) and planning of the PEP.

The specific objectives of this study are to:

- Describe water quality conditions at representative sensitive ecological receptors sites in Cleveland Bay over a 12 month period.
- Based on these data, develop revised water quality threshold values to assess impacts from the revised project design in the AEIS.
- Describe benthic communities on reefs along the southern and eastern coasts of Magnetic Island, to document short term temporal changes in communities, and increase spatial resolution of data along the south eastern coast of Magnetic Island.
- Describe and characterise benthic habitats in areas not previously surveyed in the EIS and which now form the PEP development footprint following the design refinement.

2 Water Quality

2.1 Water Quality Data Presented in the EIS

Cleveland Bay has been subject to numerous water quality monitoring studies, which are summarised in the PEP EIS. These water quality monitoring studies have different aims and objectives, and the underpinning data varies among studies in terms of parameters measured (and measurement techniques), data currency, spatial and temporal resolution of data, and data quality. The description of baseline water quality conditions presented in the EIS was based on the most applicable data available at the time of report production.

Numerical modelling was undertaken in the EIS to predict the characteristic of sediment plumes generated by dredging. The existing water quality data provided a basis for determining the degree to which dredge-related sediment plumes (predicted by modelling) varied from 'background' conditions.

The EIS acknowledged that additional water quality data were required to understand patterns in temporal variability of water quality conditions at sensitive ecological receptor sites. Consequently, a commitment to collect a further 12 months of continuous water quality data at sensitive receptor sites was included in the EIS. It is intended that these data will be used to devise locally specific water quality threshold values, based on statistical metrics describe 'natural variability' in water quality conditions at different time intervals.

The water quality threshold values were originally intended for use in a future reactive water quality monitoring program for the PEP. The water quality thresholds will also be used to assess the degree to which dredge-related sediment plumes from the revised project design (predicted by modelling) vary from 'background' conditions, as documented in the Additional Environmental Impact Statement (AEIS).

Details of the additional water quality data collected are included in the following sections.

2.2 Additional Data Collected

2.2.1 Monitoring Stations

Water quality monitoring was carried out at five stations containing benthic primary producer habitats (seagrass and/or corals) and in areas most likely to be affected by dredge plumes. Two stations were located in nearshore areas close to the mainland (the Strand and Virago Shoal), and three locations were located in offshore waters on the east coast of Magnetic Island (Geoffrey Bay, Florence Bay and Picnic Bay) (Table 2-1 and Figure 2-1).

Table 2-1 Monitoring stations

Station	Location	Longitude	Latitude	Water Depth (m LAT)
The Strand	Nearshore	146.82343	-19.241371	-3 m
Virago Shoal	Nearshore	146.791949	-19.213799	-3 m
Geoffrey Bay	Magnetic Island	146.869291	-19.155137	-4 m
Florence Bay	Magnetic Island	146.883527	-19.123141	-5 m
Picnic Bay	Magnetic Island	146.848674	-19.181414	-7 m

Figure 2-1 Location of Water Quality Monitoring Instruments

2.2.2 Water Quality Instruments

Physical and chemical water quality parameter measurements were collected at each station using Yellow Spring Instruments (YSI) 6600 multi-parameter automated data loggers, also known as sondes. The sondes were equipped with self-cleaning optical sensors, anti-fouling wipers, optimal power management, and a built-in battery compartment which improve reliability and maintain high data accuracy during extended deployments. The sondes house multiple probes that simultaneously measured temperature, electrical conductivity, dissolved oxygen (percent saturation), depth, pH and turbidity. Other parameters are not measured directly but calculated by the sonde, namely: salinity, which is calculated using specific conductivity and temperature; and dissolved oxygen which is calculated using temperature, salinity and dissolved oxygen percent saturation. The sondes were mounted on secure frames placed on the sea bed, thereby measuring water quality at the location of benthic primary producer habitats (i.e. seagrass and coral).

A terrestrial PAR sensor was installed on the roof of the Yongala Lodge Motel during April 2012. An additional terrestrial PAR sensor was installed on the roof of the Magnetic Island Police Station in July 2012. Data from these sensors will be used to represent PAR levels at the water surface. This allows a correction to be made for decreased light levels due to cloud cover.

Following retrieval, the instruments and sensors were thoroughly inspected and any significant fouling or damage was noted in order to compare with reported values. Raw data were downloaded from the sonde to a lap-top computer. Raw data were saved in an Excel data file that was named after the station and time period.

2.2.3 Duration and Frequency of Monitoring

Data were collected at 10 minute intervals between March 2012 and July 2013 to collect 12 months of baseline water quality data.

The monitoring period for each instrument was as follows:

- Strand: March 2012 – May 2013.
- Virago Shoal: March 2012 – May 2013.
- Picnic Bay: July 2012 – July 2013.
- Geoffrey Bay: July 2012 – July 2013.
- Florence Bay: July 2012 – July 2013.

2.3 Data Quality

2.3.1 Field Quality Assurance (QA) Procedures

The following QA procedures were in place prior to instrument deployment:

- All instruments were calibrated as recommended by the manufacturer using standard solutions prepared from National Institute of Standards and Technology (NIST) traceable reagents.
- Accuracy and precision checks were undertaken in accordance with manufacturer instructions. Re-calibration of instruments was undertaken if accuracy and precision tests failed to meet data quality objectives shown in Table 2-2.
- New Energizer 'ProCell' batteries were used throughout the campaign.
- A checklist was followed for programming instruments. The checklist prescribed:
  - Download data file from instrument to PC.
  - Verify data file is complete and without error. Reattempt download if data file is incomplete.
  - Download calibration file to PC.
  - Delete all files from instrument.

- Synchronise instrument time to 'real' time (obtainable from PC connected to internet).
- Check sensor wiping is on and set to correct interval.
- Check correct sensors are enabled.
- Check correct reporting fields are selected.
- Set start time and date. Ensure logging date is correct and period is set to '365' days.
- Ensure battery voltage is >12.0 volts.
- Ensure battery life and free memory exceed the expected duration of sampling.
- Commence logging.
- Verify instrument is logging in 'Status' screen.
- Verify instrument is logging just prior to deployment by observing wiper on optical sensor.

Table 2-2 Data quality objectives

Parameter	Resolution (and Range)	YSI Accuracy (±)	Data Quality Accuracy (±)	Precision Criteria (Relative Percent Difference)
Temperature (°C)	0.01 (-5 to 45)	0.15	0.3°C in the range of 0 to 45°C	≥95% (≤5% RPD) as determined from duplicate recordings at the same time and space
Depth (m)	0.001 (0 to 61)	0.12	0.12	
Conductivity (mS/cm)	0.001 (0 to 100)	0.5% of standard (+0.001)	2% of standard	
Dissolved oxygen (mg/l)	0.01 (0 to 50)	0.2 or 2% of standard	5% of standard	
Turbidity (NTU)	0.1 (0 to 1000)	2.0 or 5% of standard	2.0 or 5% of standard	

2.3.2 Instrumentation Calibration and Frequency

Sondes were calibrated and deployed for four-six week periods. At the end of the deployment period, the sondes were retrieved and replaced with recently calibrated sondes.

2.3.3 Data Quality Control (QC) Procedures

Data were plotted as a time series and visually scanned for outliers and evidence of failed probes. Obvious issues were noted in the spreadsheet. Potential outliers were highlighted and questionable data were re-examined following the calibration. With the exception of debris blocking turbidity optics, most outliers are caused by probe failure and were therefore flagged during post-deployment calibration.

Erroneous turbidity and PAR measurements can occur as a result of fouling of the optical sensors. Some turbidity and PAR data outliers are readily identifiable and others are measurements that could occur naturally without clear indication that these marginal values should be censored.

Debris covering the turbidity sensor produces a high turbidity reading (>200 NTU). If a single reading or block of readings in that high range occurred with typical 'base' turbidity (i.e. mean values) on either side of the measurement or block of measurements, this outlier was quarantined from the final data worksheet.

Random spikes (over 100 NTU) are more difficult to identify. Suspected outliers were investigated with the following process:

- Fouling/interference of the optical equipment was suspected where turbidity spikes (>50 NTU) exceeded either (i) >50% of the values either side of the spikes; or (ii) were greater than three standard deviations from the seasonal mean.
- Data were then examined with consideration to the meteorological conditions at the time (with data from the Bureau of Meteorology) to determine whether rainfall or wind conditions may have affected the measurements in question. If high rainfall or strong winds did not accompany dips in EC or spikes in turbidity, the data were considered potentially erroneous and subjected to further scrutiny.
- The suspect data were compared with trends in data from other instruments known to experience similar conditions. If other instruments did not show similar patterns, the data were considered potentially erroneous.
- Finally, recalibration of the equipment for subsequent deployments identified whether an individual sensor, or entire sonde, could be responsible for erroneous readings (for example, a turbidity wiper inoperable, or a pH probe out of specification).

Data were also quarantined during periods of capital and maintenance dredging in Cleveland Bay.

2.4 Baseline Assessment

As the key parameter of concern for dredging, turbidity was the focus of the analysis of the 12 month monitoring data set. Summary statistics were calculated for the wet season (November to April - Table 2-3) and the dry season (March to October - Table 2-4).

Findings from the data analysis indicate the following:

- Nearshore sites had higher turbidity compared to offshore sites along Magnetic Island.
- There was little difference in median (50th percentile) turbidity values between the wet season and dry season, however there was greater variability in the data during the wet season as indicated by the higher mean values and standard deviation values. Based on rainfall records from Townsville Aero, the wet season of 2012/2013 was slightly drier (especially Nov/Dec) than the long term average wet season rainfall.
- Peaks in turbidity (represented by 80th and 95th percentile values) were higher during the wet season than the dry season, most likely due to wet weather riverine inflows into the Bay.

Table 2-3 Summary of Wet Season (Nov-Apr) Turbidity Data (excluding dredging periods)

Monitoring Site	Summary of Turbidity Data (NTU)					
	Mean	Standard Deviation	20th Percentile	50th Percentile	80th Percentile	95th Percentile
Near-shore Sites						
The Strand	80	172	11	18	43	424
Virago Shoal	31	58	6.6	17	38	105
Magnetic Island Sites						
Florence Bay	4.3	7.2	0.5	2.3	5.4	17
Geoffrey Bay	3.3	4.2	1.0	2.0	4.8	10
Picnic Bay	3.9	6.6	0.9	2.1	5.0	15

Table 2-4 Summary of Dry Season (Mar-Oct) Turbidity Data (excluding dredging periods)

Monitoring Site	Summary of Turbidity Data (NTU)					
	Mean	Standard Deviation	20th Percentile	50th Percentile	80th Percentile	95th Percentile
Near-shore Sites						
The Strand	33	76	6.3	15	38	104
Virago Shoal	21	32	4.3	11	29	74
Magnetic Island Sites						
Florence Bay	2.4	1.5	1.4	2.0	3.3	5.6
Geoffrey Bay	2.8	1.7	1.7	2.8	3.3	5.1
Picnic Bay	2.8	1.7	1.7	2.3	3.5	5.9

Other parameters, including electrical conductivity (EC), salinity, pH and dissolved oxygen (DO), were also recorded during the 12 month monitoring program. Percentile values were calculated and are presented in Table 2-5.

Table 2-5 Summary Statistics of other Water Quality Parameters (March 2012- July 2013)

Monitoring Site	Summary Statistic	EC (mS/cm)	Salinity (ppt)	pH	DO (% sat)
Strand	20th percentile	46.99	30.47	7.91	94.5
	Median	52.08	34.20	8.10	98.2
	80th percentile	54.86	36.39	8.17	102.9
	95th percentile	57.09	37.88	8.20	107.5
Virago Shoal	20th percentile	46.58	30.20	7.98	94.5
	Median	53.42	35.14	8.09	97.9
	80th percentile	55.67	36.86	8.23	102.8
	95th percentile	57.43	38.21	8.26	108.4
Florence Bay	20th percentile	53.24	35.08	7.96	93.7
	Median	54.71	36.27	8.05	97.4
	80th percentile	55.80	36.99	8.18	103.8
	95th percentile	56.71	37.62	8.21	110.6
Geoffrey Bay	20th percentile	52.75	34.71	7.54	91.6
	Median	54.15	35.86	8.01	96.1
	80th percentile	56.14	37.24	8.14	101.7
	95th percentile	56.98	37.81	8.20	110.9
Picnic Bay	20th percentile	52.60	34.56	7.94	85.3
	Median	54.23	35.91	8.06	94.2
	80th percentile	56.20	37.27	8.16	103.0
	95th percentile	57.35	38.09	8.20	113.4

2.4.1 Time Series Data

2.4.1.1 Turbidity

Time series of the ‘cleaned’ turbidity data (refer to Section 2.3) are presented in Figure 2-2 to Figure 2-4 for the three monitoring locations along the east coast of Magnetic Island. Figure 2-5 and Figure 2-6 present the time series turbidity data for the two nearshore sites (refer to Figure 2-1 for locations). These figures show the entire monitoring period, along with periods when capital and maintenance dredging occurred. Data collected during these periods of dredging were quarantined from the data set and are therefore not shown in the time series.

To compensate for data periods required to be quarantined from the 12 month dataset, the revised water quality impact assessment in the AEIS makes use of previous monitoring data from 2008/2009 to enhance the 2012/2013 dataset.

