LINDEMAN GREAT BARRIER REEF RESORT PROJECT

ENVIRONMENTAL IMPACT STATEMENT

APPENDIX X - BMT WBM MARINE ECOLOGY REPORT

Addendum: This EIS was initially prepared assuming that the safe harbour was to be part of the Lindeman Great Barrier Reef Resort Project. With the commencement of the Great Barrier Reef Marine Park Authority's (GBRMPA) Dredging Coral Reef Habitat Policy (2016), further impacts on Great Barrier Reef coral reef habitats from yet more bleaching, and the recent impacts from Tropical Cyclone Debbie, the proponent no longer seeks assessment and approval to construct a safe harbour at Lindeman Island. Instead the proponent seeks assessment and approval for upgrades to the existing jetty and additional moorings in sheltered locations around the island to enable the resort's marine craft to obtain safe shelter under a range of wind and wave conditions. Accordingly, remaining references to, and images of, a safe harbour on various figures and maps in the EIS are no longer current.

Lindeman Island Resort Safe Harbour and Temporary Barge Access: Marine Ecology Survey

Reference: R.B20346.002.00.Marine Ecology.docx
Date: October 2013
Confidential

Lindeman Island Resort Safe Harbour and Temporary Barge Access: Marine Ecology Survey

Prepared for:	White Horse Australia
Prepared by:	BMT WBM Pty Ltd (Member of the BMT group of companies)

Offices

Brisbane
Denver
London
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver

Document Control Sheet

BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane 4000
Queensland 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.B20346.002.00.Marine Ecology.docx
Title:	Lindeman Island Resort Safe Harbour and Temporary Barge Access: Marine Ecology Survey
Project Manager:	Lyn Léger
Authors:	Daniel Moran, Conor Jones
Client:	White Horse Australia
Client Contact:	Paul Nyholt
Client Reference:	Contract 4th July 2013

Synopsis: **This report provides a constraint-based site-selection for the development of a safe harbour and temporary barge access associated with the redevelopment of Lindeman Island. The marine ecology, habitat characteristics, and potential impacts of development at these sites are described.**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	25/10/2013		Darren Richardson		Conor Jones

DISTRIBUTION

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

Executive Summary

White Horse Australia (WHA) purchased Lindeman Island Resort and intends to develop it and integrate the resort with a residential community. The proposed development includes an upgrade to the marine facilities and establishment of a safe harbour and temporary barge access for movement of materials and equipment during the construction phase.

Maritime access is currently *via* a south-east facing fixed jetty which is difficult and unsafe to use in an animated sea state. Establishment of a safe harbour is critical for emergency evacuation scenarios. Based on environmental and engineering constraint investigations, the existing jetty area was considered the least constrained location from the perspectives of required approvals, finance, and based on engineering design to the extreme weather events. After investigating potential locations for the safe harbour, three design options were proposed that utilised existing infrastructure and attempted to reduce the footprint of the harbour and the costs of construction.

Desktop-based marine ecology, legislative, and marine ecology constraint mapping was performed to evaluate the relative suitability of a range locations around Lindeman Island as potential safe harbour locations. These studies modelled extreme weather events to determine preliminary design heights, provided cost implications of safe harbour designs, and described legislative and marine ecology constraints to safe harbour development. All assessment criteria suggested that the area surrounding the existing jetty was best site for safe harbour development, while temporary barge access would be possible at a range of potential locations.

Preliminary marine ecology field surveys were conducted at five study regions which included the existing jetty location, Boat Port and at range of other potential barge landing sites on the northern, western and eastern sides of the island. Rapid assessment methods were used to map and quantify benthic habitats and communities at each site. A total of 167 spot dives were undertaken across the five study regions. Bathymetry data were collected and interpolated to give a Digital Elevation Model (DEM), as were spatial distributions for per cent cover values of hard corals, soft corals, seagrass, and macroalgae to give “heat maps” of benthic cover.

The highest density living coral communities were found on the reef directly south of the jetty and surrounding the existing dredged channel. Other reef areas generally had sparse living coral communities consisting of coral skeletons dominated by macroalgae or sand and rubble substrates.

Following the field assessment, three safe harbour design options were created at the jetty location to utilise existing infrastructure and minimise impacts to corals. Direct loss of macroalgal and seagrass communities within and adjacent to the proposed design option footprints will not be likely to constitute a major impact due to the small extent of seagrass to be affected, and the extreme abundance of macroalgae elsewhere.

The extent of significant living coral communities present within the proposed design option footprints at the jetty site will likely represent a point of concern for GBRMPA given their emphasis on the preservation of corals and other habitats of biodiversity significance. Of the three layouts considered, Options 1 and 2 had the advantage of affecting areas already disturbed by the existing dredged channel, jetty, and ramp infrastructure. While the footprint of Option 3 had lower coral cover that at Options 1 and 2, this area was in a largely undisturbed condition.

Seagrass and coral communities of Boat Port (and Gap Beach to a lesser degree) are situated offshore from beach landing site and would not likely be degraded by a regular high-tide barge service. While there will need to be management of impacts to turtle nesting and human users of the site, the distribution of seagrasses and corals, and the derived bathymetry at Boat Port are not prohibitive to the establishment of the high-tide barge access. Depending on where the road access point meets the beach, there may be some marine plant disturbances (mangroves) required.

It is recommended that consultation with GBRMPA occur prior to any further re-configuration or field work to determine their preferences for design modification, mitigation, or offsetting within the realised limitations of the project. Other construction and operational impacts can foreseeably be mitigated and are not likely to represent significant challenges to the project.

Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

White Horse Australia (WHA) purchased Lindeman Island Resort in August 2012 and intends to develop the island as a premium tourist resort and integrated residential community. As part of this development, an upgrade to the marine facilities is proposed through the establishment of a safe harbour.

Maritime access is currently *via* a south-east facing fixed jetty which is difficult to access in an animated sea state and this is unacceptable on comfort and safety grounds, even for large ferries. There are concerns regarding the use of this access in cyclones or other emergency evacuation scenarios. For these reasons, establishment of a safe harbour is critical.

Barge access is also required for movement of materials and equipment during the construction phase, away from the reconstructed resort area. Depending on the final location of the barge loading site, unloaded material is proposed to be transported along existing roads, the golf course, and potentially via an access track (to be developed from an existing hiking track).

Landing of the barge at high tide along the beach allows for operations to be undertaken without any need to construct infrastructure or for blasting/dredging of the fringing reef. The only construction activities would be associated with the development of access tracks linking the beach to the golf course. These terrestrial activities are outside the scope of this report.

BMT WBM performed an initial desktop constraints study that investigated the engineering, legislative, and likely marine ecology constraints to the development of a safe harbour and temporary barge landing at a range of locations around Lindeman Island (Figure 1-1). The full details of the marine engineering components are provided in BMT WBM (2013; ref. R.B20346.003.00Engineering.docx), and a summary of the legislative and marine ecology constraints are provided in Section 2. All assessment criteria suggested that the area surrounding the existing jetty was the best site for safe harbour development, while temporary barge access would be possible at a range of potential locations.

These locations were then surveyed in greater detail to describe marine habitats and potential impacts of various aspects of development. After investigating potential sites for the safe harbour, a design was proposed that utilised existing infrastructure and attempted to reduce the footprint of the harbour (Figure 1-2). This design was modified subsequently into three different options to investigate how re-configuration might reduce footprint impacts.

This report presents the results of preliminary marine ecology survey that was conducted at Lindeman Island in relation to the proposed safe harbour development at the existing jetty location (Figure 1-2), and potential temporary barge access sites at Boat Port and at range of other potential barge landing sites on the northern, western and eastern sides of the island. Recommendations on the location and design of the proposed safe harbour and temporary barge landing site have been presented based on potential impacts to the marine environment.

LEGEND

Approximate Locations of Seawalls

Title:

Lindeman Island Locality Plan and Study Locations

Figure: 1-1

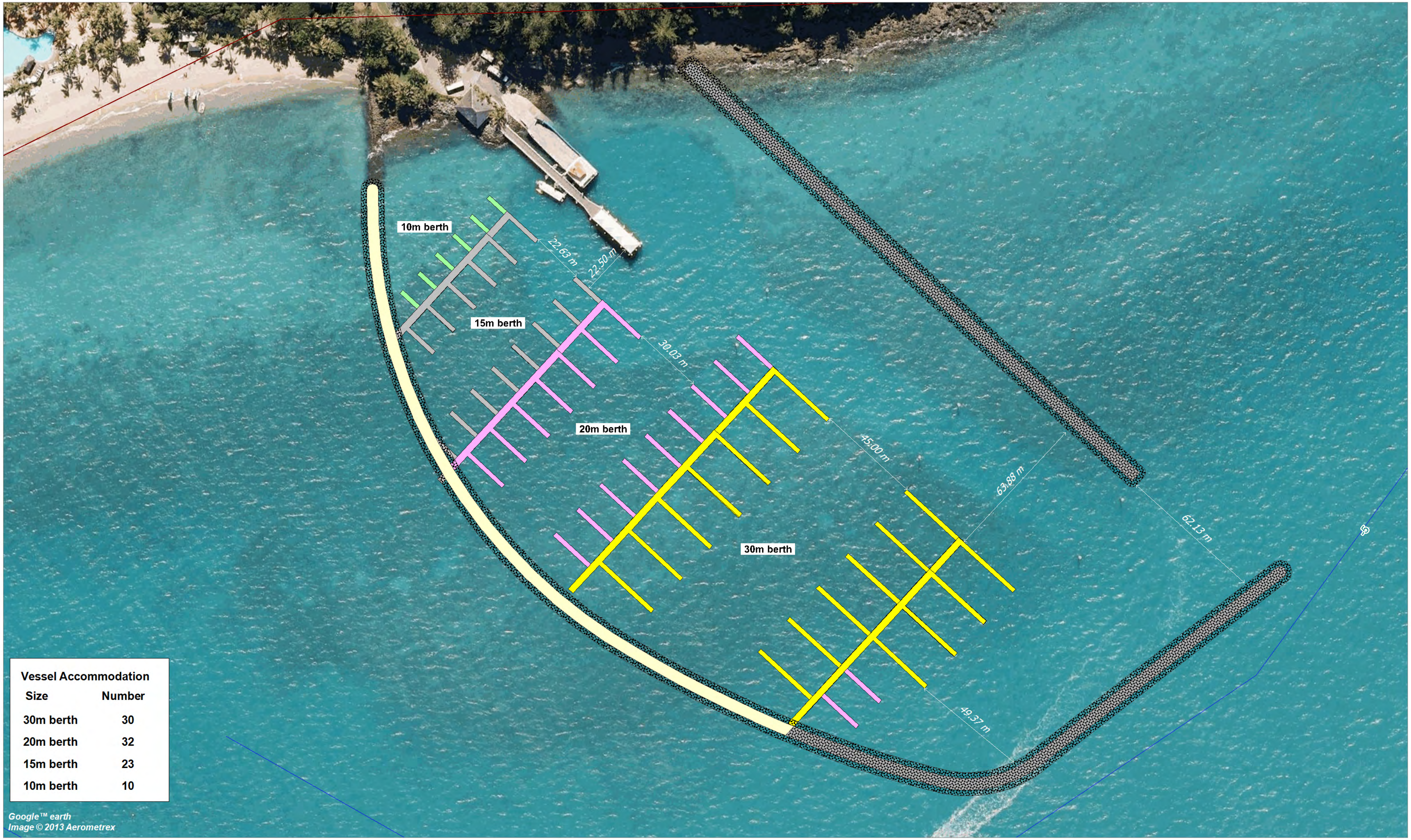
Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N 0 0.5 1km
Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_016_131008_Locality.wor



Vessel Accommodation

Size	Number
30m berth	30
20m berth	32
15m berth	23
10m berth	10

LEGEND

Berth Fingers

- 30m
- 20m
- 15m
- 10m

- Seawall
- Walkway

Contours

- Land
- Bathymetry

Title:

Proposed Safe Harbour Development at the Existing Jetty Site, Option 1

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 25 50m
Approx. Scale

Figure: **1-2**

Rev: **D**

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\GIS_010_131002_30m_Lindeman_South_Marina_revD.wor

1.2 Study Aims and Objectives

The study was undertaken in two stages:

- A preliminary desk-top assessment of environmental and legislative constraints; and
- A more detailed ecological assessment and field investigtation.

The aim of the desktop constraint mapping exercise was to identify and assess environmental and legislative constraints that need to be considered in the selection of a safe harbour and temporary barge landing site.

The aim of the ecological assessment was to characterise and map marine communities and habitats at and adjacent to the proposed safe harbour and potential temporary barge landing locations, in order to refine the initial desk-top based constraints assessment. The specific objectives of this component were to:

- Undertake mapping of marine habitats and communities to ground-truth the findings of the desk-top constraints assessment.
- Provide supplementary information that will be required to support preliminary development approval documentation (i.e. maps and other information required for EPBC Act Referral).
- Provide input to the design team for the safe harbour and temporary barge access in order to minimise environmental impacts.

Note that while the information collected in this field assessment is sufficient to inform (for example) a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), it has not been scoped to provide a comprehensive baseline as would be required for EIS reporting purposes. In this regard, it would be expected that more detailed analysis of collected data and possibly additional (seasonal) surveys would be required to satisfy EIS reporting requirements.

1.3 Study Area Context

Lindeman Island is an island in the Lindeman Island Group of the Whitsunday Islands off the central coast of Queensland. It is an area of high ecological value and is of recognised conservation significance.

Areas of high conservation significance that occur in the study area include:

- Great Barrier Reef Marine Park (GBRMP) Conservation Zone and Public Appreciation areas (the latter having site specific management requirements).
- GBR World Heritage Area (WHA) and National Heritage Place.
- The terrestrial area of Lindeman Island is also protected as part of the Lindeman Islands National Park, with the exception of the excised area of the resort.

2 Desktop Constraints Assessment

2.1 Marine Engineering Constraint Summary

BMT WBM (2013) modelled ambient winds at gale forces (40 knot from 8 major directions) and 3 cyclones (approx. 1:100 ARI) with outputs at each of the potential safe harbour locations shown in Figure 1-1. Existing data (storm tide levels, bathymetry, winds and waves) were used to set up models to determine wave climates at each location. Marina designs considered the height of breakwaters to resist cyclonic conditions, given macro-tidal conditions environment and significant storm surge. The ability to provide safe passage in storm conditions was also considered. Some designs provided berths for larger vessels (in the order of 50m length, which require around 4.2m of clear water depth). The volume of rock required to build marina infrastructure above and below -5 m LAT contours, and the volume of dredging required for these berths and access channels and fairways, were also calculated. Preliminary estimates of breakwater arrangements, armour size and volumes were made. A cost estimate of $\$250/m^3$ of breakwater was applied to all calculations.