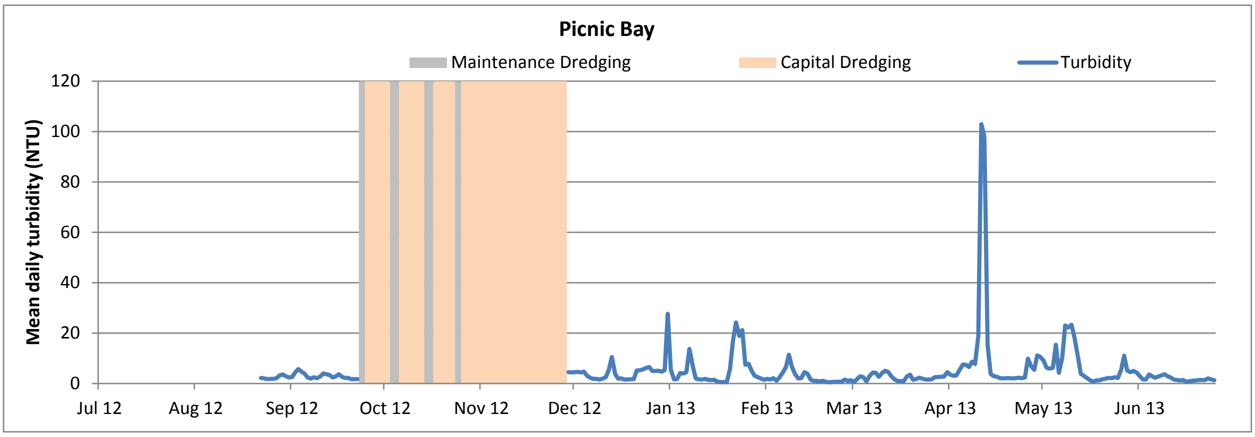


Figure 2-2 Picnic Bay Turbidity

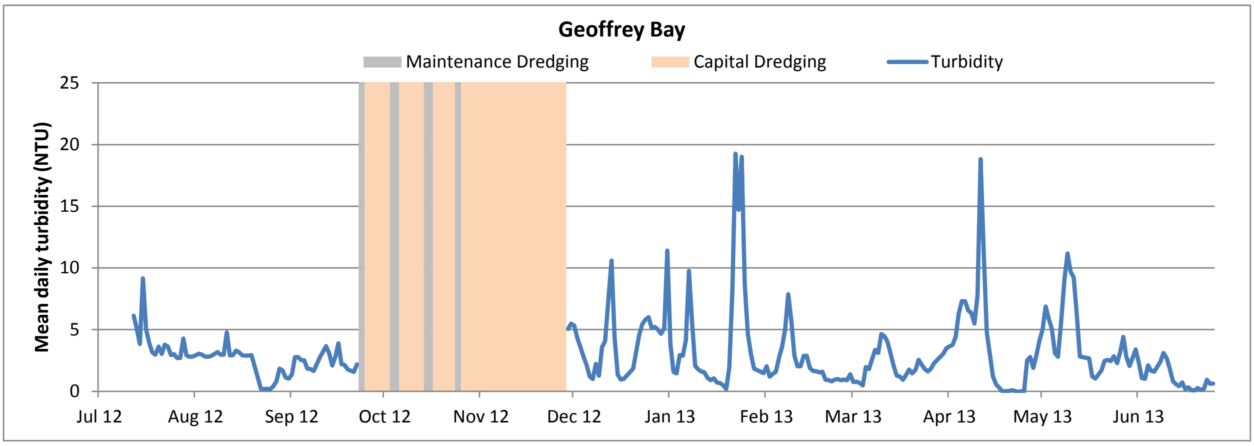


Figure 2-3 Geoffrey Bay Turbidity

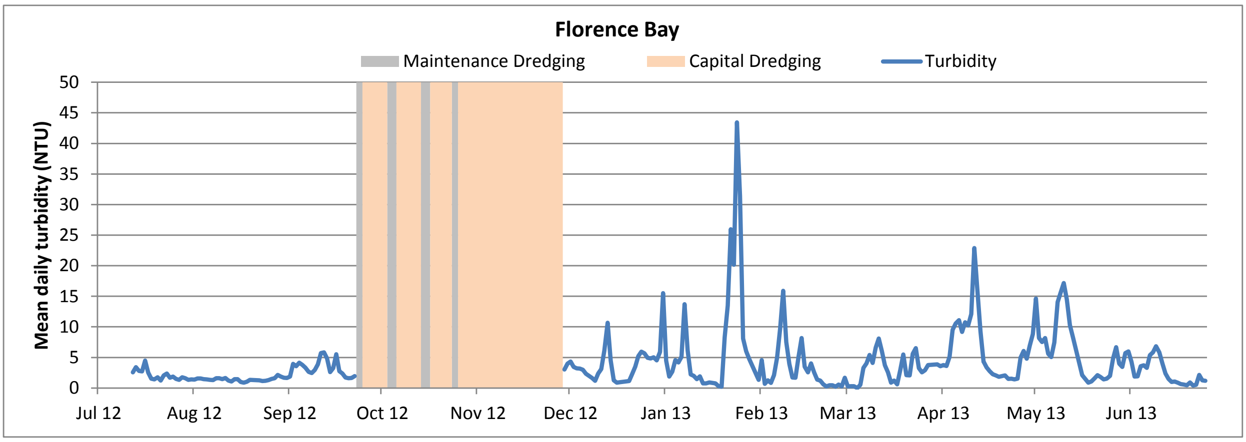


Figure 2-4 Florence Bay Turbidity

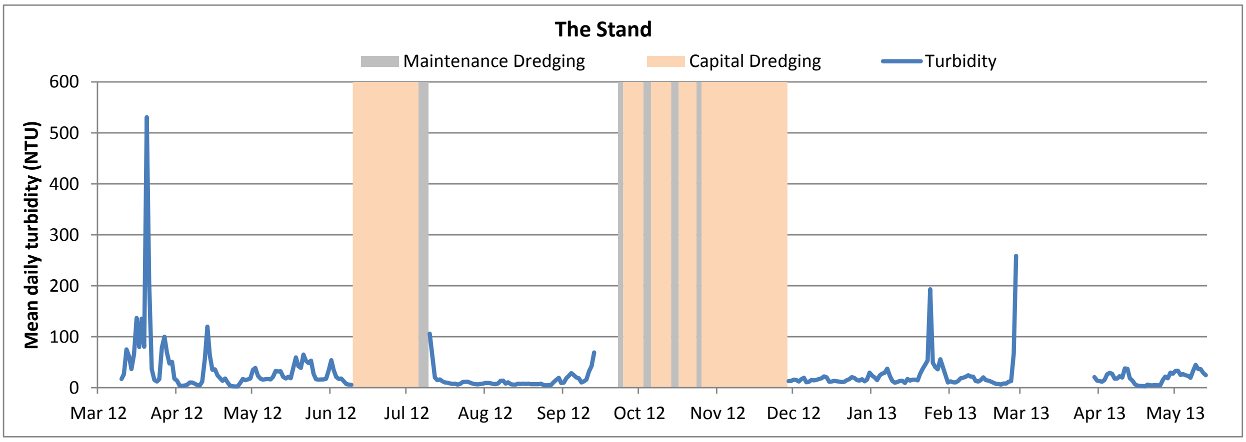


Figure 2-5 Strand Turbidity

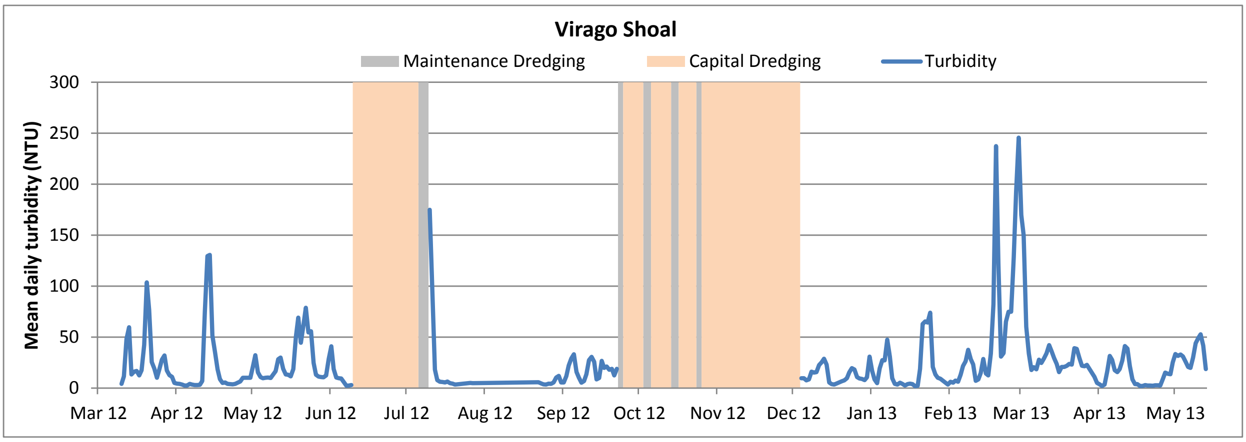


Figure 2-6 Virago Shoal Turbidity

2.4.1.2 Benthic PAR

The benthic PAR time series data (which provides a measure of light levels reaching the seabed) was analysed and total daily benthic PAR at each site calculated. The data are presented as a two week rolling average in the figures below. A two week running average was chosen as recent studies in Gladstone for the key intertidal seagrass Zostera muelleri (capricorni) found that a two week average of daily light was a critical time window to support seagrass growth (Chartrand et al. 2012).

Figure 2-7 to Figure 2-9 present the time series total daily benthic PAR data for the three monitoring locations along the east coast of Magnetic Island, while Figure 2-10 and Figure 2-11 present the time series total daily benthic PAR data for the two nearshore sites (near the mainland).

These figures show the monitoring period for each site where good quality data was recorded. Data collected during capital and maintenance dredging were quarantined from the data set and are therefore not shown in the time series. Note that for all monitoring sites, there are substantial data gaps in PAR due to equipment failure and bio-fouling.

The time series of total daily benthic PAR indicate the following:

- Total daily benthic PAR (2 week rolling average) for sites along Magnetic Island ranged from 10 to 20 mol/m^2/day at Picnic Bay, 5 to 8 mol/m^2/day at Geoffrey Bay, and 5 to 20 mol/m^2/day at Florence Bay. It should be noted that benthic PAR is influenced by the depth of water at each instrument.
- Total daily benthic PAR (2 week rolling average) for nearshore sites ranged from 2 to 12 mol/m^2/day at the Strand and 2 to 14 mol/m^2/day at Virago Shoal.

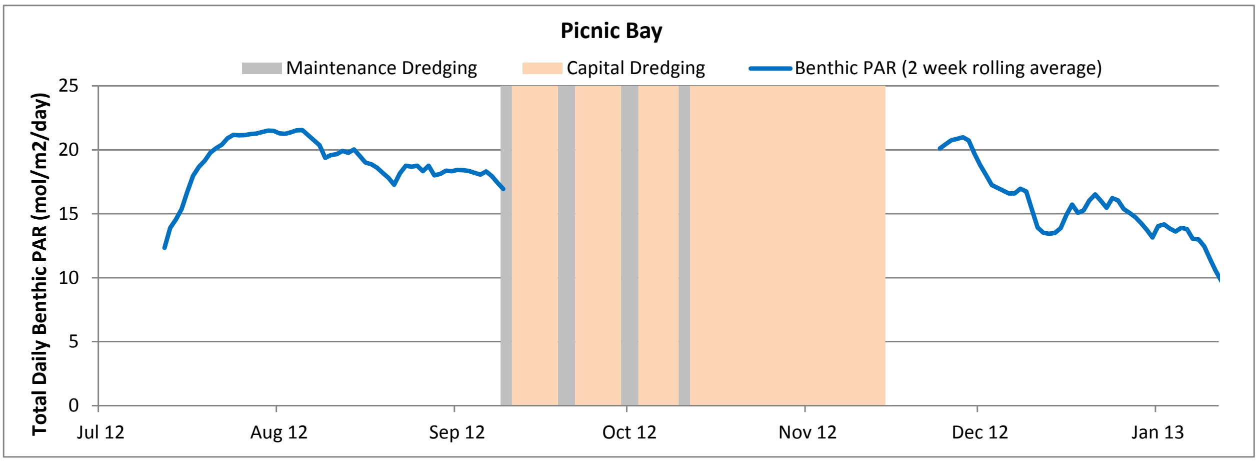


Figure 2-7 Picnic Bay Total Daily Benthic PAR (mol/m2/day) (2 week rolling average)

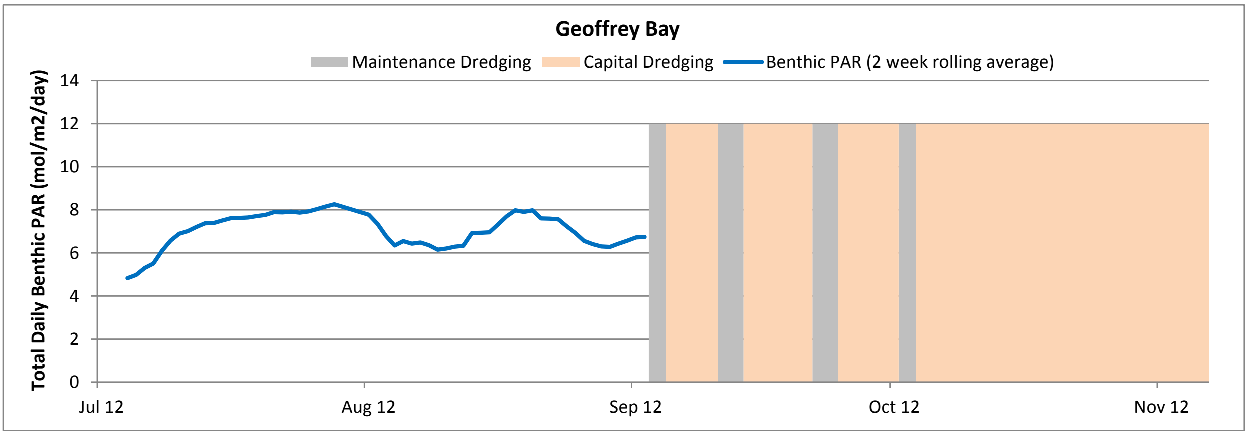


Figure 2-8 Geoffrey Bay Total Daily Benthic PAR (mol/m2/day) (2 week rolling average)

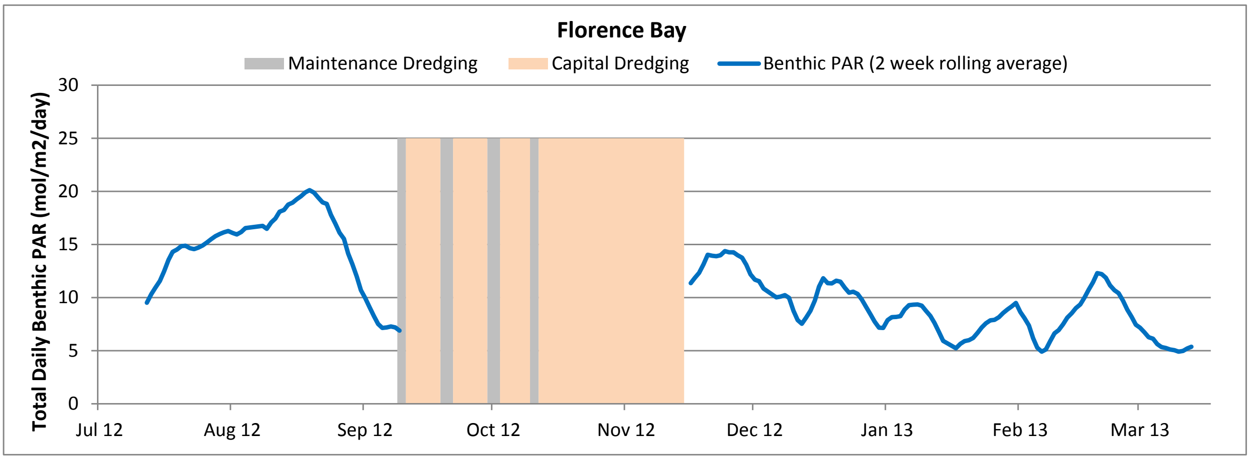


Figure 2-9 Florence Bay Total Daily Benthic PAR (mol/m2/day) (2 week rolling average)

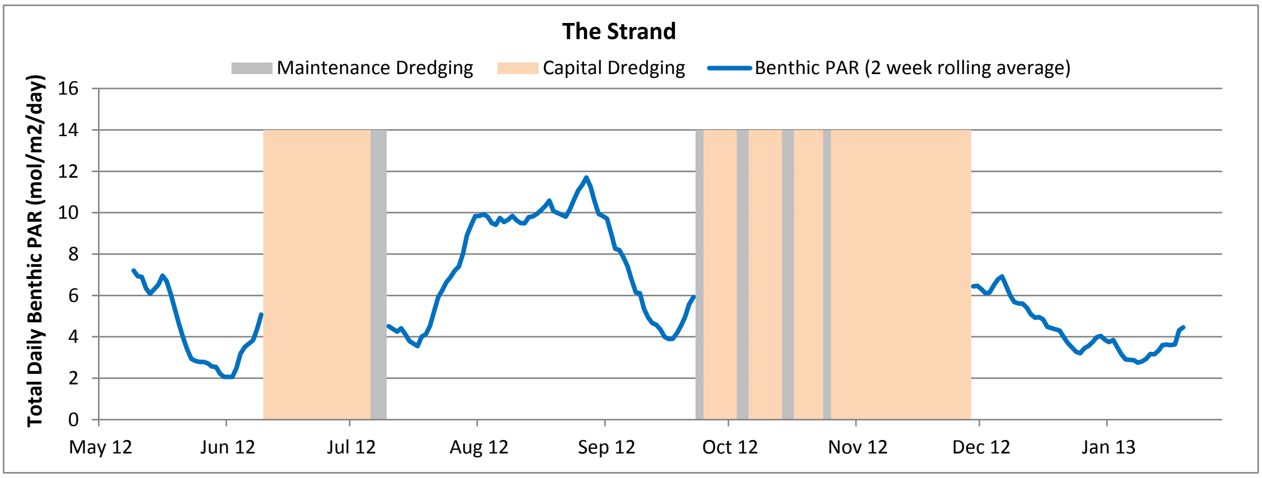


Figure 2-10 Strand Total Daily Benthic PAR (mol/m2/day) (2 week rolling average)

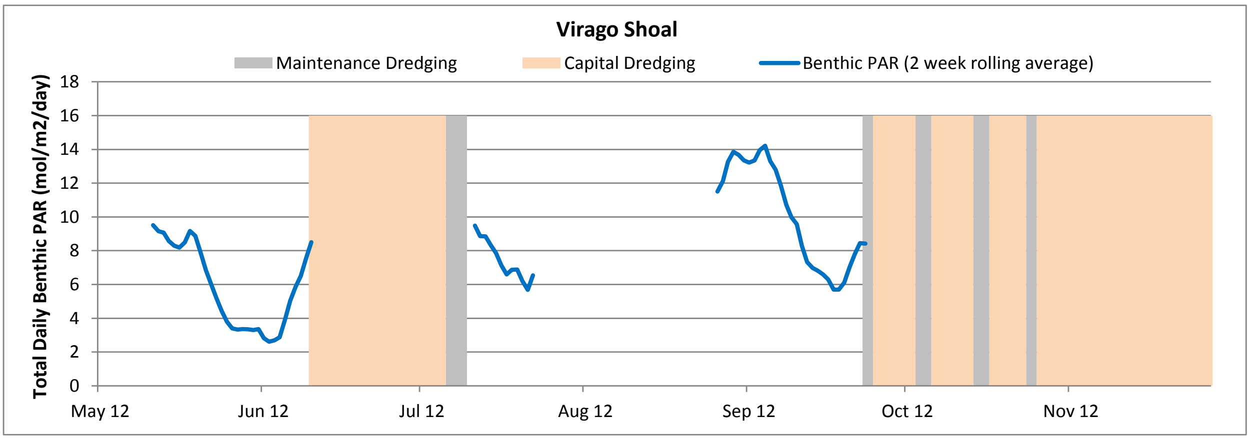


Figure 2-11 Virago Shoal Total Daily Benthic PAR (mol/m2/day) (2 week rolling average)

2.4.2 Relationship between PAR and NTU

Daily light requirements for several species of seagrass have been developed in Townsville (Collier *et al.* 2012a; 2012b) and Gladstone (Chartrand *et al.* 2012). In order to compare changes in turbidity (NTU) and PAR, and subsequent light-based impacts of turbidity, the relationships between mean daily PAR and NTU was estimated using data from the Virago Shoal and the Strand (Figure 2-12). The Virago Shoal relationship was used to examine putative impacts because the instrument was situated within an existing *Halophila* meadow, it is relatively distant from the influence of the Ross Creek and Ross River (for better comparison with modelled data), and was situated in water depths consistent with the presence of *Halophila* sp. (2.2- 6.17 m below the water surface, mean = 4.01 m). Mean daily PAR was calculated for ease of comparison with established daily light requirement values for seagrass. Fitted relationships were similar at the two locations.

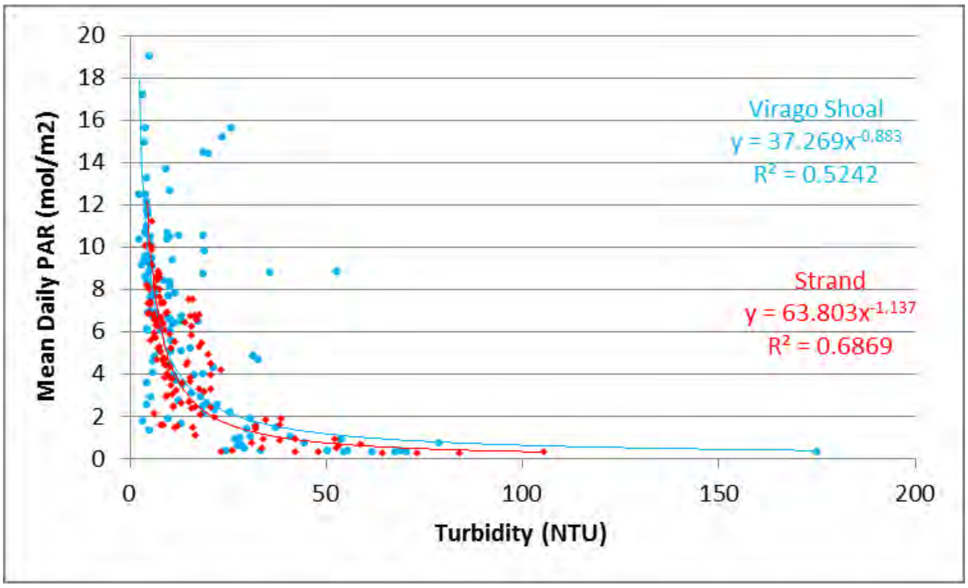


Figure 2-12 Relationship between Mean Daily PAR and Turbidity at Virago Shoal

3 Reef Habitat Surveys

3.1 Additional Data

Reef surveys were undertaken in response to a number of submissions on the EIS, regarding:

- Limited sampling effort at Cockle Bay (southern coast of Magnetic Island).
- No discussion on the stromatolites purported to exist in Geoffrey Bay.

The adopted sampling methods are described below.

3.1.1 Cockle Bay Reef Habitat and Community Surveys

Reef habitat and community surveys were undertaken at Cockle Bay Reef from 24 to 28 September 2014, inclusive. The methodology was consistent with that employed in 2012 and consisted of: (i) qualitative habitat mapping and, (ii) quantitative reef community surveys in reef slope and reef crest habitats. The locations of transects sampled in the present study and in the 2012 (EIS) survey are shown in Figure 3-1.

Habitat Survey

A preliminary habitat map was developed by digitising the boundaries of distinct mapping units (based on texture, colour, tone) from geo-rectified digital satellite imagery (Google Earth Pro imagery, 3 October 2009). Each map unit/polygon was assigned a preliminary map unit code prior to field survey and re-evaluated and attributed following field survey, analysis and classification of field data.

The field survey was undertaken by divers (on snorkel) swimming the length of transects extending from the near the low tide mark to the reef edge. The divers recorded major changes in benthic habitats with a hand-held GPS. Reef habitat categories adopted for this survey are shown in Table 3-1, and were mapped using the MapInfo GIS package.

Table 3-1 Reef habitat categories

Category	Description
Unconsolidated sediment (sand)	Bare sand substrate - sparse to no cover of seagrass or algae in places
Unconsolidated sediment (mud)	Bare mud substrate - sparse to no cover of seagrass or algae in places
Reef flat with macroalgae	Reef flat with >5% cover of macroalgae +/- soft coral
Seagrass meadow	Seagrass with >2% cover - may occur on other habitats
Lagoon (scattered micro-atolls)	Lagoonal habitat within the reef flat
Reef crest	Low gradient, distal edge of reef flat
Reef slope/edge	High gradient, distal edge of reef flat
Occasional bomboras & scattered rubble	Soft sediment habitat at distal margin of reefs with occasional bomboras and scattered rubble

Quantitative reef community surveys were carried out in reef slope and reef crest habitats. At each site, three 30 m transects were positioned along a depth contour at approximately 1-3 m below mean sea level (MSL). Each transect start position was marked using a hand-held GPS tethered to the diver's surface float. Transect imagery was collected using paired high-definition submersible cameras with dual 1800 lumen video lights to maximise image quality. Imagery was collected from 20-30 cm above the seafloor, providing a 0.5-1 m wide swath of imagery. One camera collected still imagery every two seconds while the other filmed continuously. This approach allowed for objective selection of still imagery because stills were collected randomly, and a video recording to aid in identification if necessary. Each photo covered approximately 1 m^2 so that each transect provided a 30m^2 belt transect.

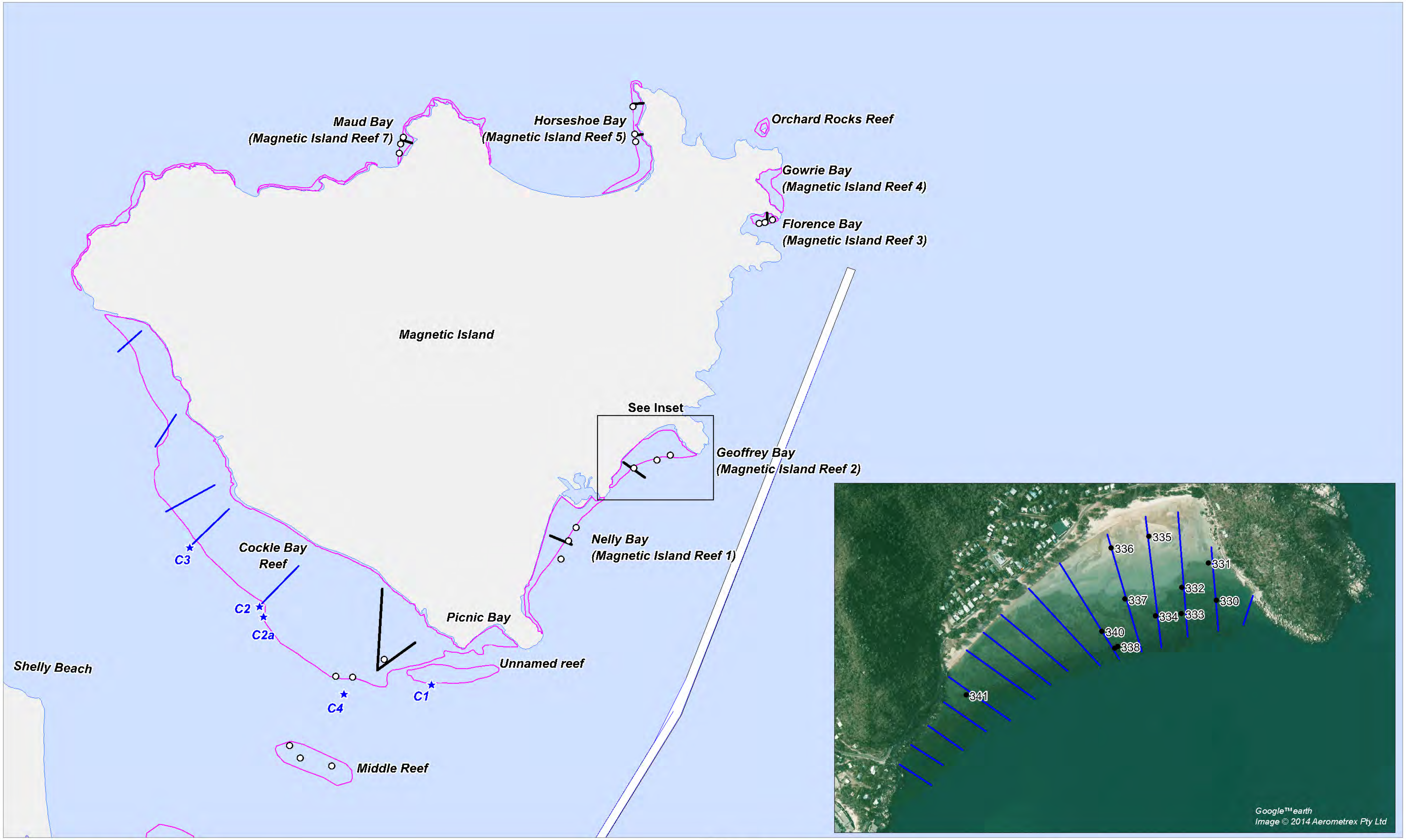
Coral Point Count (Kohler and Gill 2006) was used to quantify benthic cover. Using CPCe 4.1, a 300 pixel setback was used to ensure point identifications were made in the brightest, clearest part of the photo, and also to reduce the chances of non-independence between partially overlapping photos. Twenty points were identified from each photo, giving 600 point IDs per transect.

At the most westerly quantitative site on Cockle Bay Reef (site C3) the reef edge was highly simplified and lacking major changes in bed elevation that could be described as a crest or slope, so one transect collected here and was considered the reef edge. Similarly, only the reef edge was sampled at site C2A.

3.1.2 Geoffrey Bay Stromatolite Survey

At Geoffrey Bay, 15 transects (separated by a distance of 70 m) were surveyed by divers on snorkel, covering a total distance of 5 km. The position of transects is shown in Figure 3-1 (see inset). Any features (outcrops of rock or coral) bearing any similarity to stromatolites or microbial mats were photographed, and GPS points were taken using a submersible GPS tethered to a surface float.

Dr Jane Mellors from James Cook University (JCU) was also consulted regarding the status of stromatolites at Geoffrey Bay. Dr Mellors provided information and several photos of structures that are currently the subject of research by JCU researchers.