The existing jetty location was relatively well protected from gale-force and cyclonic conditions and had with a preliminary estimate of breakwater and dredging costs of $25M. The location south of Billy Goat Point could be developed without reef dredging but the breakwater costs may be in the order of $200-300M because of the deeper water at the site and exposure to extreme wave conditions. Boat Port and Gap Beach would both require significant breakwaters to protect against extreme northerly fetches, and dredging with development costs are in the order of $100M and $50M, respectively.

2.2 Legislative and Marine Ecology Constraints

2.2.1 Approach

The basic approach of the marine approvals and ecology constraint mapping was to collate relevant spatial information describing environmental features and legislative tenure and overlay these layers to show areas of highest and lowest constraint to safe harbour/barge access site development. Constraints were also tabulated in a ‘traffic light’ approach to show the detail behind the assessment. The review considered the ecological character of the study area, including the distribution, extent and abundance of marine flora and fauna species, and their habitats. The following datasets were analysed:

- Historical seagrass survey data carried out by Hyland et al (1988) and coarse spatial layers available from the Federal Government (CAMRIS);
- Reef habitat included in GBRMPA Reef Gazetteer;
- Historic shipwrecks (Historic shipwrecks database) or otherwise;
- Other existing spatial data mapping (bathymetry, regional ecosystem mapping, conservation zone/area mapping etc.);
- Marine flora and fauna database records (protected matters search, DEHP database); and
- High ecological value habitats such as coral reefs, seagrass and mangroves;
- Associated foreshore vegetation, including threatened vegetation communities

- Habitats and features of high amenity and social value, including reefs and beaches;
- Marine park and World Heritage Area boundaries;
- Marine park management areas;
- Known or likely habitat for threatened or migratory marine species;
- Known or likely habitat for marine species of fisheries significance;
- Protected area boundaries;
- Any other matters of State Environmental Significance (MSES) or National Environmental Significance (MNES) available from Government databases;
- Native Title mapping by Commonwealth Native Title Tribunal;
- Local government overlays.

Spatial data analysed were used to derive a constraints map (covering all proposed safe harbour/barge access sites), and provide broad definition of suitable and unsuitable areas for development of a safe harbour and/or temporary barge access along the coastline of Lindeman Island. Hectares of coral reef beneath the footprint of each of the safe harbour arrangements shown in Figure 1-1 were calculated using GBRMPA coral reef polygons, navigation charts and visible reef areas from available aerial photography. Hectares of seagrass were not calculated due to the unreliability and poor temporal currency of the available data.

2.2.2 Constraint Maps

Figure 2-1 to Figure 2-5 provide the available environmental and planning spatial data layers for the study area, illustrating the key marine ecological and associated legislative constraints. A summary map based on this preliminary constraints assessment is provided in Figure 2-6, demonstrating that the least constrained area for the marine development is the nearshore area along the south of Lindeman Island, near the existing jetty. This conclusion was reached prior to any field surveys.

Key constraints identified were the Whitsundays Plan of Management zoning (for vessel and aircraft restrictions) and the GBR Marine Park zoning plan (Conservation Park zone and Marine National Park zones). This effectively prohibits the establishment of a safe harbour within these areas, as legislative changes and other approvals would be required.

LEGEND

- Seawall
- Reef (GBRMPA)
- Developed (70m, no limits)
- Moderate Use (35m, 40 pax)
- Natural (35m, 15pax)

Contours

- Land
- Reef
- Bathymetry

Title:
Lindeman Island - Whitsunday Planning Area

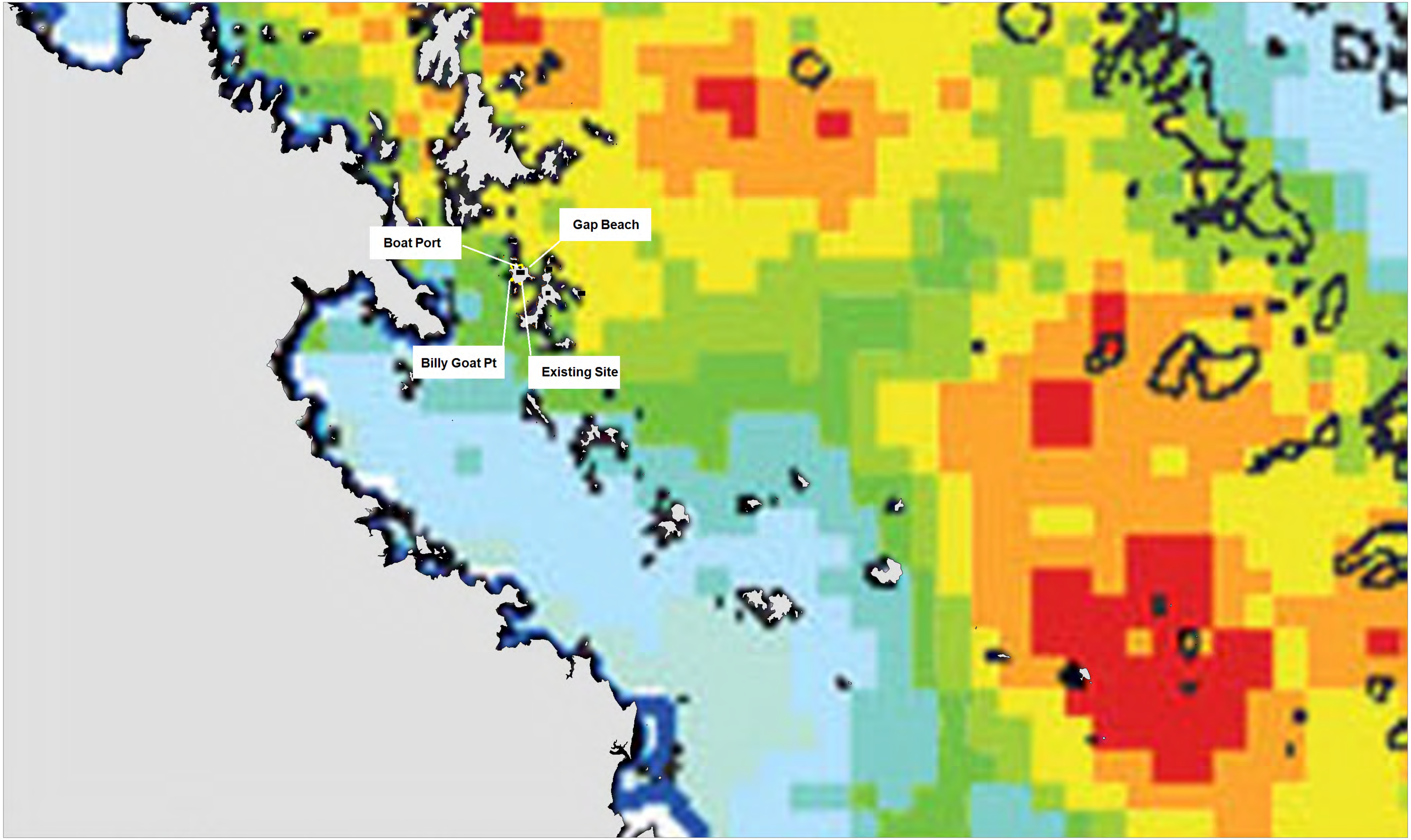
Figure: **2-1**

Rev: **A**

N 0 0.5 1km
Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_003_130805_Whitsunday_planning.wor



LEGEND

Seawall

Land

Contours

Reef

Environmental suitability

0.7 - 0.82

0.6 - 0.7

0.5 - 0.6

0.4 - 0.5

0.3 - 0.4

0.2 - 0.3

0.1 - 0.2

0 - 0.1

Title:

Lindeman Island - Humpback Whale Habitat (Smith et al. 2012)

Figure: 2-2

Rev: A

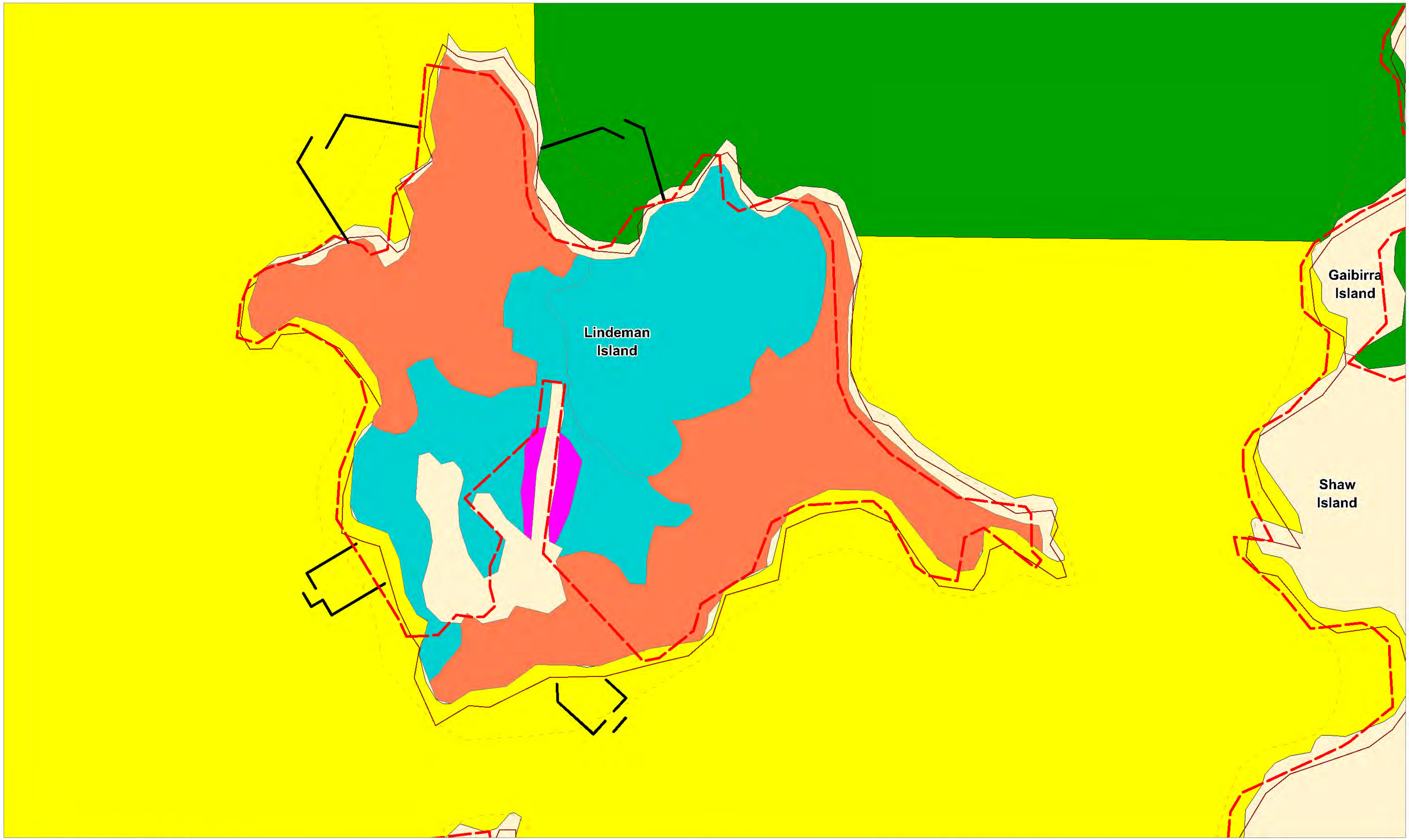
N 0 15 km 30 km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_002_130802_Whale Habitat.wor



LEGEND

- Seawall
- Reef
- Land
- National Park
- Conservation Park
- Marine National Park

Remnant Vegetation

- Remnant with Endangered REs
- Remnant with "of Concern" REs
- Remnant with "least concern" REs

Title:
Lindeman Island - GBRMPA Zones (Marine) and Remnant Vegetation (Terrestrial)

Figure: **2-3**

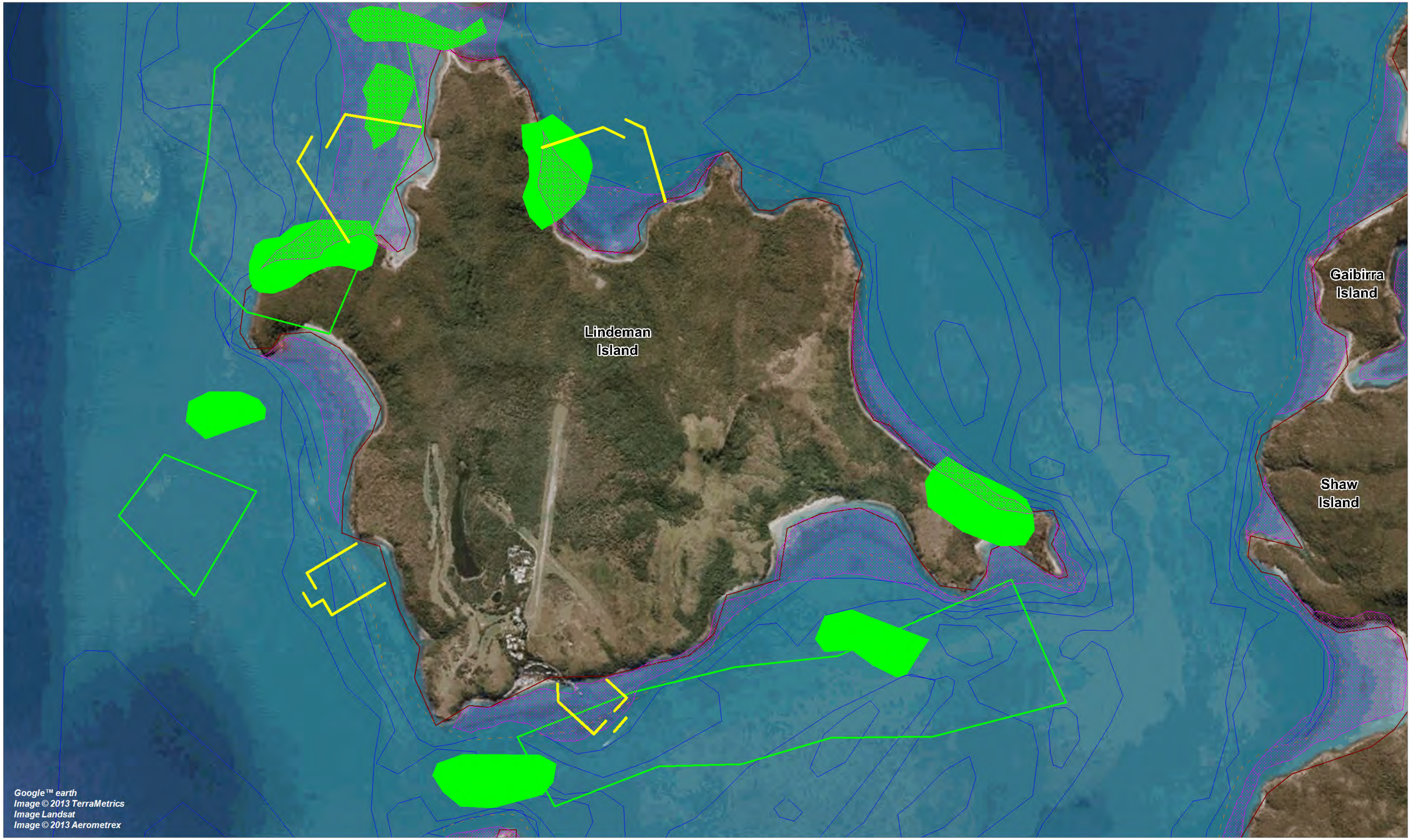
Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N 0 0.5 1km
Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_004_130805_GBR_and_Remnant_veg.wor