LEGEND

- Transects 2012
- Transects 2014
- Coral Reefs (GBRMPA Gazetteer)
- Channel Area
- Quantitative 30m Transects 2012
- Quantitative 30m Transects 2014
- Quantitative 30m Transects 2014

Title:

Locations of snorkel and photo transects surrounding Magnetic Island and Middle Reef

Figure 3-1

Rev: A

N

0 1.25 2.5km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B21057.I.bmg_PEP\DRG\ECO_006_141105_Coral_methods.wor

3.2 Cockle Bay

3.2.1 Reef Habitats

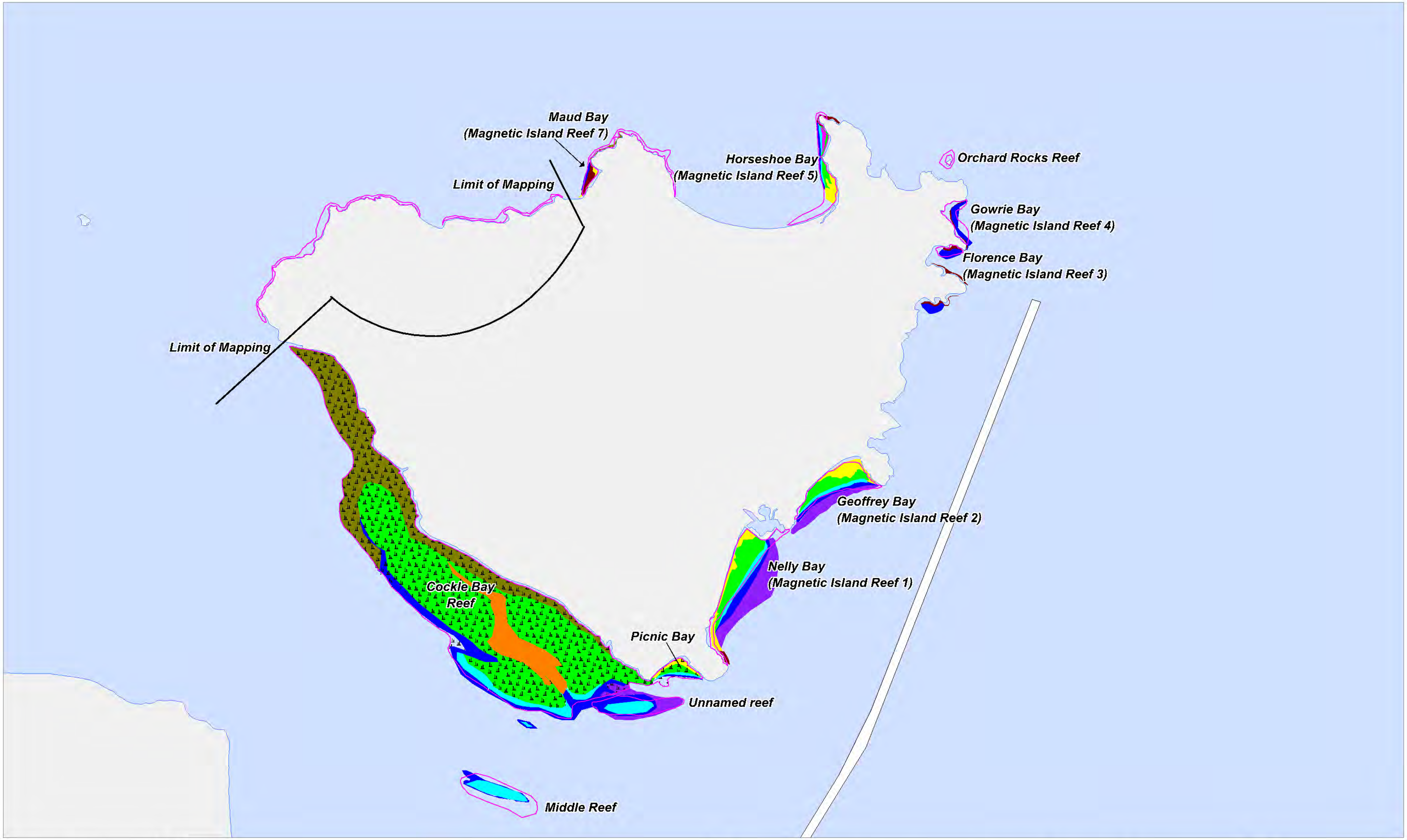
Figure 3-2 shows the distribution of different reef habitat types on Cockle Bay Reef.

The shoreline fringing the mangroves at Cockle Bay and most of the northern reef flat was composed of unconsolidated sandy mud. Sediments fringing the mangroves had a sparse cover of *Halophila ovalis* while other seagrass species (*Zostera, Halodule* and *Cymodocea*) were more common on unconsolidated sediments in slightly deeper waters.

Reef flat with macroalgae was the largest habitat type represented on Cockle Bay Reef. This habitat type was comprised of low to high cover of macroalgae on sand, mud and/or rubble fragments, with occasionally dense patches of seagrass (primarily *Cymodocea, Halodule* and *Halophila*). *Porites latistella* was also common over the reef flat, and soft corals (e.g. *Sarcophyton*) were present in places.

A shallow lagoon (shaded orange in Figure 3-2) was located in the centre of the reef flat, and contained microatolls and occasional coral outcrops. The substrate in this lagoon was composed of sandy mud and seagrass was present in places. The lagoon area appeared to include natural deeper areas as well as deeper sections that may have created or exacerbated by human disturbances such as historic dredging, or altered hydrodynamics associated with the pipeline alignment between Cape Pallarenda and Magnetic Island.

The reef crest at Cockle Bay Reef was structurally similar to that of the reef edge/slope, and often had highly simplified habitat structure. The reef edge had the densest cover of living hard coral, which progressively became less prominent with distance in a north-westerly direction, towards Cape Pallarenda and Rattlesnake Island. There was no distinct reef edge habitat north-west of site C3; instead a low gradient reef flat (with occasional seagrass patches) gradually merged with the seabed. This characteristic is not reflected in the GBRMPA Gazetteer layer for Cockle Bay, but it is identified on the Australian Navigation Chart 256.



LEGEND

- New Channel Extent
- Coral Reefs (GBRMPA Gazetteer)
- Reef Flat with Soft Coral and Algae
- Unconsolidated Mud
- Granite Boulders With Occasional Coral and Algae
- Seagrass Meadow
- Unconsolidated Reef Flat (Sand)
- Reef Flat with Macroalgae
- Scattered Micro-atolls
- "Reef Crest"
- Reef Slope/ Edge
- Occasional Bomboras and Scattered Rubble

Title:

Reef community types around eastern Magnetic Island and Middle Reef

Figure **3-2**

Rev: **A**

N

0 1.25 2.5km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B21057.I.bmg_PEP\DRG\ECO_007_141105_Coral_mapping.wor

3.2.2 Reef Communities

Reef communities on the reef crest and slope showed great variability in community structure (Figure 3-3). In terms of coral cover:

- Site C1 had the highest living coral cover of any of the sites investigated through the entire EIS process, and was dominated by acroporids (namely *Montipora*) and dendrophyliids (*Turbinaria* spp.). As discussed in Section 3.2.1, living coral cover declined with increasing distance to the north-west away from site C1.
- Site C2A was located in a recessed section of the reef edge that formed a protected pocket of coral with mud and seagrass patches (*Halophila spinulosa*) between coral colonies. Site C2A had the next highest living coral cover, and unlike other sites, was composed primarily of large bomboras of *Pavona cactus* (Agariciidae).
- Site C2 had low living coral cover and was not dominated by any particular taxa.
- Site C3 was almost devoid of living hard coral cover apart from occasional small colonies of *Goniastrea* and *Favites* (Faviidae).
- Site C4 had approximately 10% coral cover, which was comparable with cover observed at Maud, Florence, and Nelly Bays. Coral cover at Site C4 was dominated by *Montipora* and *Acropora* with occasional *Porites* and *Lobophyllia* (Mussidae) colonies.

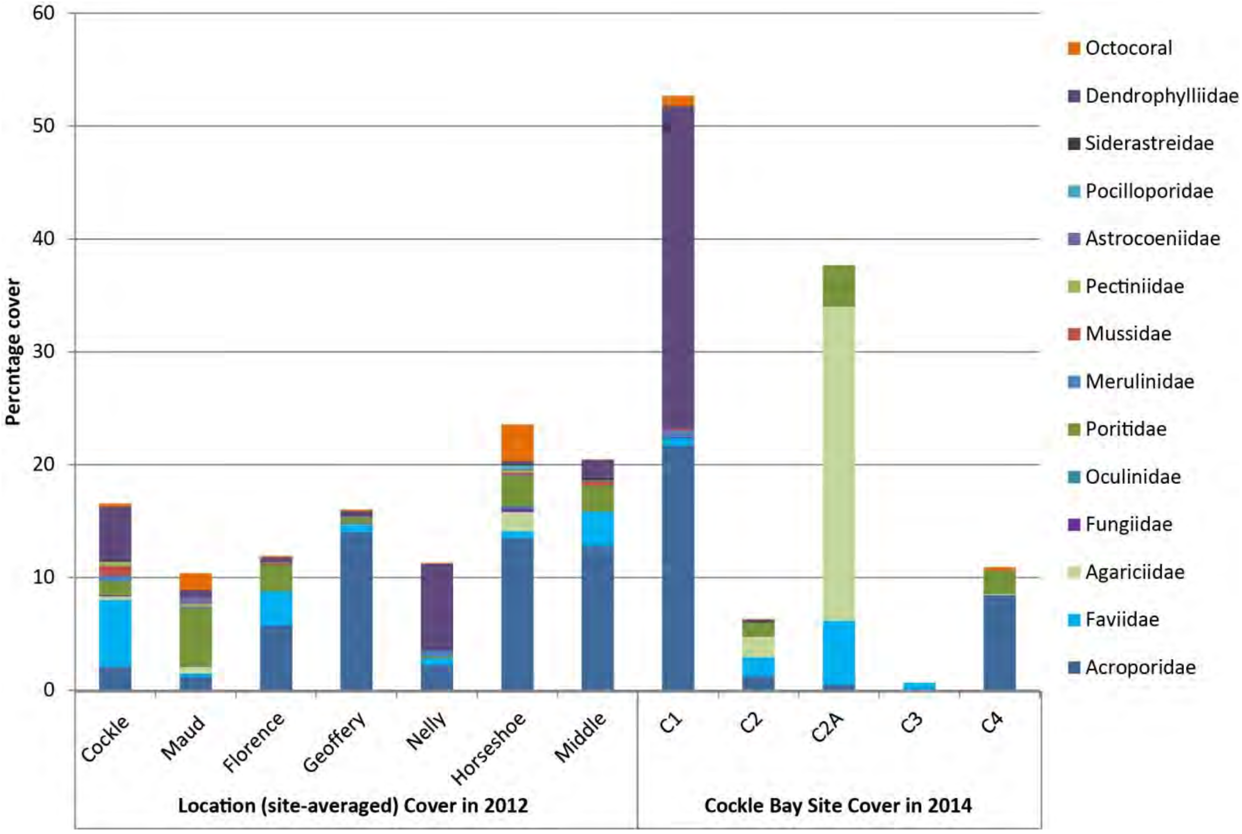


Figure 3-3 Percent cover of living coral at Cockle Bay Reef Sites (C1-C4) and sites visited previously

Macroalgal communities differed between the previously surveyed sites and the additional sites at Cockle Bay Reef (Figure 3-5). The additional Cockle Bay Reef sites had a higher percentage cover of *Acanthophora* and *Caulerpa* than the sites surveyed previously. *Asparagopsis* was also observed at site C3, which had not been observed previously. *Sargassum* was the dominant macroalgae at most sites, the exception being C3 which lacked suitable hard substrate for holdfast attachment. Otherwise, the additional Cockle Bay Reef sites had *Sargassum* cover that was similar to that observed elsewhere around Magnetic Island.

Differences in macroalgal species present between the two surveys may be related to spatial or temporal differences that have occurred between survey events. Geographical differences in communities may have been the result of a greater influence of catchment runoff at Cockle Bay Reef, alternatively some of the differences in macroalgal communities may simply be explained by broad-scale temporal changes that have occurred since 2012.

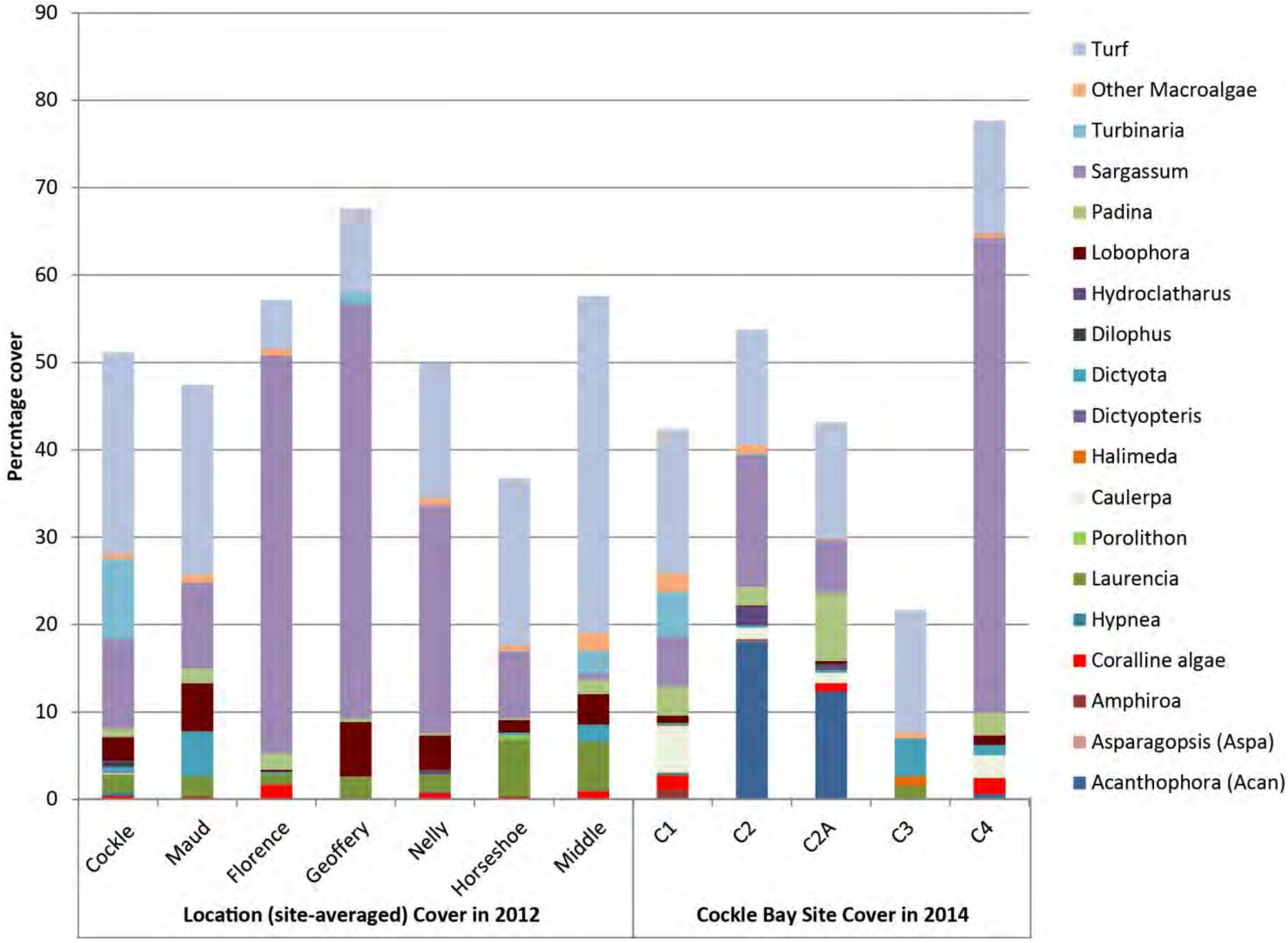


Figure 3-4 Percent cover of macroalgal forms at Cockle Bay Reef Sites (C1-C4) and sites visited previously

Other benthic classes (Figure 3-5) also differed between Cockle Bay Reef sites and other sites surveyed in 2012. Seagrass was abundant at sites C2, C2A and C3 (13-27%), but was uncommon at other reef sites. Sand was a dominant form of cover at Site C3, while macroalgal cover much lower compared to other sites, reflecting the lack of a clear reef edge and available hard substrates in this area. Unlike the 2012 survey, no coral bleaching was observed at the additional Cockle Bay sites sampled in 2014. This was not unexpected given the difference in season (and water temperature) between the two events; the 2012 survey was conducted in summer while the 2014 survey occurred in spring.