LEGEND

- Seawall
- Reef (GBRMPA)
- Seagrass (Hyland 1988)
- Seagrass (CAMRIS 1984)

Contours

- Land
- Reef
- Bathymetry

Title:
Lindeman Island - Seagrass and Reef

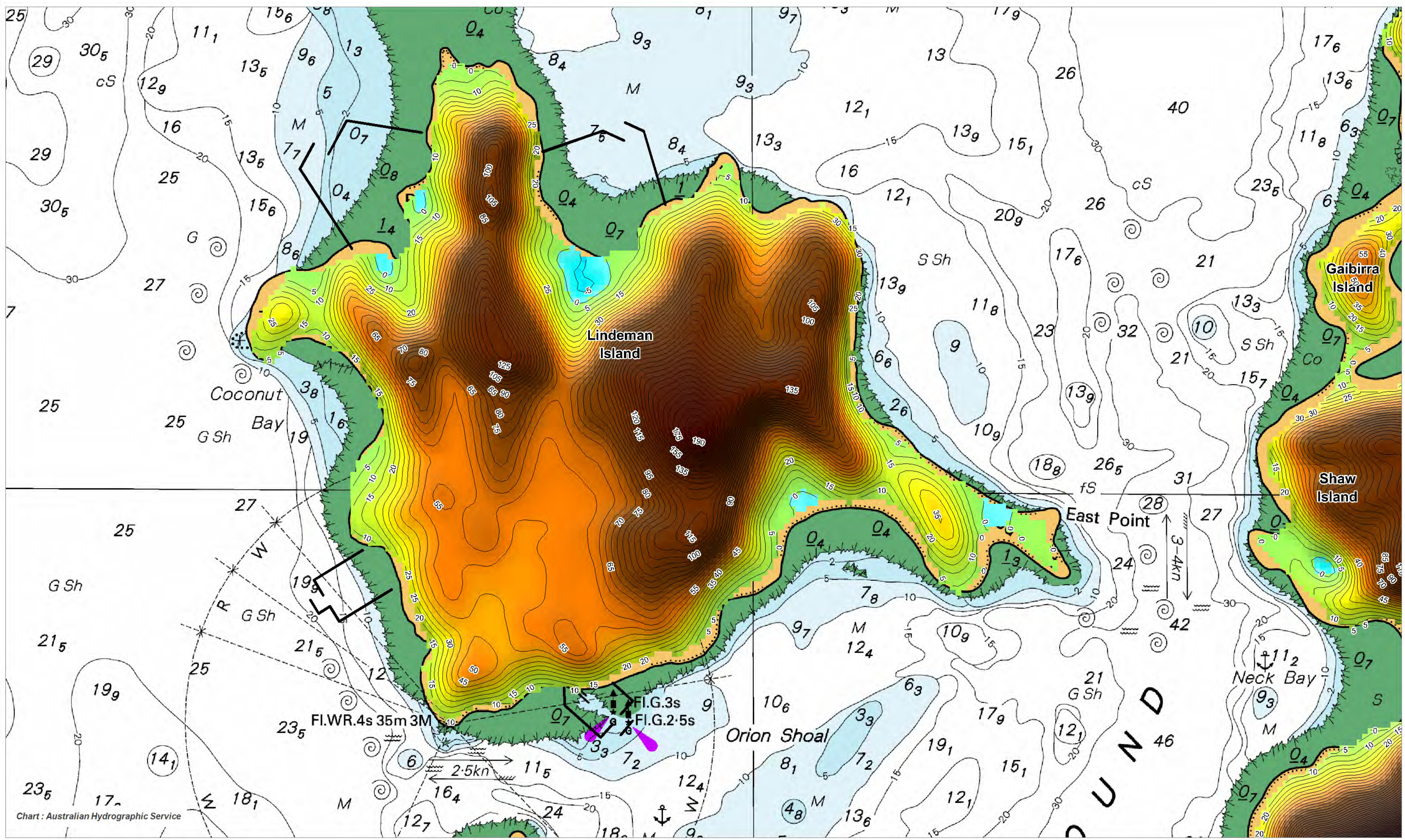
Figure: **2-4**

Rev: **A**

N 0 0.5 1km
Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_005_130805_Coral_and Seagrass.wor



LEGEND

Seawall

0 20 40 60 80 100 120 140 160 180 200

Elevation (mAHD)

Title:

Lindeman Island - Digital elevation Model

Figure: **2-5**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

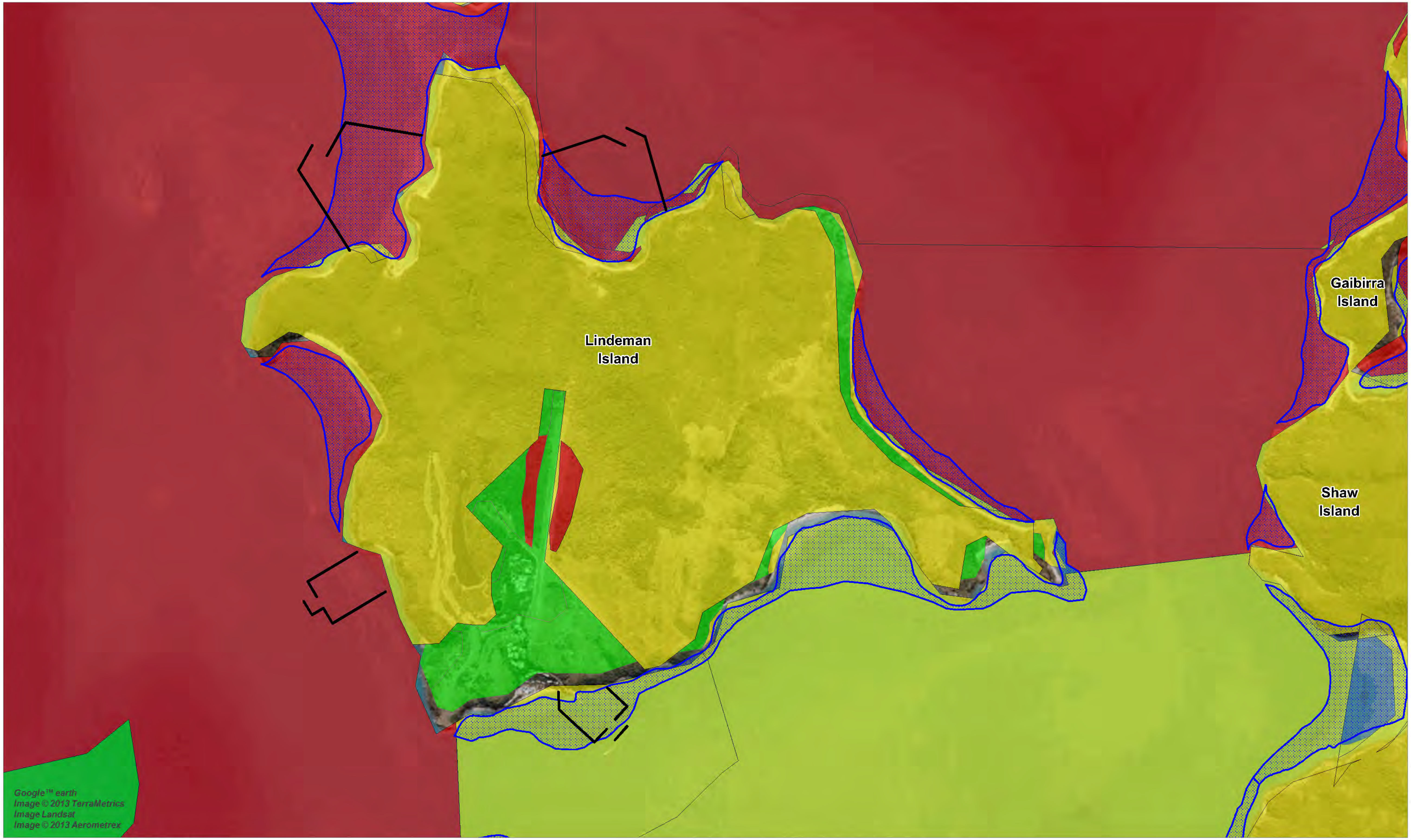
N 0 0.5 1km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_001_130802_Lindeman_Constraint.wor



LEGEND

- Seawall
- Coral Reef
- Least constrained
- Moderately constrained
- Heavily constrained

Title:

Lindeman Island - Constraint Layer Summary

Figure: **2-6**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N 0 0.5 1km Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_001_130802_Lindeman_Constraint.wor

2.2.3 Assessment Table

The preliminary constraints assessment summarised in Table 2-1 shows the detail of the each of the spatial layers considered in the overall constraints map. Table 2-1 shows the colour-coded performance of each of the potential locations against a range of key criteria. Red refers to direct constraint, where extensive negotiation with Government or prohibitive capital expenditure is required. Orange requires high expenditure and/or time investment and some negotiation with Government. Yellow requires moderate-to-low expenditure and/or time investment and negotiation with Government. Green represents low existing constraint, (comparatively) low associated costs, and white is not applicable or data deficient.

Marine engineering, legislative tenure, and marine ecology criteria are as follows:

- Engineering:
  - Exposure to extreme conditions (day to day strong winds, waves, and tides as well as cyclonic conditions including storm surge)
  - Breakwater cost
  - Dredging cost
- Marine Ecology
  - Habitat directly impacted (within each marina arrangement):
    - Area (ha) of mapped reef (based on desk-top information)
    - Existing condition (completed after field survey)
  - Habitat indirectly impacted (shoreward of each marina arrangement)
    - Area (ha) of mapped reef (based on desk-top information)
    - Existing condition
  - Threatened species
  - Shipwrecks
- Marine Approvals and Legal Constraints[1]
  - Federal
    - EPBC Act referral and approval requirements
    - Sea installations permit
    - GBRMP construction and operations permits
    - Whitsunday Plan of Management constraints
    - Offset requirements/negotiation
    - Native Title
  - State

[1] This is based on the current cost, timing and rigour required for each approval application and ongoing conditions/constraints. Criteria do not include land-based approvals or staging of applications.

        - Protected Area permit
        - Single Assessment Referral Agency (SARA)/Coordinator-General project assessment
        - Offset requirements/negotiation
        - Native Title
    - Local
        - Operational works permit
        - Material change of use permit
        - Local government planning
- Terrestrial (for access considerations- not part of the present scope)
    - Area (ha) of habitat which supports one or more of the following ecological features:
        - remnant vegetation (Endangered/Of Concern/Not Of Concern RE's)
        - Threatened Ecological Community (EPBC Act)
        - Protected Area
        - known/potential habitat for EPBC Act listed threatened species
        - Essential Habitat for *Nature Conservation Act 1992* listed threatened species
    - Significance of impact to 'aesthetics' and visual amenity
    - Tenure arrangements
    - Approvals for accessing rock from the island
    - Approval for bringing dredged material onto the island
    - Native Title.

Table 2-1 shows that on the basis of this preliminary assessment that the existing jetty location is the most preferable location for safe harbour development because it:

- will be the least expensive to construct;
- has the least exposure to the full range of extreme weather conditions; and
- will require the least number of approvals or effort/time to gain approvals.

Additionally, all locations except the existing jetty will require changes to both the Whitsundays Plan of Management and the GBR Marine Park zoning plan. These legislative amendments would require extensive negotiation with Government, and there is no guarantee that negotiations would be successful.

Boat Port and Gap Beach were identified for potential temporary barge access sites for further investigation during field studies.