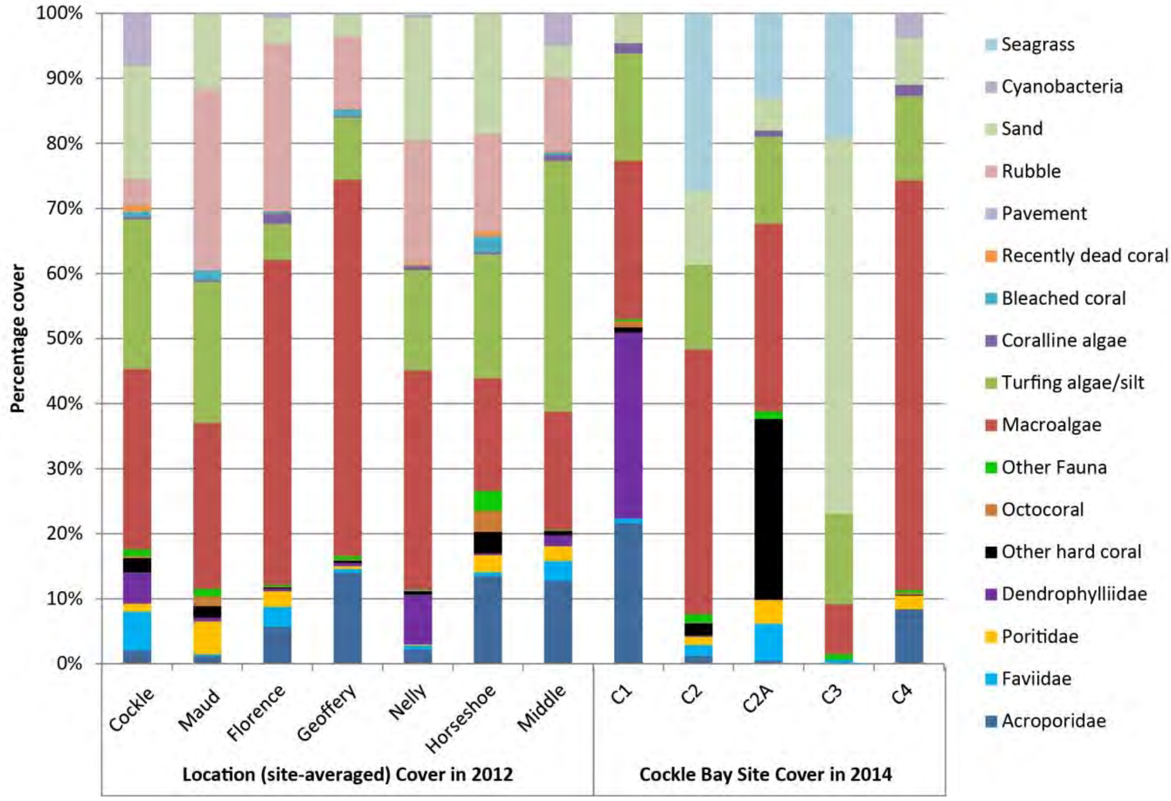


Figure 3-5 Percent cover of major cover types at Cockle Bay Reef Sites (C1-C4) and sites visited previously

3.3 Geoffrey Bay Stromatolite Assessment

3.3.1 Habitat and Ecology

Modern stromatolites are the ancestors of bacteria that began to appear on earth 350 million years ago, and formed the earliest known reefs. They are presently rare on earth and it is hypothesised that predation from early grazers, and competition from macroalgae caused a massive reduction in stromatolite abundance once multi-cellular life evolved (Awramik 1971).

Stromatolites are built by cyanobacteria as a refuge from ultra-violet radiation. Stromatolites grow when sediment particles adhere to the mucus coating the microbial mat. The cyanobacteria then migrate up towards the surface of the accreted sediments and the previous layer of sediment becomes calcified. This cycle repeats, leading to layers of calcified sedimentation, or lamina.

Present day stromatolites generally exist in extreme environments where competitors and grazers cannot live, such as pools that are hypersaline or too warm to support grazing molluscs or competing macroalgae. Hamelin Pool in Shark Bay is one of the best known examples of such a habitat.

The shallow surface waters, particularly of tide pools, surrounding Magnetic Island can exceed 30°C during calm, sunny weather in summer, and excessive evaporation can lead to higher than usual salinity during low tides. However, these extreme conditions only occur at certain times of the year when low tides co-occur with hot, calm, sunny weather.

3.3.2 Survey Findings

Eight points of interest were recorded on transects at Geoffrey Bay intersected (Figure 3-6). Lithified (rocky) structures at points 331, 332, 337, 338, and 341 appeared to be dead coral fragments with microbial/ algal coverings, and those at points 335 and 336 resembled photos supplied by Dr Jane Mellors of potential stromatolites (Figure 3-7). While the structures at points 335 and 336 were covered in a thick microbial mat, they differed greatly in morphology to the dome-shaped structures of Shark Bay in Western Australia. Whether these mounds have been created by microbes (true stromatolites), or if they are microbial coverings on dead coral skeletons could not be ascertained during the field trip (by visual survey alone, without destructive sampling).

Information supplied by Jane Mellors suggests that these structures may be low-profile stromatolite mounds, as personally communicated by John Talent (Emeritus Professor of Geology, Macquarie University) in Farabegoli *et al.* (2007). While there is nothing in the primary literature to suggest that the structures are stromatolites, Macquarie University lecture notes by John Talent refer to them, as do interpretive signs located in Cairns (Figure 3-7J).

Research grants to David Vardeh (PhD candidate at the University of New South Wales) included a provision for analysis of microbial communities from stromatolites at Magnetic Island; however, none of this research has been published to date. Interestingly, research by Shiba *et al.* (1991) examined surface bacterial communities from a range of substrates including stromatolites, coral, sponges, algae, sand, and rocky surfaces across the east and west coasts of Australia. Sites included a range of locations in Shark Bay, including Hamelin Pool in Western Australia, as well as Arcadia, Horseshoe and Radical Bays at Magnetic Island. Shiba *et al.* (1991) did not examine any stromatolite structures from Magnetic Island, but found concentrations of 6.7-20% aerobic bacteriochloropyll containing bacteria (ABB; a type of bacteria that can form stromatolites) in intertidal algal mats from Magnetic Island (exact location unspecified). ABB can live on non-stromatolite surfaces such as rock, algae and other marine plants, but Shiba *et al. (*1991) recorded their highest concentrations in Shark Bay in Western Australia.

Based on the above information, the presence of stromatolites at Geoffrey Bay is possible but inconclusive. The structures could be either low-profile microbial mounds created by cyanobacteria as suggested by John Talent, or they could be weathered coral microatolls covered in turfing algae and cyanobacteria. Sectioning of rock sample and identification of bacterial lamina would be required in this regard. The structures bear little physical resemblance to stromatolites from Shark Bay or the Caribbean, but have been likened to fossilised structures from the Tethys Sea in modern day Italy (John Talent pers. com. in Farabegoli *et al.* 2007).

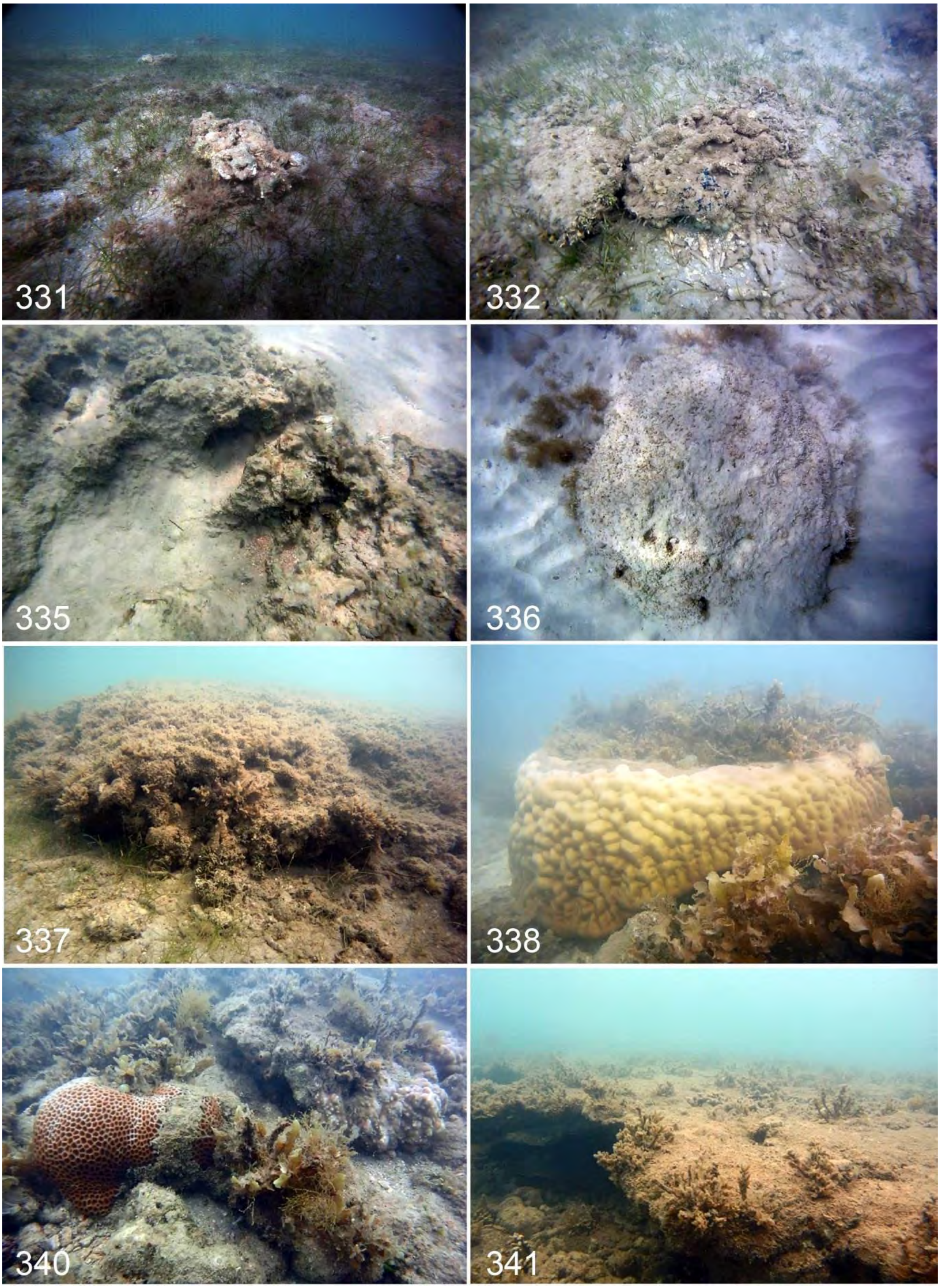


Figure 3-6 Potential stromatolites and microbial mats observed at Geoffrey Bay (see Figure 3-1 for photo locations)

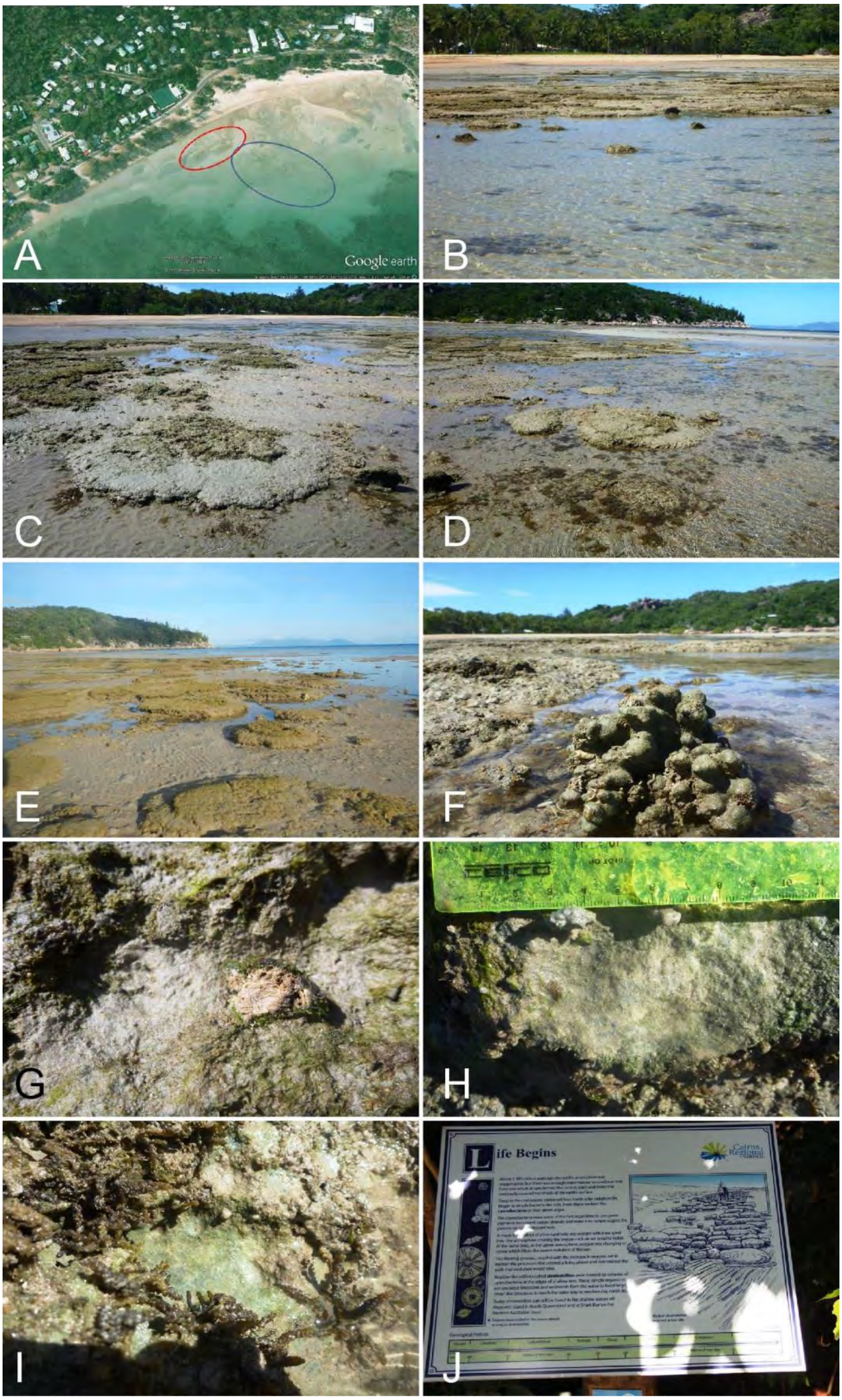


Figure 3-7 Photos of potential stromatolites supplied by Jane Mellors; photo locations (A); structures at low tide (B-E); close-ups (F-I); interpretive signage located in Cairns referencing Magnetic Island stromatolites

4 Benthic Habitat Assessment

In response to submissions on the EIS, the PEP project design was revised as follows:

- The size of the reclamation was increased to accommodate all dredge material (i.e. no unconfined placement of dredge material at sea).
- The channel will be widened (previous design included deepening only).