Table 2-1 Constraints Assessment Table for Safe Harbour Development at Four Locations

Criteria	Existing Jetty[2]	South of Billy Goat Point	Boat Port	Gap Beach
Engineering				
Exposure to day-to-day 40-kt wind max. significant wave height (Hs) at 5m	1.4	1.7	1.6	2.3
Extreme conditions (Cyclone maximum significant wave height including storm surge)	5m	6m	6m	6m
Breakwater cost (AUD)	22,250,000	286,000,000	93,600,000	47,400,000
Dredging cost (AUD)	3,700,000	nil	6,000,000	1,200,000
Marine Ecology				
Direct loss- reef ha based on GBRMPA Layer (based on aerial imagery)	6.14 ha (4.7 ha)	0 ha (0.3 ha)	10.16 ha (8.86 ha)	5 ha (0.14 ha)
Direct loss (existing condition)	Very good	Fair	Fair	Fair
Direct loss of seagrass (based on desktop information)	Data deficient	Data deficient	Data deficient	Data deficient
Indirectly impacted- ha reef	2.77	1.13	7.71	11.18
Indirectly impacted- existing condition	Fair	Very good	Good	Very good
Threatened species (likelihood of turtle nesting)	Fair	Fair	Good	Good
Shipwrecks	None	None	None	None
Humpback Whale Habitat	Low	Low	Low	Low

[2] For each criterion, squares have been shaded to indicate the following: red – direct constraint, requires extensive negotiation with Government or prohibitive capital expenditure; orange – high cost and/or time investment required, some negotiation with Government required; yellow – medium-to-low cost and/or time investment required, negotiation with Government required; green – low-to-no existing constraints, low costs; and white – not applicable

BMT WBM

Criteria	Existing Jetty[2]	South of Billy Goat Point	Boat Port	Gap Beach
Marine Approvals[3]				
Federal				
EPBC Act (including World Heritage values, GBRMP, threatened species, migratory species)	Works will be 'controlled activity' requiring EPBC Act Referral and Approval; approval application likely to involve PER or EIS	Works may be 'controlled activity' requiring EPBC Act Referral and Approval; application may involve PER or EIS	Works may be 'controlled activity' requiring EPBC Act Referral and Approval; application may involve PER or EIS	Works may be 'controlled activity' requiring EPBC Act Referral and Approval; application may involve PER or EIS
Marine Park Permit	Permit application likely to involve PER or EIS	Permit application likely to involve PER or EIS	Permit application likely to involve PER or EIS	Permit application likely to involve PER or EIS
Whitsundays Plan of Management	No limit on group size 70m limit on vessel length	No new moorings Limit on group size of 15 35m limit on vessel length	No new moorings Limit on group size of 15 35m limit on vessel length	No new moorings Limit on group size of 15 35m limit on vessel length
Sea Installations Permit	Permit required; limited application requirements	Permit required; limited application requirements	Permit required; limited application requirements	Permit required; limited application requirements
Offset requirements	Offsetting required for destroyed coral reef	Offsetting required for impact in Conservation Park zone	Offsetting required for impact in Conservation Park zone	Offsetting required for impact in Marine National Park zone
Native Title	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification
State				
Protected Area permit	n/a	Protected Area permit	Protected Area permit	Protected Area permit required

[3] Includes costing, timing and application requirements, as well as any necessary negotiation to secure the approval.

Criteria	Existing Jetty[2]	South of Billy Goat Point	Boat Port	Gap Beach
		required	required	
SARA/Coordinator-General project assessment[4]	No State Interests likely to constrain project	No State Interests likely to constrain project	No State Interests likely to constrain project	No State Interests likely to constrain project
Offset requirements	Offsetting required for destroyed coral reef	Only small-scale offsetting required	Offsetting required for impact in Marine National Park zone	Offsetting required for impact in Marine National Park zone
Native Title	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification
Local[5]				
Material change of use permit	n/a	Impact assessment[6]	Impact assessment	Impact assessment
Operational works permit	Code assessable	Code assessment	Code assessment	Code assessment
Local government planning	No applicable policy	No applicable policy	No applicable policy	No applicable policy
Terrestrial (for access considerations)				
Remnant vegetation	n/a	Vegetation approval required	Vegetation approval required	Vegetation approval required
Threatened ecological community	n/a	Unlikely	Unlikely	Unlikely
Protected Area	n/a	Protected Area permit	Protected Area permit	Protected Area permit
Known/potential habitat for listed threatened/migratory species	Low impact to habitat	Low impact to habitat	Medium impact to habitat of threatened/ migratory species; unlikely to be 'controlled action' with mitigation	Medium impact to habitat of threatened/ migratory species; unlikely to be 'controlled action' with mitigation
Essential Habitat for NC act listed	Low impact to habitat	Low impact to habitat	Clearing permit	Clearing permit

[4] Includes all consideration of works above and below HAT, including development approval for operational works and material change of use
[5] Applies only to works above HAT
[6] Assessment levels are based off the current *Mackay City Plan 2006* but may change with the introduction of the *Mackay Regional Plan* in 2013/2014

Criteria	Existing Jetty[2]	South of Billy Goat Point	Boat Port	Gap Beach
threatened species				
Aesthetics and visual amenity associated with new track	n/a	High impact to amenity from access roads; 'controlled action' requiring EPBC Act Referral and Approval	High impact to amenity from access roads; 'controlled action' requiring EPBC Act Referral and Approval	Medium impact to amenity from access roads; unlikely to be 'controlled action' through mitigation
Tenure arrangements	n/a	New tenure to be negotiated	New tenure to be negotiated	New tenure to be negotiated
Approvals for accessing rock from the island (ERA)	Significant volumes of rock required	Significant volumes of rock required	Significant volumes of rock required	Significant volumes of rock required
Approval for dredging material disposal on the island	Medium levels of material produced	Low levels of material produced	Medium levels of material produced	Medium levels of material produced
Native Title	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification	No current Native Title claim over area; may require notification

3 Field Methodology

3.1 Survey Timing

Field surveys were conducted between the 21st and 24th of August 2013 at Lindeman Island. Benthic cover surveys in the jetty area were undertaken on foot at low tide on the afternoon of the 21st of August while the resort tender *N.B.O.* was used subsequently on the 22nd and 23rd of August. The survey vessel had a draft of 40 cm; hence, was able to survey very shallow and deep areas alike.

3.2 Survey Approach

3.2.1 Benthic Habitats

Rapid assessment methods were used to characterise benthic habitats and communities. Sampling focused on potential marine infrastructure development areas for the project, hereafter referred to as study regions. Five study regions were sampled (Figure 3-1, Figure 3-2):

- existing jetty area;
- Plantation Beach;
- Gap Beach;
- Boat Point; and
- Coconut Beach and Billy Goat Beach.

A total of 167 sites were sampled across the five study regions.

At each site, a five metre transect was positioned on the substrate, and the start position was recorded using a Garmin handheld GPS (with realised accuracy of ±3 m). A diver swam along the transect line and visually estimated the percentage cover of the following benthic categories: hard and soft corals, seagrasses, macroalgae, sand, rubble, and other features such as oyster beds and sponges. The survey location, site details, depth, and time were also recorded.

The diver also used a dual high definition camera system to record the substrate along each transect line. The system had one camera recording stills on two second intervals and another camera recording a continuous image of the substrate[7]. At deeper sites, underwater lights were used to provide additional lighting.

Per cent cover estimates by the diver were cross-checked to recorded footage at regular intervals to ensure consistent estimation between study team members. Visibility conditions were at times less than 1 m but this did not prevent accurate estimations of cover, as photo transects were taken approximately 0.2 m above the sea floor.

3.2.2 Bathymetry Assessment

Bathymetry data was collected opportunistically during the surveys the 22nd and 23rd of August using a Trimble differential GPS (dGPS) and Navman echo sounder, with vertical accuracy of 10 cm and sub-metre horizontal accuracy. The echo sounder transducer was fitted (23 cm below

[7] video and photographs have been archived for future more detailed analysis if required

the waterline) on the survey vessel at the start of the survey period, the dGPS and echo sounder was then activated whenever the vessel was operating at low speeds within each of the survey areas but not during transit between these areas. The extent of soundings is shown in Figure 3-1.

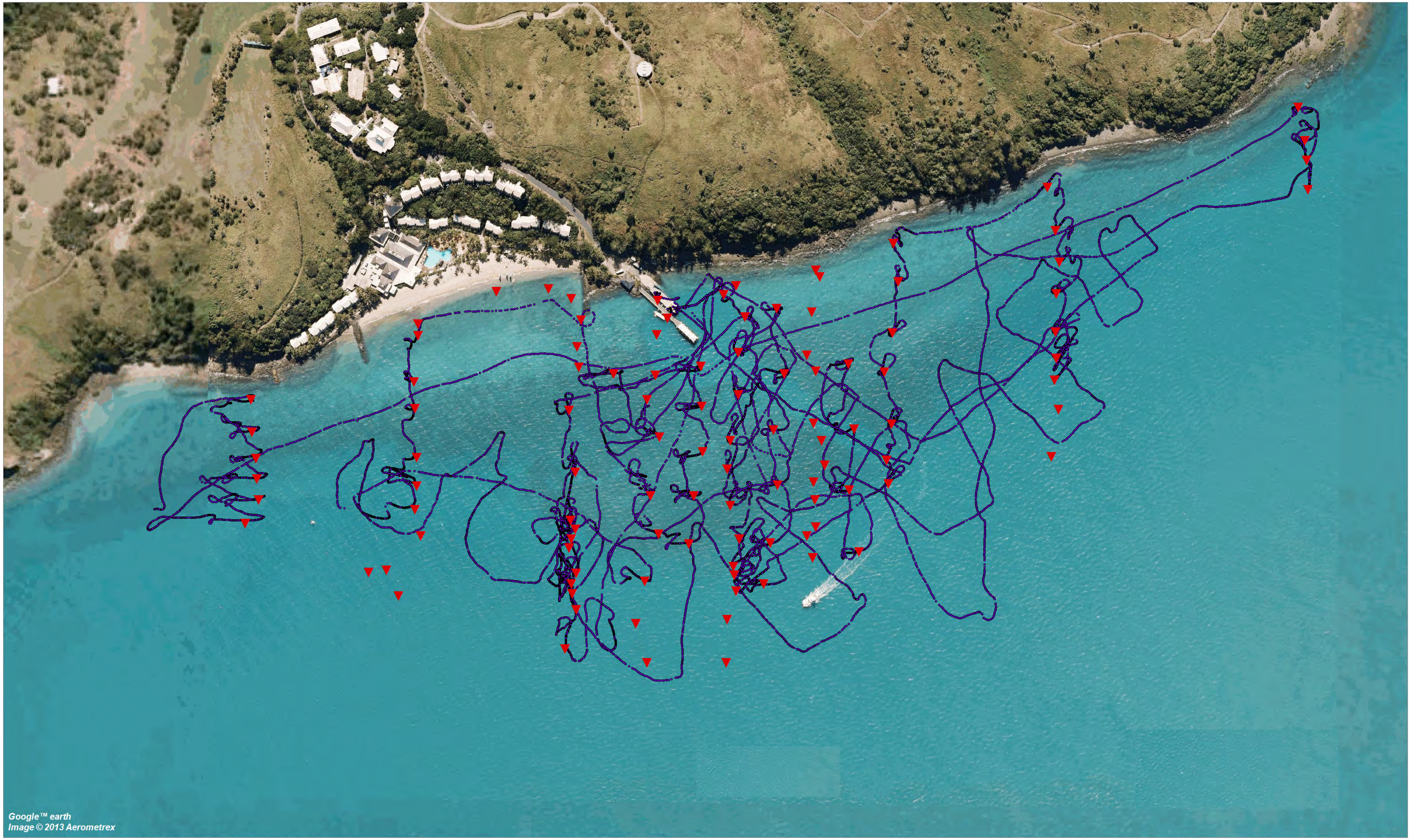
Subsequently, there was extensive coverage coinciding with coral cover survey lines and throughout each of the coral survey areas more generally. No bathymetry data was collected at Plantation Beach or Gap Beach due to technical issues with the dGPS in the afternoon of the 22nd of August but this issue was resolved and a full day of data collection occurred on the 23rd of August. The bathymetry data was corrected post-survey to give values relative to Lowest Astronomical Tide (LAT) and offset against the recording depth of the transducer.

Variation in water depth due to the tidal cycle was recorded throughout the survey period (from 18:30 on the 21st August to 07:30 on the 24th August 2013) using a Greenspan tide gauge (accurate to ± 1mm). All data were corrected to LAT using a Permanent Survey Mark (102646), located 4.255 m above LAT on the boat ramp (Latitude -20.45925; Longitude 149.0409722). The datum of the tide gauge established by measuring the water level below this permanent survey mark at 21:15 on the 21st August 2013, using a spirit level and tape measure.

3.3 Data Analysis

All bathymetry and coral survey data were interpolated using Vertical Mapper 3.7 in MapInfo Professional 11.5 to give a Digital Elevation Model (DEM) and spatial distribution for per cent cover values of hard corals, soft corals, seagrass, and macroalgae for each survey area. Grid interpolations were converted to polygons and adjusted against the derived DEM.

The DEM was used to check maximum depths of corals, seagrass and algae at known points as inference for mapping where ground truthing data was limited. Generally interpolated boundaries agreed very well with field observations, but in some cases, interpolated benthic cover boundaries were adjusted to particular depth contours, based on other known data points within the DEM.



LEGEND

▼ Benthic Survey Point (dive transect)

• Sounding Data Point

Title:
Location of Survey Points and Soundings at the Jetty

Figure: 3-1

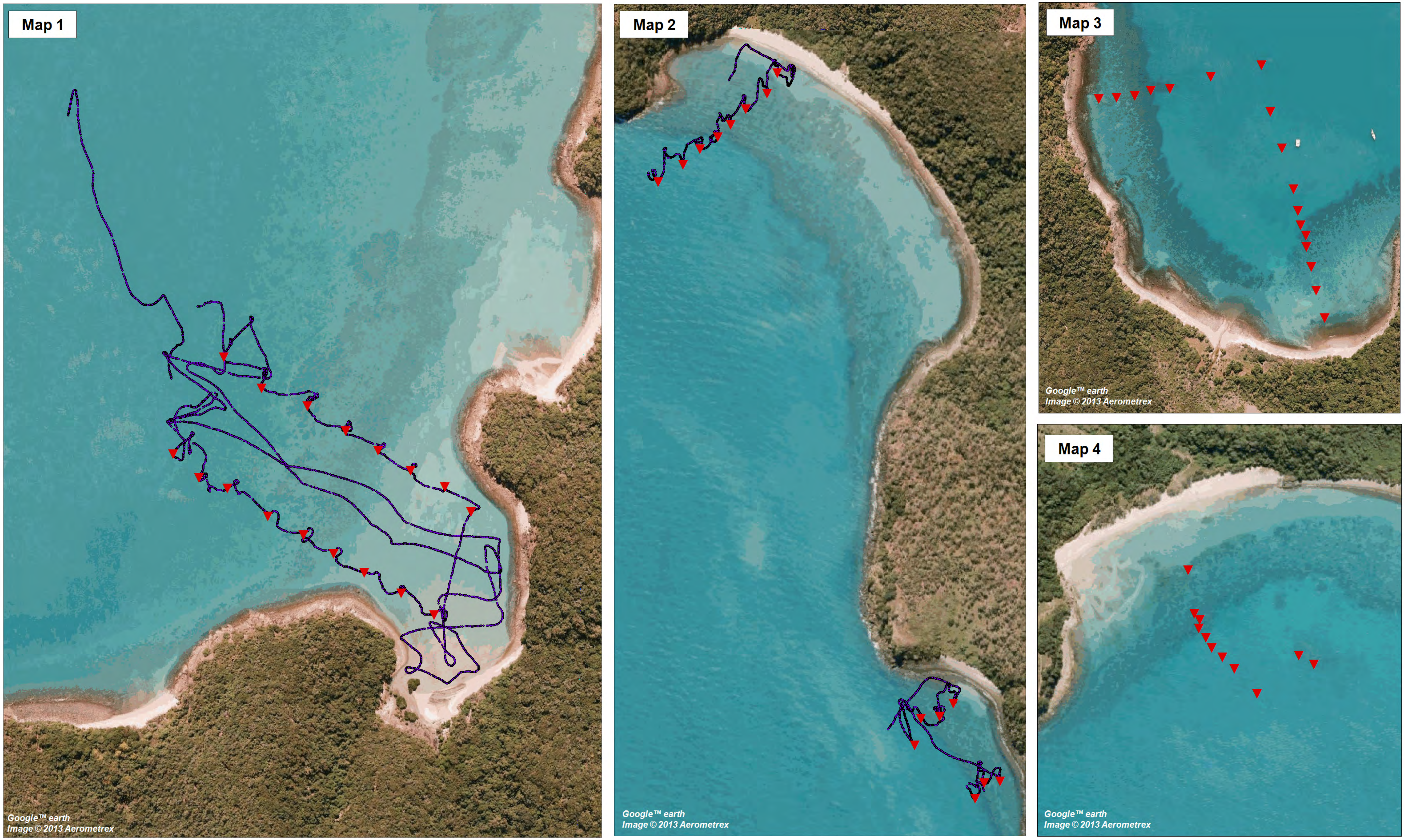
Rev: A

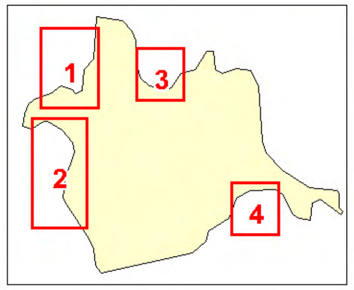
BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N 0 100 200m Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_009_130903_survey_points_resort.wor