As such, additional benthic habitat surveys were undertaken at the channel widening areas and the increased reclamation footprint. These benthic habitat surveys included:

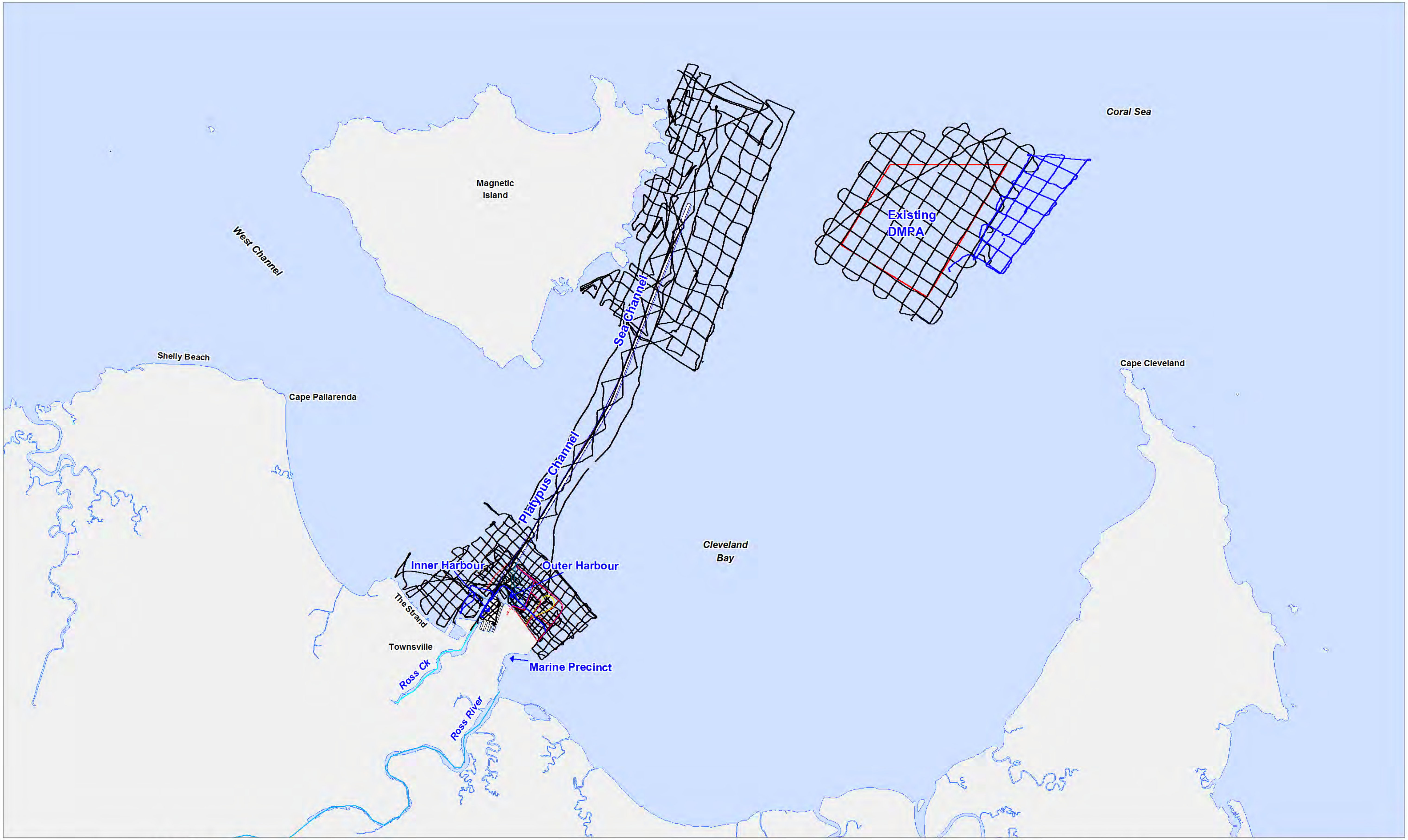
- Acoustic habitat mapping.
- Underwater video survey.
- Benthic grab samples.

4.1 Data Collection

Data were collected with the same methodologies used in the EIS. Acoustic records were collected on September 27th, 2014, and were analysed with the QTC software suite as previously described.

Of the 15,271 acoustic records collected, 12,995 had cluster confidences >95% and these were retained. Data collection parameters were set to those used in 2011 and 2012. Lines for additional data collection are shown in Figure 4-1. Some new data was collected over the previous line work to better facilitate comparison between the two datasets.

Benthic community data were collected using a combination of grab-sampling (0.028m^2 van Veen, *n*=4 per site) and drop camera observations as per the methods used in the EIS. The locations of benthic infaunal sites, PSD sites and drop camera (epifauna) investigation sites collected during the EIS process and during the present additional studies are shown in Figure 4-2.



LEGEND

Existing DMPA

Reclamation Area

Channel Extents

Acoustic Transects

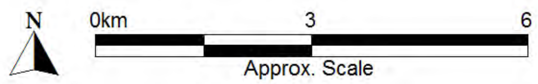
- Data Points 2010-12
- Data Points 2014

Title:

Locations of acoustic transects from 2010 to 2014

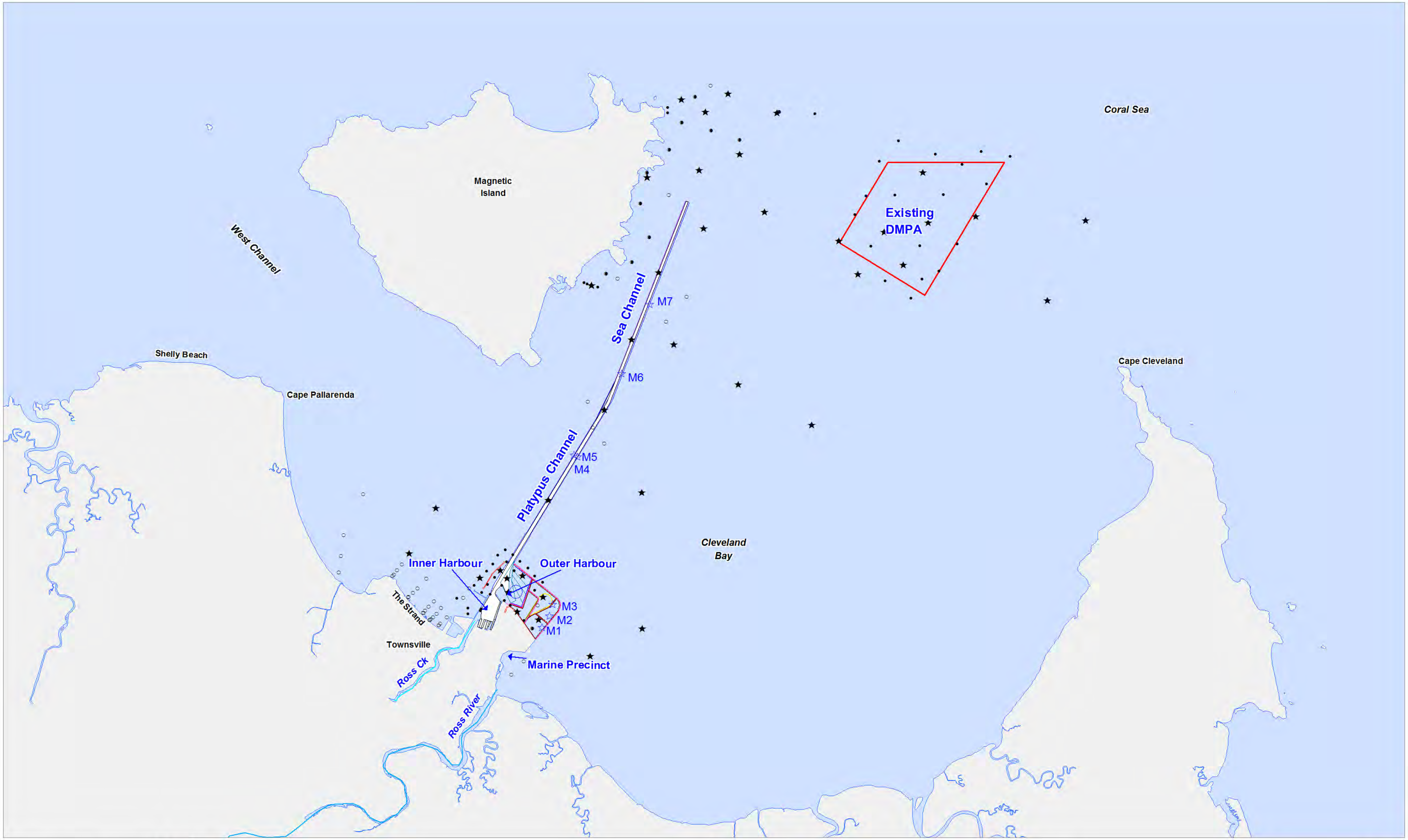
Figure: 4-1

Rev: B



BMT WBM
www.bmtwbm.com.au

Filepath : I:\B21057.I.bmg_PEP\DRG\ECO_004b_160329_Acoustic_methods.wor



LEGEND

- Existing DMPA
- Reclamation Area
- Channel Extents

Benthic Sites

- Video Sites 2012
- PSD Sites 2012
- Infauna, PSD, and Video Sites 2012
- Infauna Sites 2014

Title:

Locations of video transects, epifauna and infauna sampling sites (2012-2014)

Figure: 4-2

Rev: B

N

0km 3 6

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B21057.I.bmg_PEP\DRG\ECO_003b_160329_EcologySurveySites_3.wor

4.2 Acoustic Habitat Mapping

The 2014 acoustic data showed strong agreement with the 2010 dataset (Figure 4-3) - the original 2010 survey collected data in the region shown in Figure 4-1.

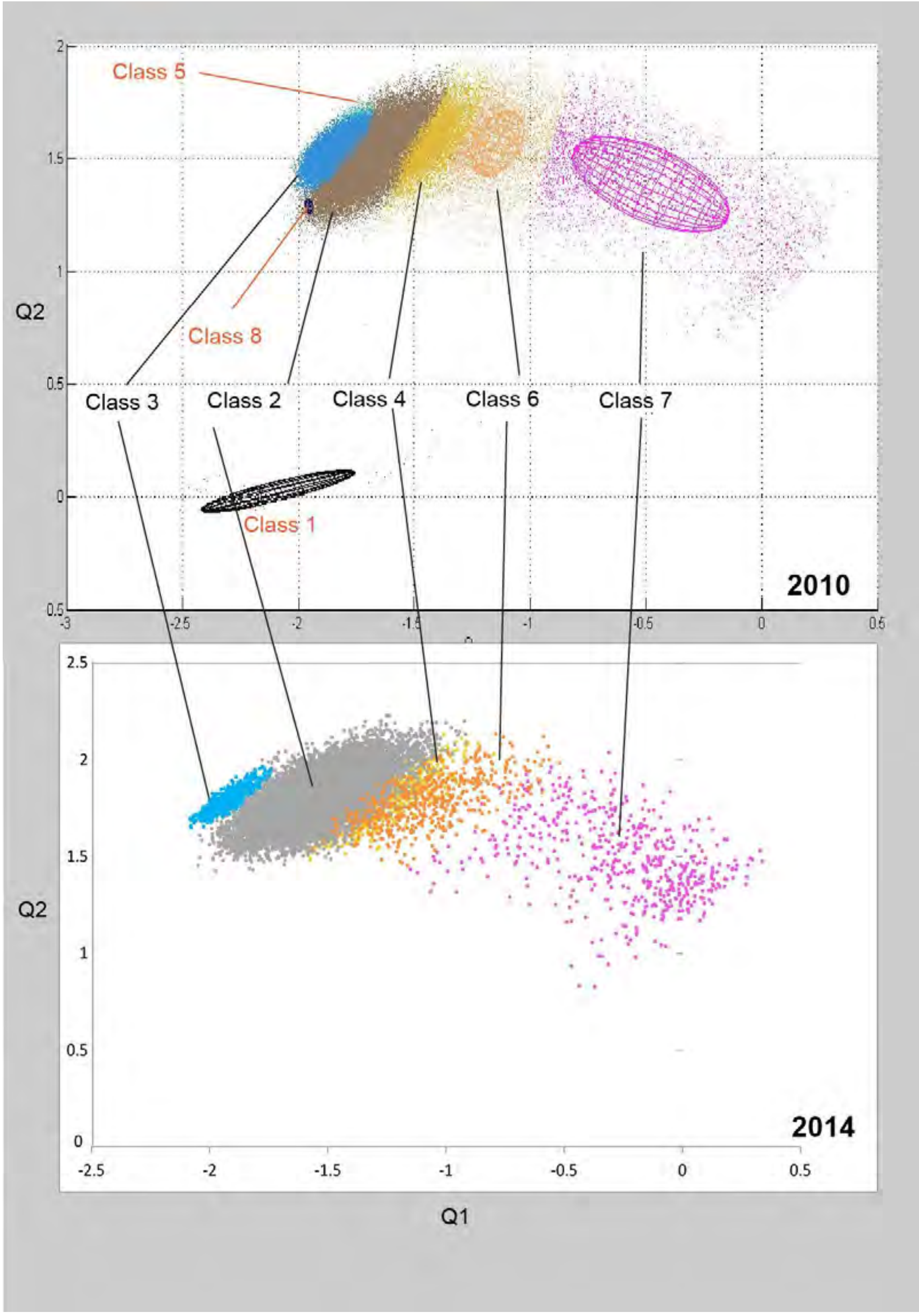
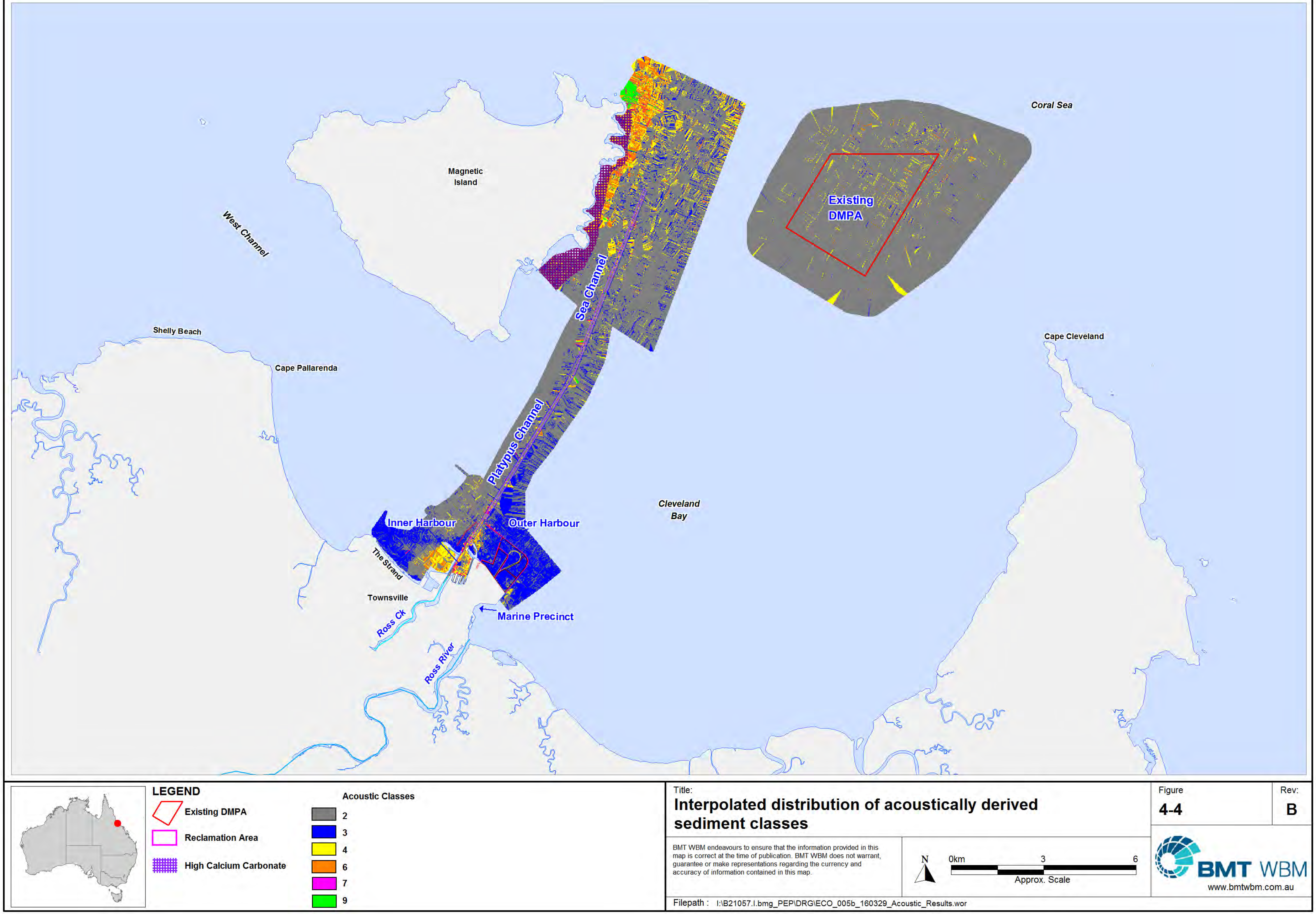