LEGEND

▼ Benthic Survey Point (dive transect)

• Sounding Data Point

Title:

Location of Survey Points and Soundings Surrounding Lindeman Island

N

0 100 200m
Scale - Map 1

0 150 300m
Scale - Maps 2,3 and 4

Figure: **3-2**

Rev: **A**

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_009b_130903_survey_points_other.wor

4 Results

4.1 Bathymetry

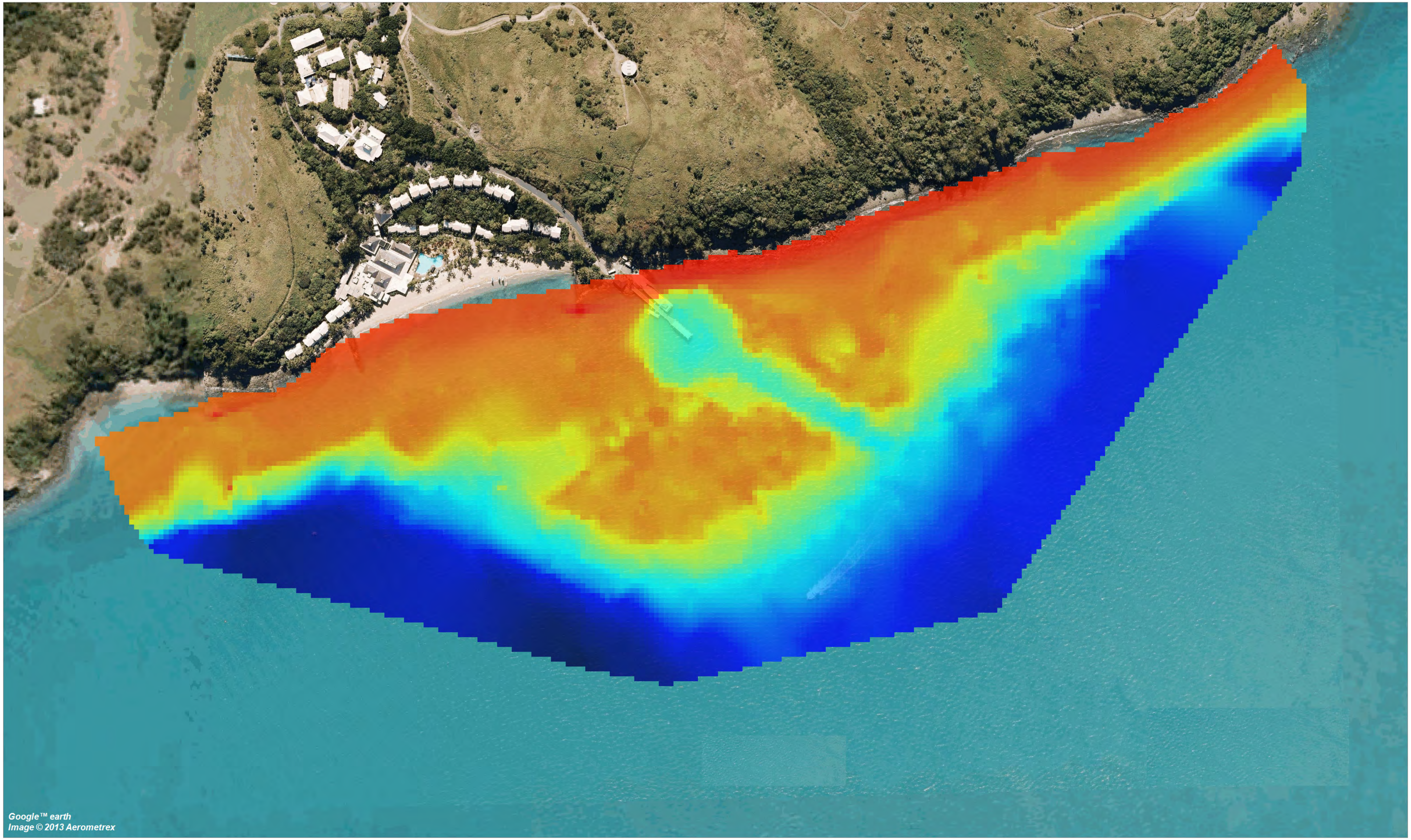
The bathymetry of the jetty area recorded in the present study was consistent to that depicted in navigation chart AUS 254, but provided greater resolution over the reef, particularly at its margin (Figure 4-1).

The western part of the reef edge (directly south of the resort) had a steeper profile than the eastern part of the reef edge (south of the jetty, and eastwards). The reef surrounding the existing dredged channel was the widest section of continuous fringing reef on the southern shore of Lindeman Island. While a wide section of coral reef had been mapped by GBRMPA at Plantation Beach, this area was non-continuous, and composed of sandy/mud sea floor interspersed with soft corals and coral bomboras.

There is a large degree of variability in depth on the outer part of the reef surrounding the existing jetty. This section of the reef slope also had high coral cover, and therefore, micro-habitat complexity (see section 4.2). The shoreward part of the reef flat had a lower gradient (Figure 4-1) and also had less live coral cover (see section 4.2).

Coconut Beach and Billy Goat Point had a well-developed, steep, reef slope and relatively narrow reef flats. At Boat Port, there was a large deep sediment bank occurring at -3 m LAT that did not consist of consolidated reef or coral structures. The bed profile of the seabed shoreward of this bank had a gentle gradient. Reefs at Boat Port were not structurally complex, but isolated soft and hard corals were present in places (see section 4.2).

None of the locations appeared to have a defined reef crest area. With the exception of Gap Beach, most reefs were without spur-and groove formations that are typical of high wave energy environments. At Gap Beach, some spur and groove formations were present along the reef edge.



LEGEND

Title:

Detailed Bathymetry at the Existing Jetty Site

Figure: 4-1

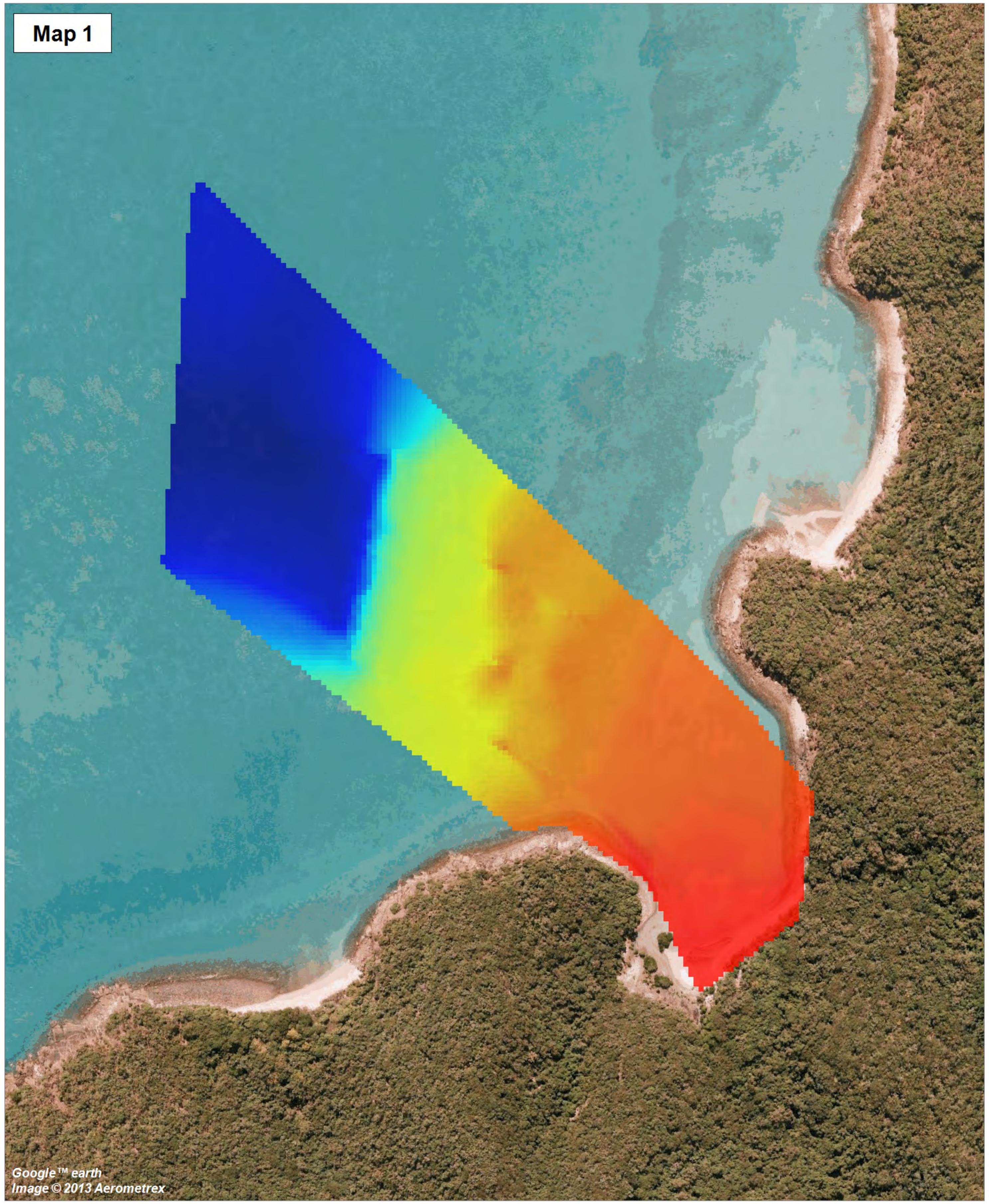
Rev: A

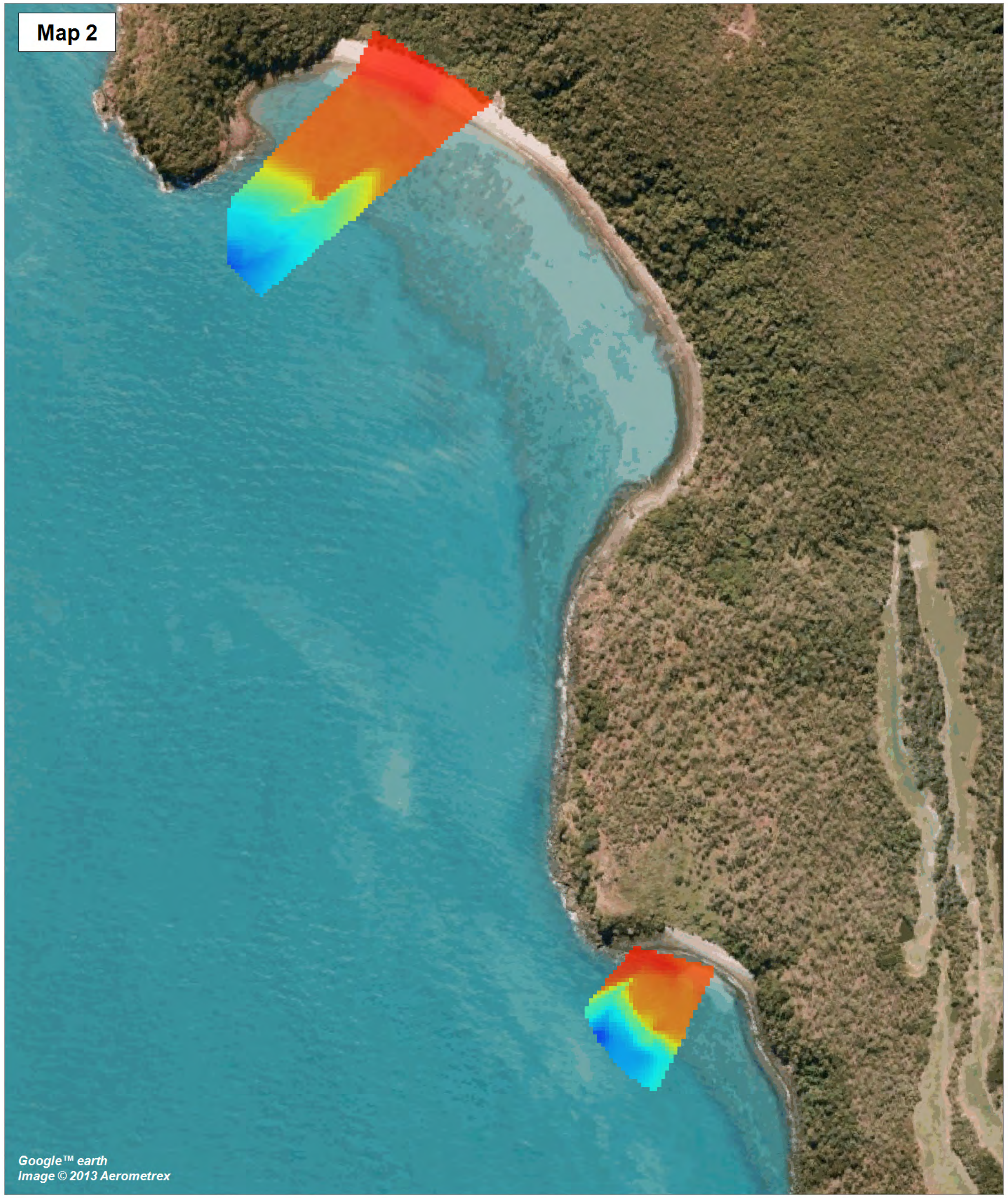
BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

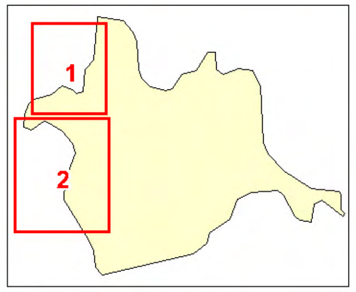
N 0 100 200m Approx. Scale

BMT WBM
www.bmtwbm.com.au

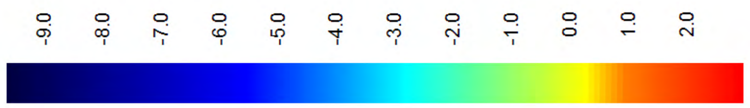
Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_008_130902_bathymetry_resort.wor







LEGEND



Depth (m LAT)

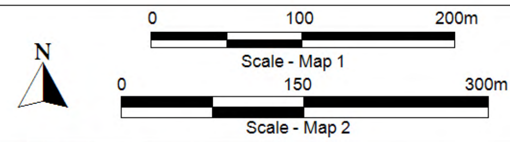
Title:

Detailed Bathymetry at Boat Port, Coconut Beach and Billy Goat Point

Figure: 4-2

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_008b_130902_bathymetry_other.wor

4.2 Live Hard and Soft Coral Cover

The highest density of living coral communities were found directly south of the jetty and existing dredged channel (Figure 4-3). These communities typically ranged in cover between 75% and 100% over the 3-5 m transect length. These were some of the highest coral cover measurements made across the study area. Only the large bombora offshore from Plantation Beach (Figure 4-4) had coral cover approaching 100% in places and was comparable to parts of the reef surrounding the existing channel. All other locations surveyed had living coral cover estimates less than 25% with most of the reef area consisting of 5-10% living coral cover.

4.2.1 Existing Jetty and Dredged Channel

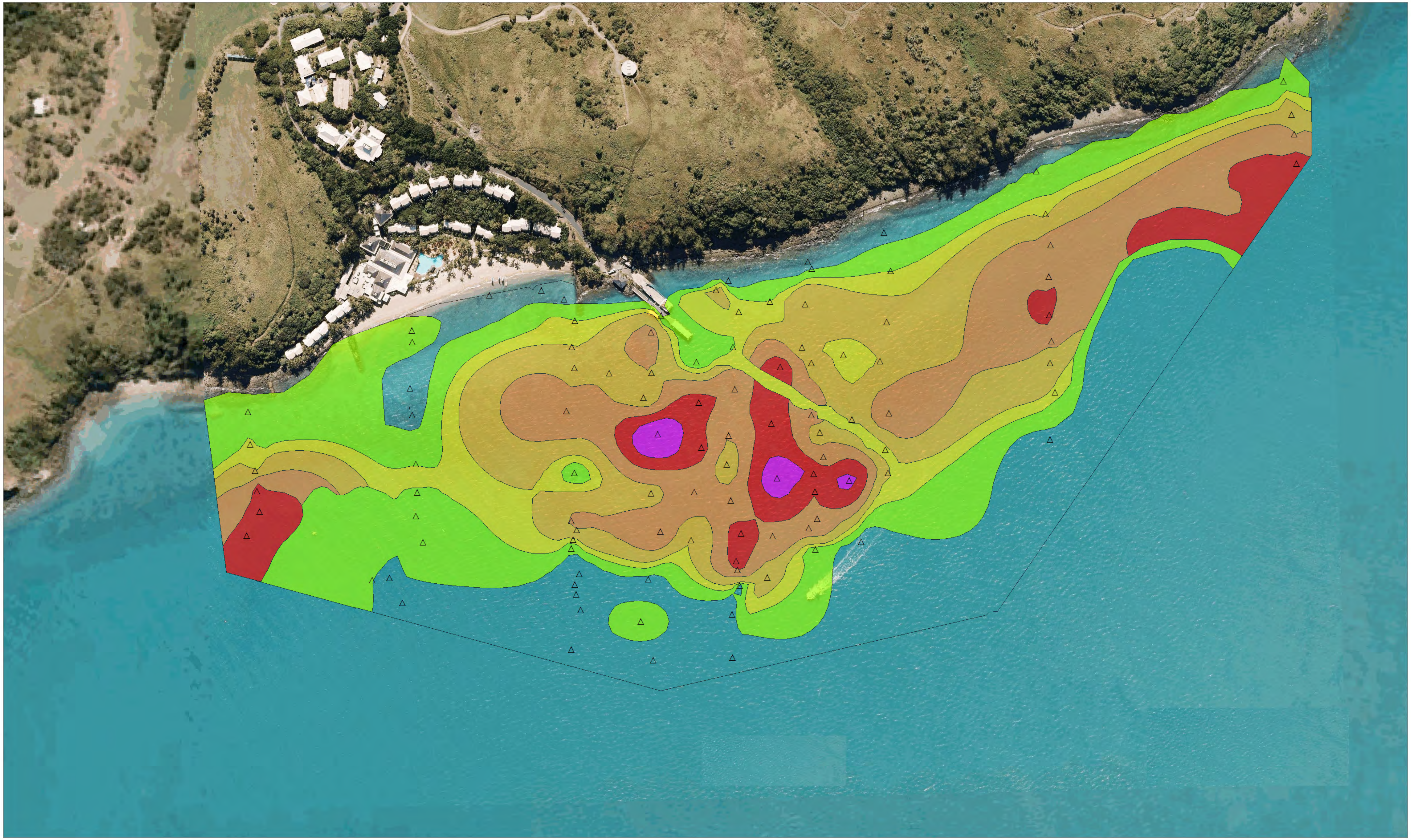
The highest density communities south of the jetty usually consisted of large stands of staghorn coral (*Acropora* spp.) occasionally interspersed with other corals such as needle corals (*Seriatophora* spp.), soft corals (*Sinularia*) or massive corals (*Porites, Galaxea*) (Figure 4-5 A, B, C). There were also large areas that were dominated by macroalgae living on dead coral fragments (Figure 4-5 E; section 4.3).

The near shore upper intertidal area was mostly devoid of corals but below the beach sands in front of the resort, there were frequently small fragments of *Porites latistella*, a small branching poritid. With increasing distance from the shore, the density of soft corals increased, predominantly consisting of *Sinularia, Sarcophyton, Lobophytum* and *Cladiella*. Sponges were also reasonably common, existing as large separate colonies (Figure 4-5 D) or interwoven into the base of acroporid coral colonies as *Ceratodictyon spongiosum* (the algal sponge symbiosis, Figure 4-5 G).

The reef slope was composed of a mixture of species and had a variable morphological and ecological character. Towards the bottom of the reef slope, growing in between patches of sand and mud were occasional large colonies of the daytime coral (*Goniopora* spp. Figure 4-5 H) and sea whips (*Junceella* sp.), with occasional other soft corals such as *Nephthya* sp. The dredged channel supported a low cover community of hard and soft corals, mostly *Goniopora, Junceella*, with occasional small poritids and acroporids. The metal I-beam structure of the jetty supports numerous very large soft coral colonies, mostly *Sarcophyton*.

4.2.2 Other Study Regions

Live coral cover was sparse at most other study regions. Soft corals numerically dominated at Gap Beach and Boat Port (Figure 4-6 D, F, G), despite the former location having a well-developed calcium carbonate reef slope. The high coral cover bombora at Plantation Beach consisted of large colonies of *Porites cylindrica* (Figure 4-5 C), *Pavona* sp. and the fire coral *Millepora* (Figure 4-5 E).



LEGEND

△ Survey Point

Coral Cover %

- < 1.00
- 1.00 to 5.00
- 5.00 to 10.00
- 10.00 to 25.00
- 25.00 to 50.00
- 50.00 to 75.00
- > 75.00

Title:

Living Coral Cover at the Existing Jetty Site

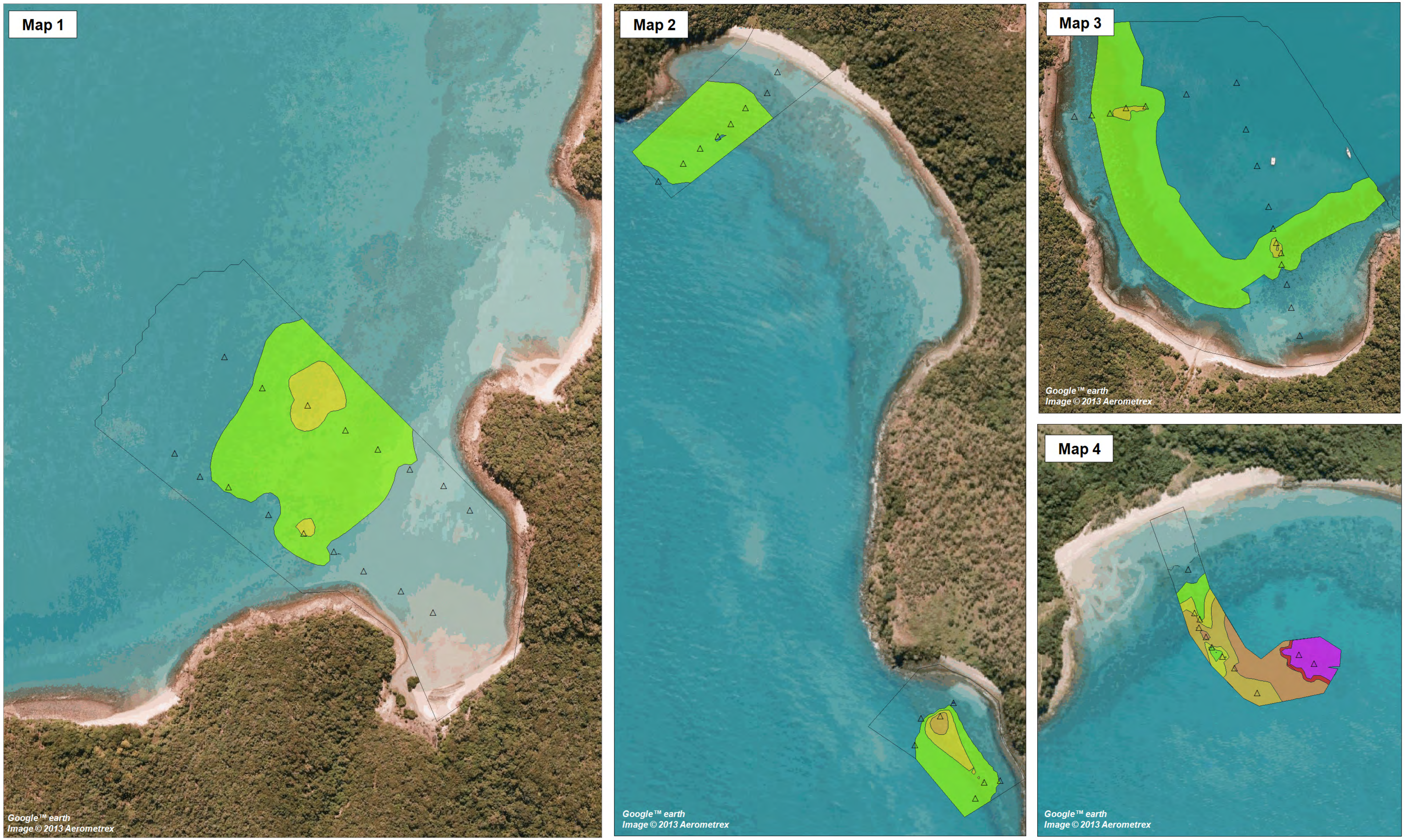
Figure: 4-3

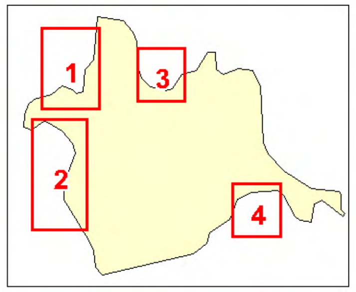
Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_010_130903_coral cover_resort.wor





LEGEND

△ Survey Point

Coral Cover %

- < 1.00
- 1.00 to 5.00
- 5.00 to 10.00
- 10.00 to 25.00
- 25.00 to 50.00
- 50.00 to 75.00
- > 75.00

Title:

Living Coral Cover Surrounding Lndeman Island

Figure: **4-4**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 100 200m

Scale - Map 1

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_010b_130905_coral cover_other.wor