Figure 4-3 Clustering of the 2010 and 2014 datasets showing the five significant acoustic classes common to both sampling events

As shown in Figure 4-4, acoustic habitat classes in the channel widening areas were composed primarily of class 2 and 3 sediments, with occasional class 4 and 6 sediments. This corresponded to a primarily silty mud substrate with occasional sandier patches, generally with high plasticity and occasional larger gravel-sized pieces.

The acoustic habitat class in the reclamation footprint area was relatively uniform across the area, composed primarily of class 3 sediments. This corresponded to primarily silty substrate.

There were no areas of reef or harder substrate, such as gravel beds or sand ridges, located in or adjacent to the channel widening areas or the reclamation footprint.



Title:

Interpolated distribution of acoustically derived sediment classes

Figure 4-4

Rev: B

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B21057.I.bmg_PEP\DRG\ECO_005b_160329_Acoustic_Results.wor

4.3 Epibenthic Communities

Sites adjacent to the existing channel area, within the channel widening footprint (M4-M7) had sparse epifaunal communities (Figure 4-5). While visibility was low, conditions were sufficient to determine that sessile epifaunal communities (such as corals and sponges) were absent, with small to medium sized burrows (most likely goby burrows) occasionally observed. These results were similar to that of the EIS, which depicted similar sparse communities over the existing DMPA and channel extension areas.

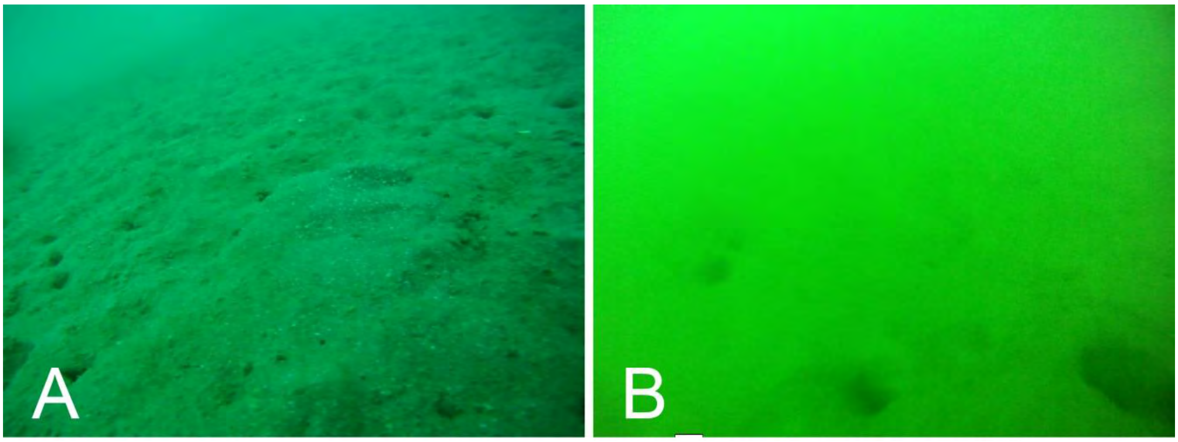


Figure 4-5 Screen captures from the channel widening area: bioturbation with slight surface dimpling at site M7 (A); poor visibility and burrows at site M6 (B).

4.4 Infaunal Communities

Infaunal communities collected during the EIS and in September 2014 had similar compositions of major taxanomic groups with polychaetes and crustaceans generally numerically dominating samples (Figure 4-6). There were substantially more "other" fauna collected during the EIS, and these consisted of peanut worms, sipunculids, blind gobies, and branchiotsomids (lancelets).

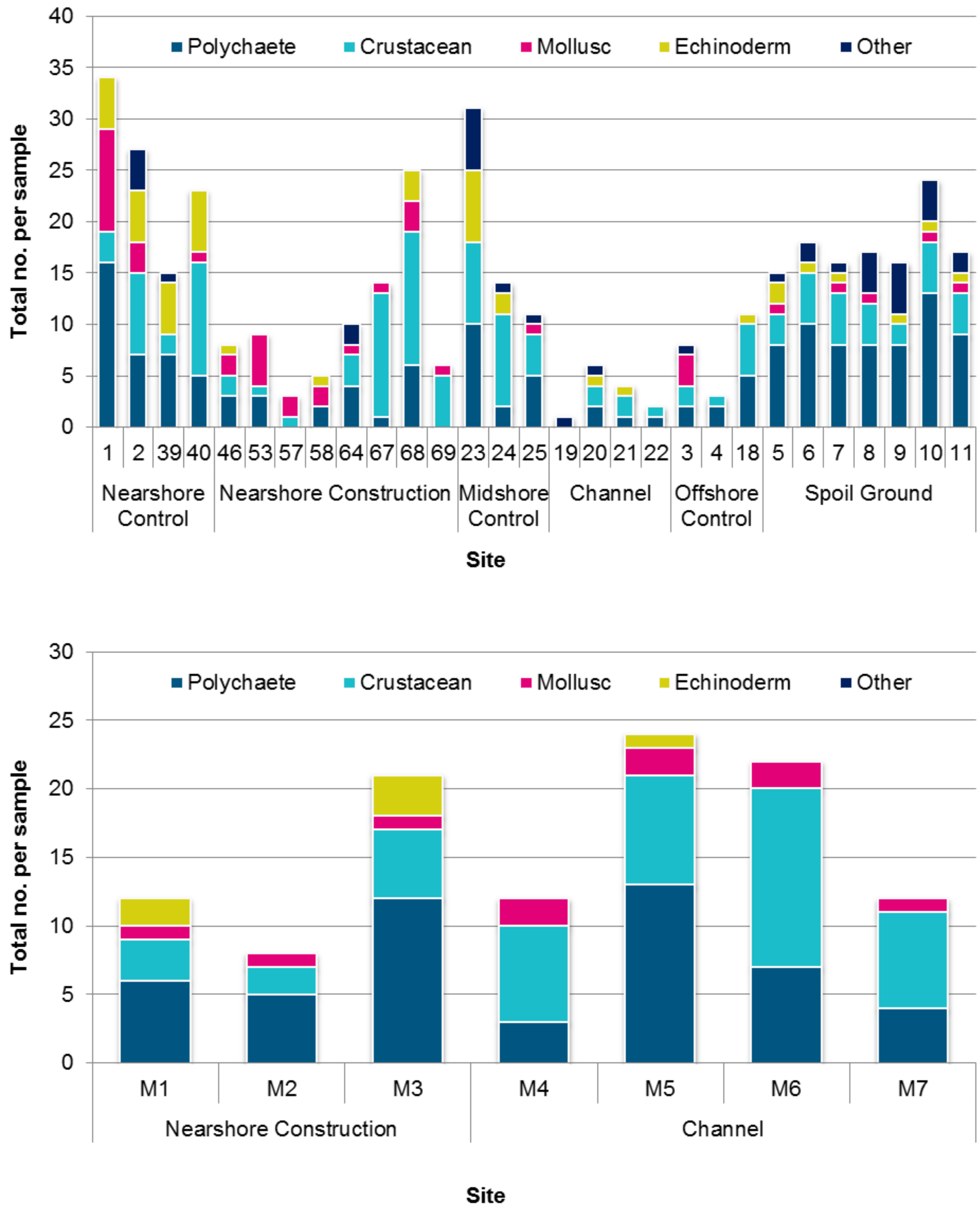


Figure 4-6 Composition of infaunal communities collected in 2012 (above) and in 2014 (below)

While there were fewer minor phyla observed in the 2014 survey, taxonomic richness was generally similar between the two events, within representative areas (Figure 4-7). The nearshore construction area had an average of between 2-3 taxa per site in the EIS while taxonomic richness ranged between about 2-4 individuals in 2014. Taxonomic richness was higher in the channel widening area in 2014 than it was in the channel area during the EIS; however, it should be noted that the channel widening area represents a relatively undisturbed habitat compared to the channel area which undergoes maintenance dredging.

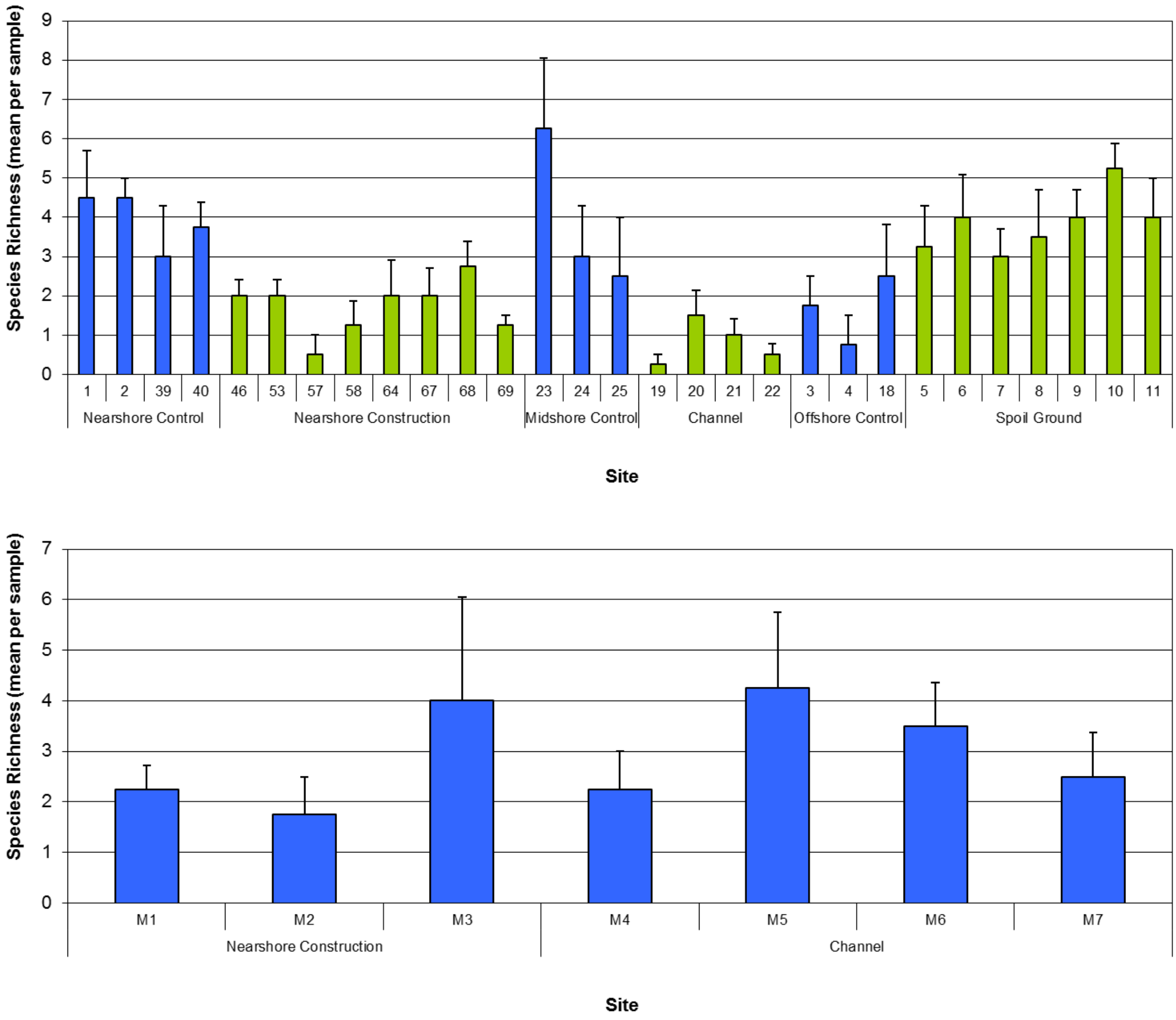
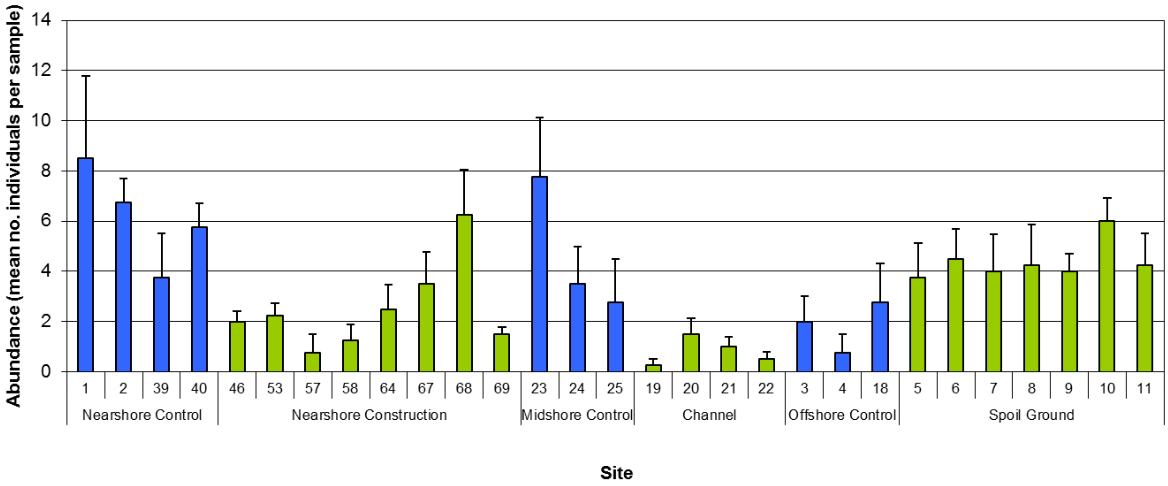


Figure 4-7 Mean (± SE) species richness of infaunal communities collected in 2012 (above) and in 2014 (below)

Patterns in taxonomic richness among representative areas and sampling events were very similar to those observed for overall abundance, with the nearshore construction area having the lowest abundance, followed by the channel widening area, and the DMPA had the most abundant communities (Figure 4-8).