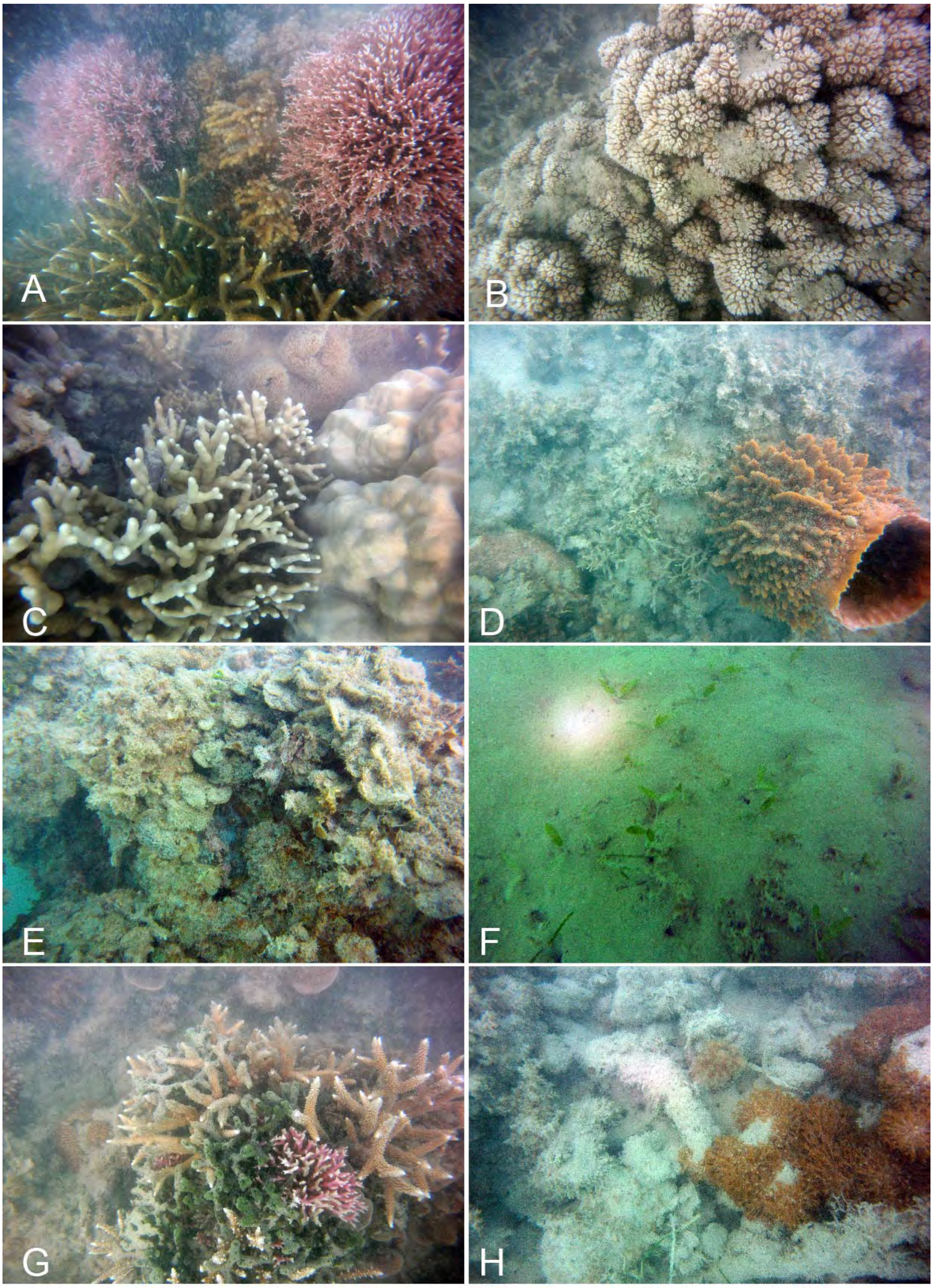


Figure 4-5 Examples of benthos surrounding the existing jetty: high-density *Acropora* and *Seriatopora* (A); *Galaxea* sp. (B); branching poritid *Porites cylindrica* and massive poritid *P. lobata* (C); vase sponge (D); dense macroalgae *Lobophora* sp. (E); sparse seagrass *Halophila* sp. at the base of the reef slope (F); *Acropora* and the sponge-algal symbiont *Ceratodictyon spongiosum* (G); and daytime coral *Goniopora* at the base of the reef slope (H)

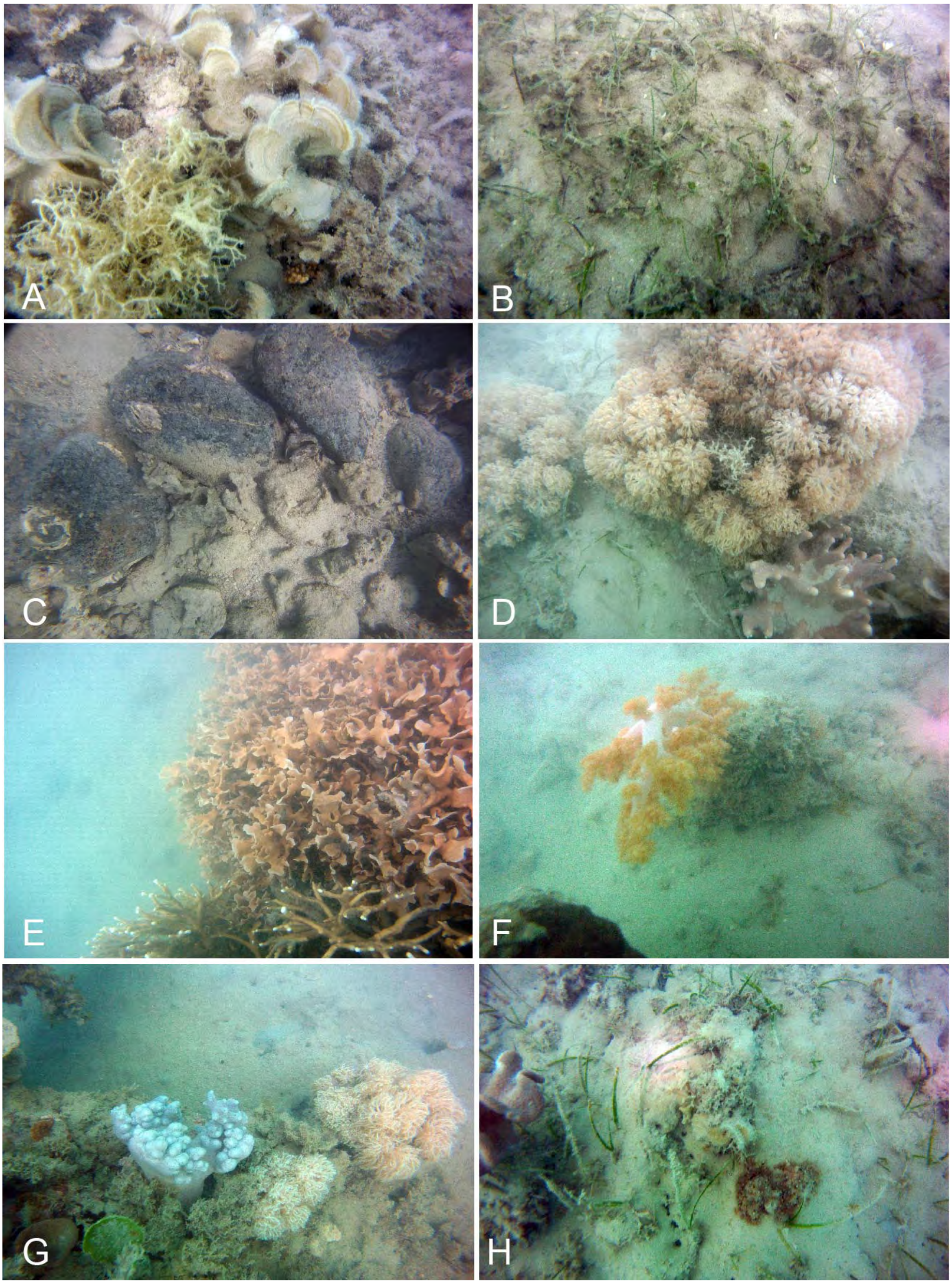


Figure 4-6 Examples of benthos from other locations around Lindeman Island: Dense macroalgae *Padina* and *Dictyota* (A); up to 30% cover seagrass *Halodule uninervis* at Boat Port (B); rocks and oysters in the upper intertidal (C); *Goniopora* and seagrass *H. uninervis* (D); *Pavona* sp. and fire coral *Millepora* sp. (E); *Nephthya* sp. soft coral (F); *Sinularia* and *Goniopora* at Gap Beach (G); and sparse seagrass, macroalgae and zooanthids (H)

4.3 Macroalgae

Macroalgae communities really dominated all locations apart from the reef surrounding the jetty (Figure 4-7, Figure 4-8). Even the jetty site had moderately high macroalgae cover in and amongst the living coral. In many cases it was difficult to identify species because of a dense epiphyte cover on the algae. Some of the dominant forms were *Padina* (Figure 4-6 A), *Sargassum, Dictyota* (Figure 4-6 A), *Laurencia,* and *Lobophora* (Figure 4-5 E).

4.4 Seagrass

Seagrass communities were generally sparse throughout the study regions. The densest seagrass meadows were located offshore from Boat Port, at the base of the reef at the jetty site, and at Coconut Beach (Figure 4-9, Figure 4-10).

Seagrass was primarily composed of two morpho-types: *Halophila* spp[8]. (Figure 4-5 F) and *Halodule uninervis* (Figure 4-6 B). Seagrass meadows were generally sparse, of low biomass, and often intermingled with soft and hard corals. A small amount of *Halophila spinulosa* was present inside the dredged channel at the jetty site. The observed distribution was closest to that mapped by Hyland *et al.* (1988), assuming a slight south-eastly rectification error the Hyland *et al.* layer.

4.5 Fauna Observations

4.5.1 Marine Turtles

Six immature marine turtles were observed during the field survey. These appeared to be green turtles (*Chelonia mydas*), but several could also have been hawksbill turtles (*Eretmochelys imbricata*), which can be difficult to discriminate from green turtles at distance. No adult marine turtles were observed.

The local Mackay and District Turtle Watch Association (2013) estimate that most mainland beaches are visited by between 30 and 100 adult flatback (*Natador depressus*) females per year. In the Whitsunday Islands, low-density nesting by green and flatback turtles occurs at a range of beaches that have the appropriate temperature, height above sea level, moisture content and salinity.

4.5.2 Marine Mammals

No dolphins or whales were sighted during the field trip but whale song was loud and continuous during diving. The central GBR lagoon area southeast of the Whitsundays has been ranked the highest value humpback whale habitat within the GBR (Smith *et al.* 2012); refer to Section 2.2.2.

No dugong or feeding trails were observed during the field studies. Meadows at each of the locations surveyed were generally too sparse to support large numbers of dugong at the time of survey, but these meadows may be visited by dugong from time to time.

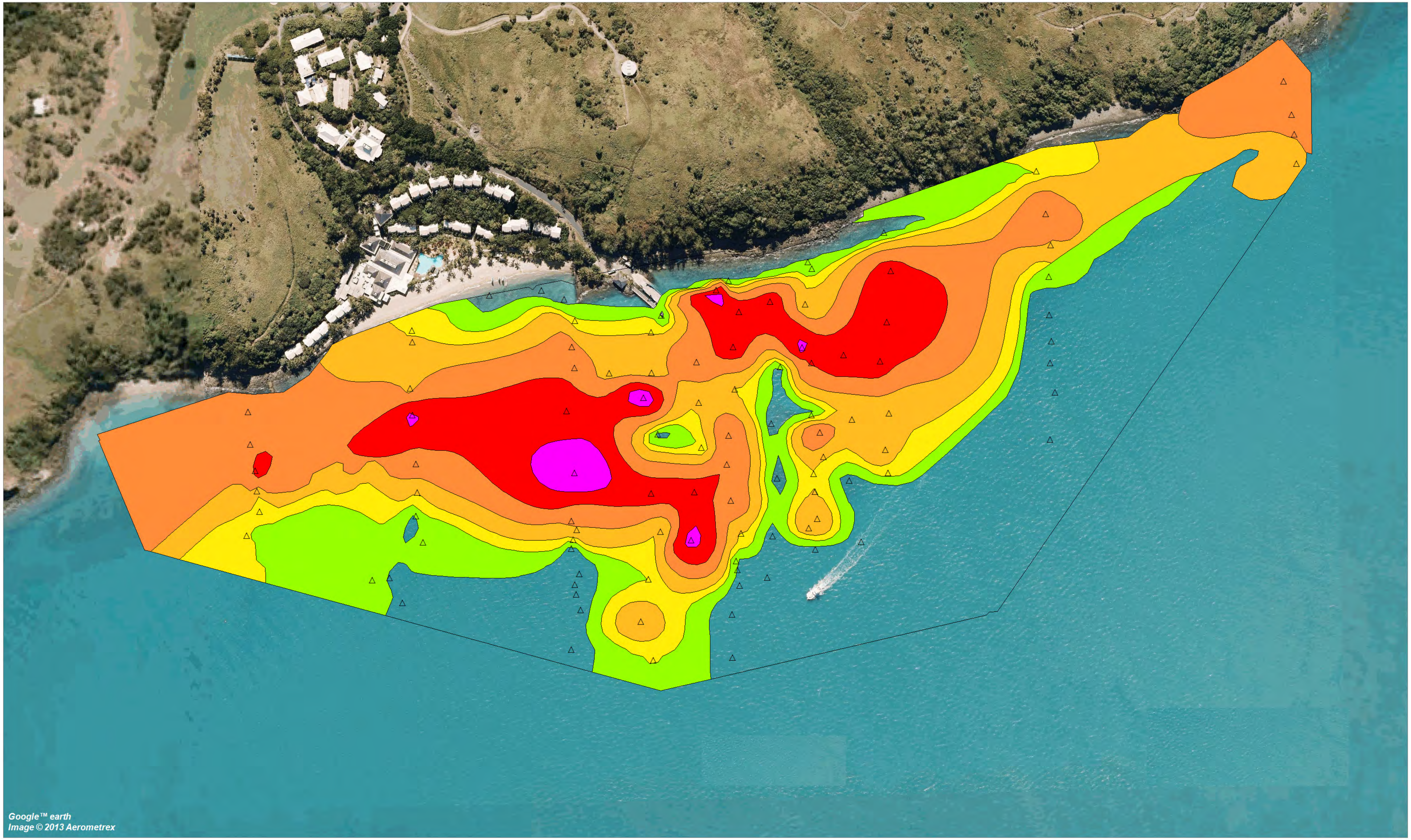
4.5.3 Wader Birds

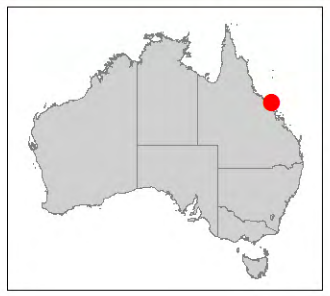
Based on incidental observations made during field surveys, very few wader birds were observed during the field study. Ruddy turnstones (*Arenaria interpres*), sooty oystercatchers (*Haematopus*

[8] Included *Halophila ovalis, H. decipens and H. spinulosa*

fuliginosus) and reef herons (*Egretta sacra*) were observed feeding on the dry exposed reef flat at low tide. Numerous other waders, including migratory shorebirds and residents may be present throughout the study area at different times of the year.

It should be noted that birds were not targeted in the present study, and that a dedicated bird survey would be required to determine the values of the study regions as a bird habitat.