It should be noted that some of the differences among the new sampling locations and those sampled during the EIS are likely due to temporal variation between events, and between the time of year that samples were collected. Despite this variability, the patterns in abundance, richness, and high-level community composition were relatively similar between the two sampling periods.



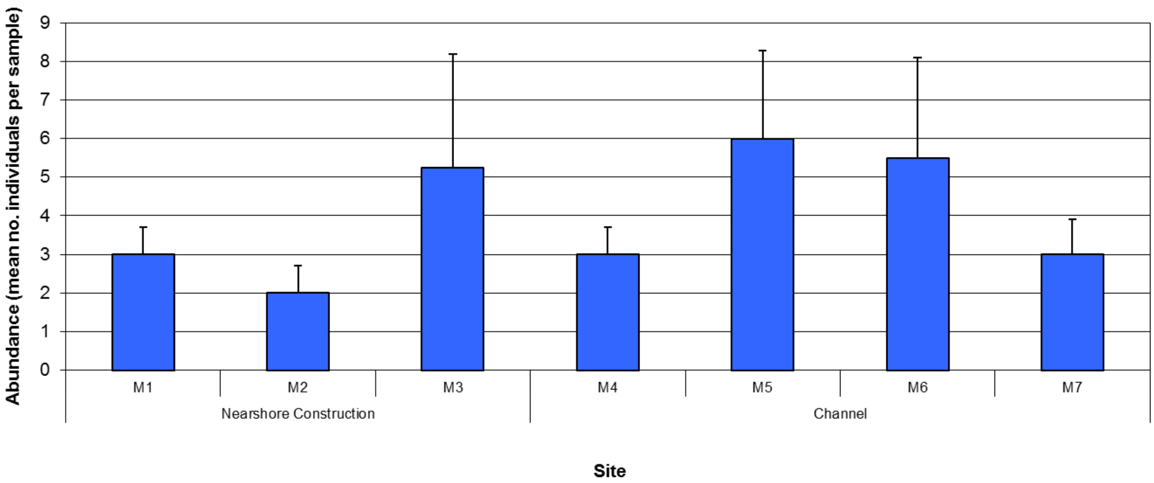


Figure 4-8 Mean (± SE) abundance of infaunal communities collected in 2012 (above) and in 2014 (below)

5 References

Awramik SM (1971) Precambrian columnar stromatolite diversity: Reflection of Metazoan Appearance. *Science* 174: 825-827. [DOI:10.1126/science.174.4011.825].

Chartrand KM, R. P. (2012). Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program. Cairns: State of Queensland (Department of Agriculture, Forestry and Fisheries).

Collier C.J., Waycott M., Ospina A.G. (2012a) Responses of four indo-west pacific seagrass species to shading. Marine Pollution Bulletin 65:342-354.

Collier C.J., Waycott M., McKenzie L. (2012b) Light thresholds derived from seagrass loss in the coastal zone of the northern great barrier reef, Australia. Ecological Indicators 23:211-219.

Farabegoli E, Perri MC, Posenato R (2007) Environmental and biotic changes across the Permian–Triassic boundary in western Tethys: The Bulla parastratotype, Italy. *Global and Planetary Change*, 55: 109-135.

Kohler, KE, Gill, SM (2006) Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Computers and Geosciences, 32: 1259–126.

Shiba T, Shioi Y, Takamiya K-I, Sutton DC, Wilkinson CR. (1991) Distribution and Physiology of Aerobic Bacteria Containing Bacteriochlorophyll a on the East and West Coasts of Australia. *Applied and Environmental Microbiology* 1991;57: 295-300.

Appendix A Particle Size Distribution Data

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: EB1444213	&'(%	) ÀĀ+Ā
123%4/	) **BMT WBM GROUP LTD**	-'.*#'/*#0	) 5463#*47%4/'2Ā836393*4Ā:#39.'4%
1*4/';/	) <=Ā:=>8Ā?=>@"	1*4/';/	) 1$9/*7%#ĀA%#63;%9Ā5:
>BB#%99	) &CĀ:CDĀ,!EĀA&=F@?ĀGF-- :=FA:>@5ĀH-8ĀI!!I	>BB#%99	) ,Ā:0/JĀA/#%%/ĀA/'++*#BĀH-8Ā>$9/#'23'ĀI!KE
5L7'32	) .#'B (#'4/M.7/N.7 ;*7 '$	5L7'32	) >-A5463#* :#39.'4%M'29(2*.'2 ;*7
"%2%OJ*4%	) PQÀĀ!RĀESEÀĀQRII	"%2%OJ*4%	) PQÀLRLE,IEĀR,,,
T';93732%	) PQÀĀ!RĀESE,ĀEQ,R	T';93732%	) PQÀLRLE,IEĀR,ĀS
&#*U%;/	) :,Ā!KR	H1Ā-%6%2	) @5<Ā,!ÀEĀĀA;J%B$2%Ā:VEWĀ'4BĀ>-AĀH1AEĀ#%X$3#%7%4/
C#B%#Ā4$7.%#	) LLLL	8'/%ĀA'7O2%9Ā=%;%36%B	) ĀELC;/L,!ĀIĀĀ,)IK
1LCL1Ā4$7.%#	) LLLL	8'/%Ā>4'20939Ā1*77%4;%B	) ĀRLC;/L,!ĀI
A'7O2%#	) 1C@C=ĀYC@5A	F99$%Ā8'/%	) ,,LC;/L,!ĀIĀĀS),R
A3/%	) LLLL		
		@* Ā*+Ā9'7O2%9Ā#%;%36%B	) I
H$*/%Ā4$7.%#	) LLLL	@* Ā*+Ā9'7O2%9Ā'4'209%B	) I

"J39Ā#%O*#/Ā9$O%#9%B%9Ā'40ĀO#%63*$9Ā#%O*#/V9WĀ%3/<Ā/J%Ā9$2%Ā#%+%#%4*Ā/J%Ā9'7O2%V9WĀ'9Ā9$.73//%B ĀĀ

"J39Ā1%#/3+3;'/%Ā*+Ā>4'20939Ā;*4/'349Ā/J%Ā+*22*N34(Ā34+*#7'/3*4

- ?%4%#'2Ā1*77%4/9
- >4'20/3;'2Ā=%9$2/9

NATA WORLD RECOGNISED ACCREDITATION

@>">Ā>;;#%B3/%BĀ-'.*#'/*#0ĀS,K

>;;#%B3/%BĀ+*#Ā;*7O23'4;%ĀN3/JĀ FAC[F51ĀĀR!,K

Signatories

"J39Ā B*;$7%4/Ā J'9Ā .%%4Ā%2%;/#*43;'220Ā93(4%BĀ0Ā /J%Ā'$/J*#3Z%BĀ93(4'/*#3%9Ā34B3;'/%BĀ %2*N Ā62%;/#*43;Ā93(434(ĀJ'9Ā . %%4 ;'##3%BĀ*$/Ā34Ā;*7O23'4;%ĀN3/JĀO#*;%B$#%9Ā9O%;3+3%BĀ34Ā,ĀĀ1T=Ā&

Signatories	*Position*	*Accreditation Category*
G'739JĀ<$##'0	A$O%#639*#ĀLĀA*329	@%N;'9/2%ĀLĀF4*#('43;9

General Comments

"J%Ă'4'20/3;'2Ă O#*;%B$#%9Ă9%BĂ0Ă /J%Ă5463#*47%4/'2Ă836393*4Ă' 6%Ă %%4ĂB%6%2*O%BĂ7Ă %9/'.239J%BĂ4/%#4'/3*4'220%;*(43Z%BĂO#*;%B$#%9Ă;JĂ '9Ă /J*9%ĂO$.239J%BĂ0Ă /J%Ă^ A5&>_Ă>&G>_Ă>AĂ '4BĂ @5&< Ă F4Ă J*$9%Ă B%6%2*O%BĂO#*;%B$#%9Ă'#%Ă%7O2*0%BĂ34Ă/J%Ă'.9%4;%Ă0Ă'#B#37%#Ă0Ă23%4/Ă#%X$%9/

\J%#%Ă7*39/$#%ĂB%/%#734'/3*4ĂJ'9Ă.%%4ĂO%#+*#7%B_Ă#O%*9$#9Ă*#%ĂB#0ĂN%3(J/Ă.'939

\J%#%Ă'Ă#%O*#/%BĂ2%99Ă/J'4ĂV`WĂ#%9$2/Ă39ĂJ3(J%#Ă39ĂA0%ĂB$%Ă/*ĂO#37'#0Ă9'7O2%Ă%a/#';/[B3(%9/'/%ĂB3#$/34Ă4B3;3%4/Ă9'7O2%Ă+*#Ă'420939

\J%#%Ă/J%Ă-C=Ă*+Ă'Ă#%O*#/%BĂ#%9$2/ĂB3++%#9Ă+#*7Ă/J%Ă#%9$2/ĂB%Ă/*ĂJ3(JĂ7*39/$#%Ă;*4/%4/_Ă349$++3;3%4/Ă9'7O2%Ă*#Ă/J%Ă7O2*0%BWĂ*#Ă7'/#3aĂ34/%#+%#%4;%

\J%4Ă9'7O234(Ă/37%Ă34+*#7'/3*4Ă39Ă4*/ĂO#*63B%BĂ.0Ă/J%Ă;23%4/_Ă9'7O234(ĂB'/%9ĂJ*N4ĂN3/J*$/Ă'Ă/37%Ă;*7O*4%4/ ĂĂF4Ă/J%9%Ă349/'4;%9_ĂĂ/37%Ă;*7O*4%4/ĂJ'9Ă.%%4Ă'99$7%BĂ.0Ă/J%Ă2'.*#'/*#0Ă+*#ĂO$#O*9%9

d%0Ă) 1>ĂĂ@$7.%#ĂbĂ1>ĂĂ#%(39/#0Ă4$7.%#Ă+#*7ĂB'/'.'9%Ă7'34/'34%BĂ.0ĂA2Ă>.9/#';/9ĂA%#63;%9 Ă"J%Ă1J%73;'2Ă>.9/#';/9ĂA%#63;%Ă3939Ă'Ă*+Ă/J%Ă>7%#3;'4Ă1J%73;'2ĂA*;3%/0
-C=ĂbĂ-373/Ă*+Ă#%O*#/34(
^ĂbĂ"J39Ă#%9$2/Ă39Ă;*7O$/%BĂ+#*7Ă34B363B$'2Ă'4'20/%ĂB%/%;/3*4ĂĂ2%6%2Ă*+Ă#%O*#/34(
cĂbĂ>-AĂ39Ă4*/Ă@>">Ă';;#%B3/%BĂ+*#Ă/J%9%Ă/%9/9

Analytical Results

A$.L<'/#3a: SOIL (<'/#3a: SOIL)			Client sample ID	M8	M9	M10	M11	----
			Client sampling date / time	eĂELC;/L,!ĂIf	eĂELC;/L,!ĂIf	eĂELC;/L,!ĂIf	eĂELC;/L,!ĂIf	LLLL
Compound	*CAS Number*	*LOR*	*Unit*	EB1444213-001	EB1444213-002	EB1444213-003	EB1444213-004	--------
				=%9$2/	=%9$2/	=%9$2/	=%9$2/	=%9$2/
EA150: Particle Sizing								
+75µm	LLLL	Ă	g	66	66	69	70	----
+150µm	LLLL	Ă	g	54	52	54	55	----
+300µm	LLLL	Ă	g	22	17	16	20	----
+425µm	LLLL	Ă	g	10	9	8	11	----
+600µm	LLLL	Ă	g	5	5	4	6	----
+1180µm	LLLL	Ă	g	2	2	2	2	----
+2.36mm	LLLL	Ă	g	`Ă	1	`Ă	`Ă	----
+4.75mm	LLLL	Ă	g	`Ă	`Ă	`Ă	`Ă	----
+9.5mm	LLLL	Ă	g	`Ă	`Ă	`Ă	`Ă	----
+19.0mm	LLLL	Ă	g	`Ă	`Ă	`Ă	`Ă	----
+37.5mm	LLLL	Ă	g	`Ă	`Ă	`Ă	`Ă	----
+75.0mm	LLLL	Ă	g	`Ă	`Ă	`Ă	`Ă	----
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	LLLL	Ă	g	34	34	31	30	----
Sand (>75 µm)	LLLL	Ă	g	66	65	68	70	----
Gravel (>2mm)	LLLL	Ă	g	`Ă	1	1	1	----
Cobbles (>6cm)	LLLL	Ă	g	`Ă	`Ă	`Ă	`Ă	----

BMT WBM

BMT WBM Bangalow	6/20 Byron Street, Bangalow 2479 Tel +61 2 6687 0466 Fax +61 2 66870422 Email bmtwbm@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Brisbane	Level 8, 200 Creek Street, Brisbane 4000 PO Box 203, Spring Hill QLD 4004 Tel +61 7 3831 6744 Fax +61 7 3832 3627 Email bmtwbm@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Denver	8200 S. Akron Street, #B120 Centennial, Denver Colorado 80112 USA Tel +1 303 792 9814 Fax +1 303 792 9742 Email denver@bmtwbm.com Web www.bmtwbm.com
BMT WBM London	International House, 1st Floor St Katharine's Way, London E1W 1AY Email london@bmtwbm.co.uk Web www.bmtwbm.com
BMT WBM Mackay	PO Box 4447, Mackay QLD 4740 Tel +61 7 4953 5144 Fax +61 7 4953 5132 Email mackay@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Melbourne	Level 5, 99 King Street, Melbourne 3000 PO Box 604, Collins Street West VIC 8007 Tel +61 3 8620 6100 Fax +61 3 8620 6105 Email melbourne@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Newcastle	126 Belford Street, Broadmeadow 2292 PO Box 266, Broadmeadow NSW 2292 Tel +61 2 4940 8882 Fax +61 2 4940 8887 Email newcastle@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Perth	Level 3, 20 Parkland Road, Osborne, WA 6017 PO Box 1027, Innaloo WA 6918 Tel +61 8 9328 2029 Fax +61 8 9486 7588 Email perth@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Sydney	Level 1, 256-258 Norton Street, Leichhardt 2040 PO Box 194, Leichhardt NSW 2040 Tel +61 2 8987 2900 Fax +61 2 8987 2999 Email sydney@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Vancouver	Suite 401, 611 Alexander Street Vancouver British Columbia V6A 1E1 Canada Tel +1 604 683 5777 Fax +1 604 608 3232 Email vancouver@bmtwbm.com Web www.bmtwbm.com