LEGEND

△ Survey Point

Macroalgae Cover %

- < 1.00
- 1.00 to 5.00
- 5.00 to 10.00
- 10.00 to 25.00
- 25.00 to 50.00
- 50.00 to 75.00
- > 75.00

Title:

Macroalgal Cover at the Existing Jetty Site

Figure: 4-7

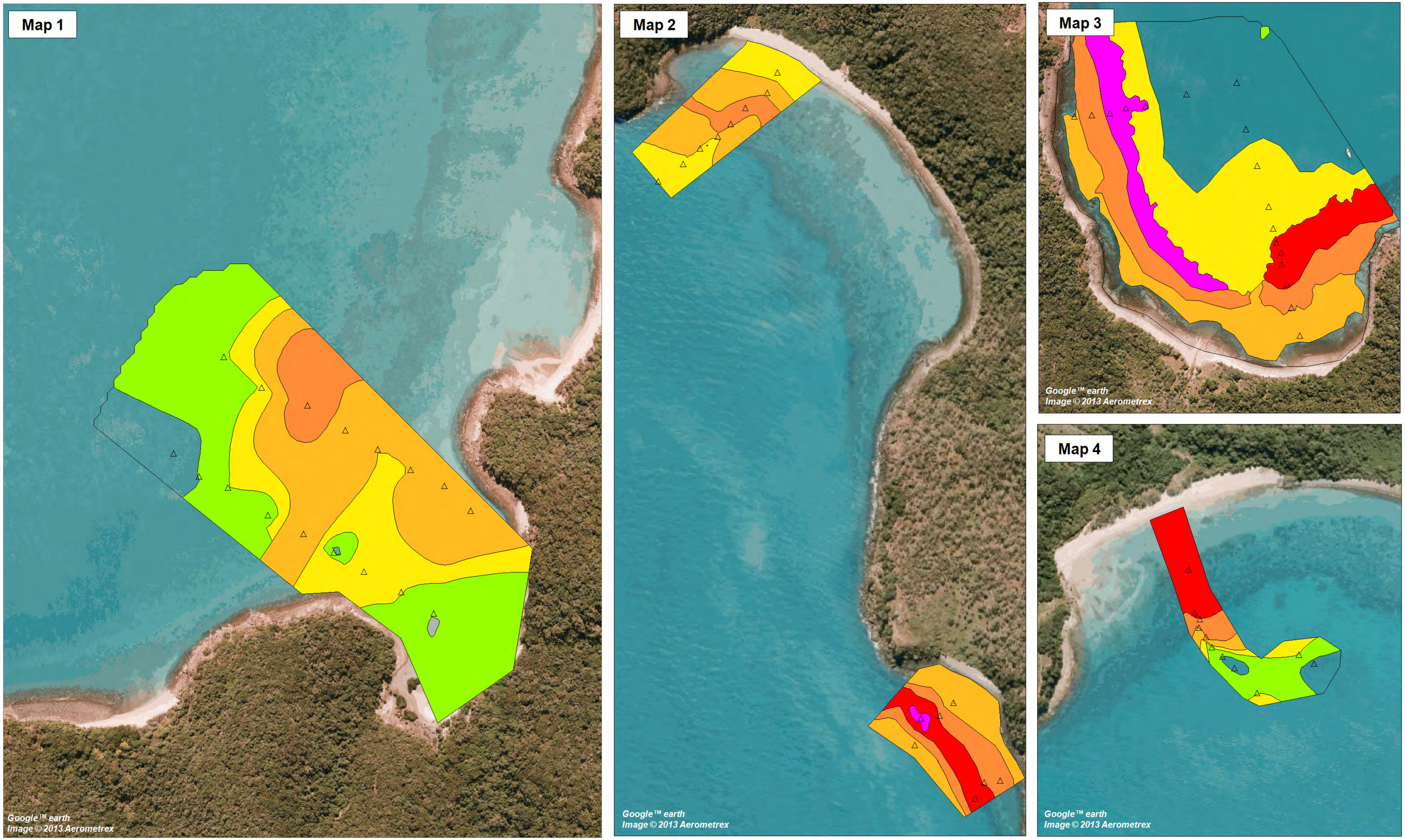
Rev: A

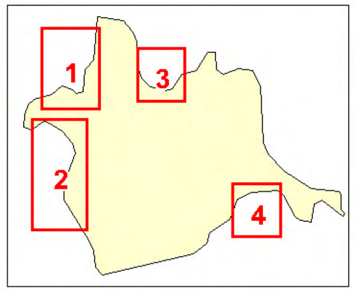
BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N 0 100 200m Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_011_130902_algae cover_resort.wor





LEGEND

△ Survey Point

Macroalgae Cover %

- < 1.00
- 1.00 to 5.00
- 5.00 to 10.00
- 10.00 to 25.00
- 25.00 to 50.00
- 10.00 to 75.00
- > 75.00

Title:

Macroalgal Cover at Other Sites Around Lindeman Island

Figure: **4-8**

Rev: **A**

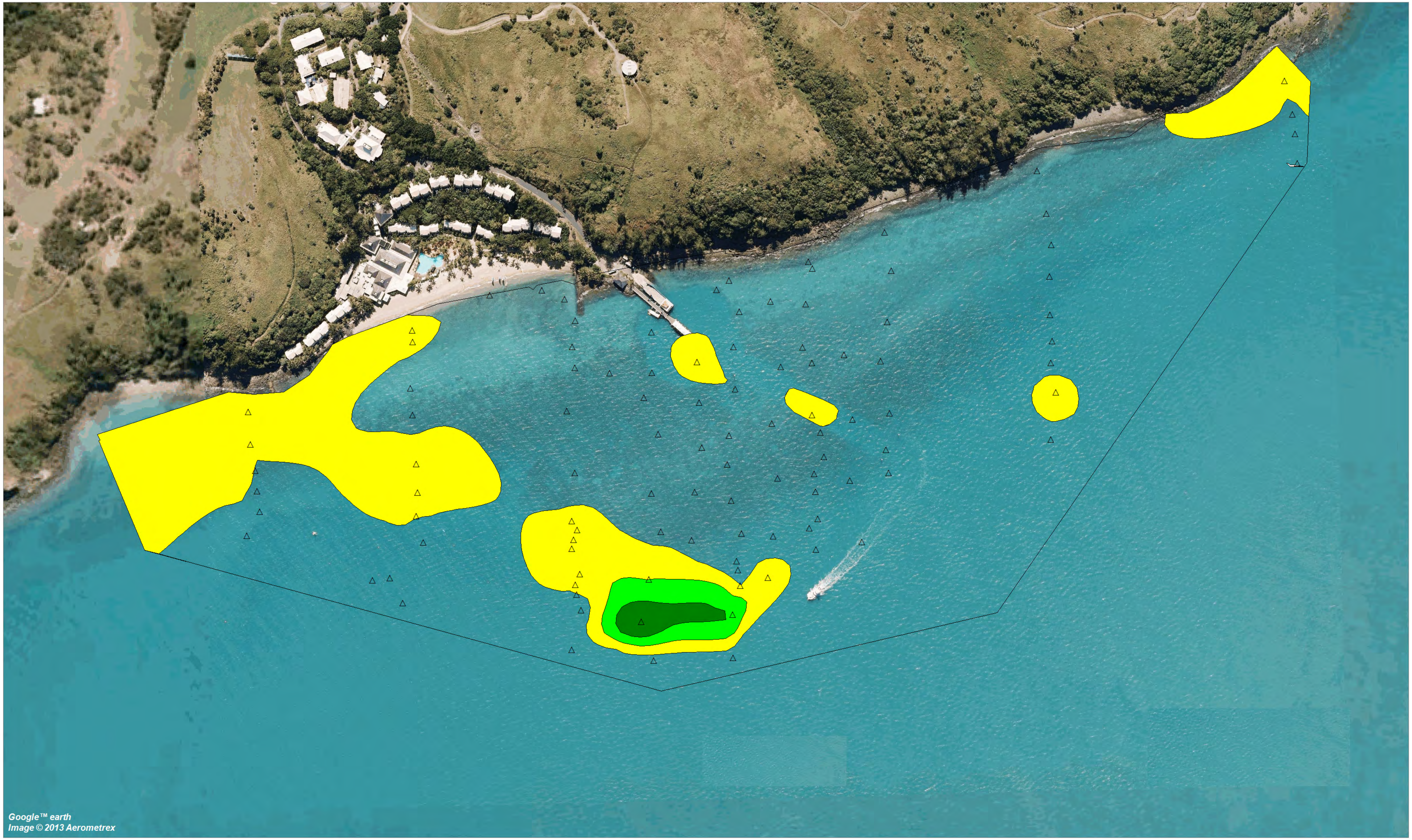
N

0 100 200m
Scale - Map 1

0 150 300m
Scale - Maps 2,3 and 4

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_011b_130905_algae cover_other.wor



LEGEND

△ Survey Point

Seagrass %

(white)	< 1.00
(yellow)	1.00 to 5.00
(light green)	5.00 to 10.00
(dark green)	> 10.00

Title:
Seagrass Cover at the Existing Jetty Site

Figure: **4-9**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

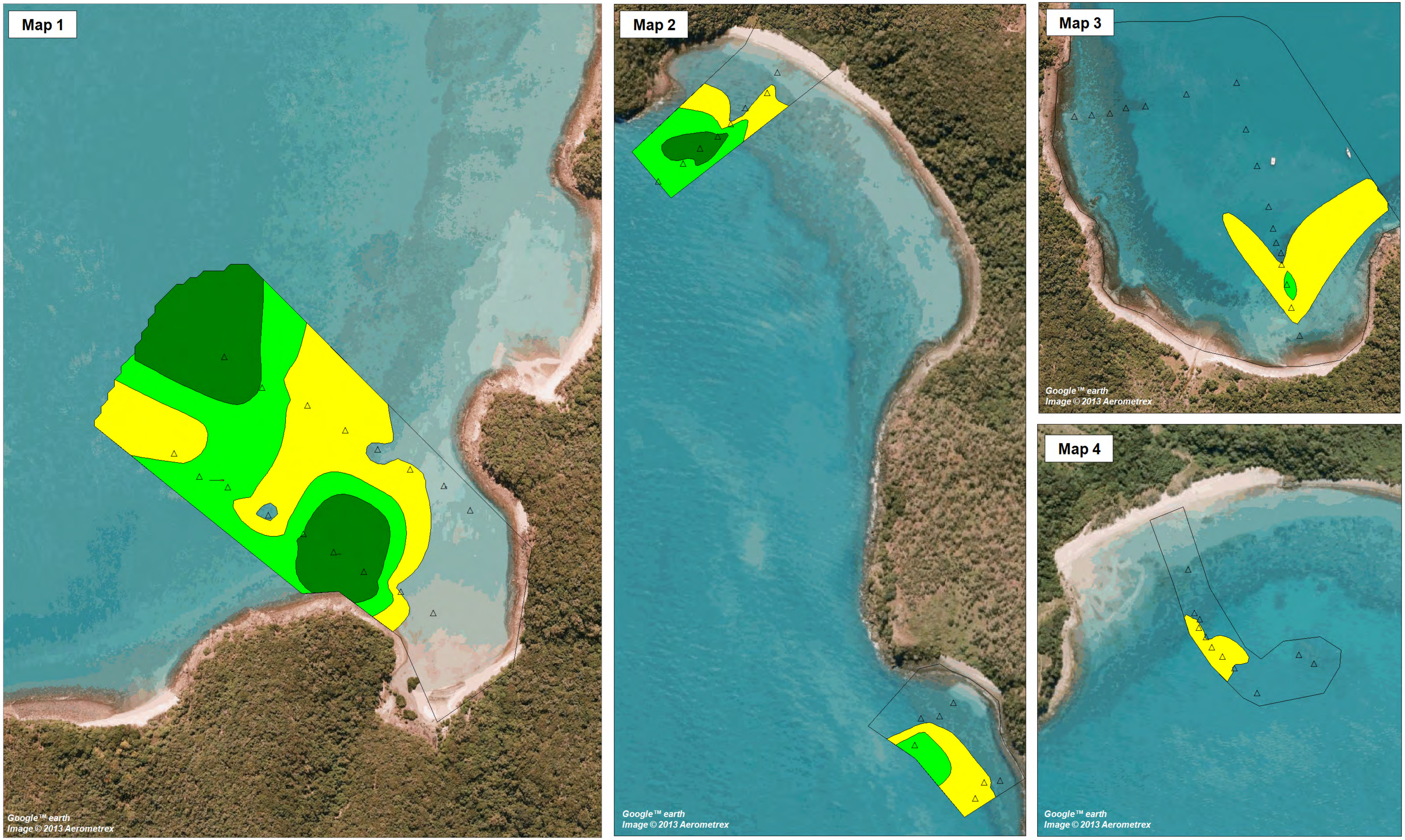
N

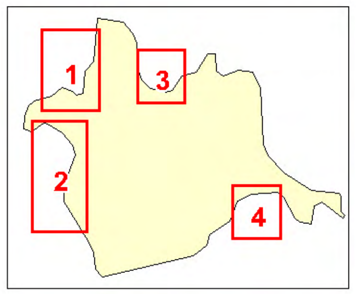
0 100 200m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_012_130904_seagrass cover_resort.wor





LEGEND

△ Survey Point

Seagrass %

- < 1.00
- 1.00 to 5.00
- 5.00 to 10.00
- > 10.00

Title:

Seagrass Cover at other Sites Around Lindeman Island

Figure: **4-10**

Rev: **A**

N

0 100 200m
Scale - Map 1

0 150 300m
Scale - Maps 2,3 and 4

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_008b_130902_bathymetry_other.wor

5 Potential Impacts

5.1 Safe Harbour

A range of direct and indirect impacts to marine life can be expected from the construction and operation of the safe harbour site. The following is a summary of the key forms of impact associated with the proposal for each of the three optional designs presented in Figure 5-1 to Figure 5-3.

5.1.1 Potential Construction Impacts

5.1.1.1 Direct Habitat Loss

The construction of the harbour would result in the direct and permanent loss of seabed habitat. Table 5-1 shows that harbour construction would lead to the direct loss of 5.029 to 6.671 ha of coral reef, depending on which design option is selected (see Figure 5-1 to Figure 5-3). These estimates are based on the total area of coral reef habitat within each breakwater. They do not however include any additional dredging that may be required outside of breakwaters, particularly for Option 1.

Overall, design option 3 had the smallest footprint, with the majority of the area consisting of low (1-5% coral cover) or bare sediment. However it should be noted that survey effort/intensity (and therefore mapping accuracy) in the Option 3 footprint was lower than it was for options 1 and 2.

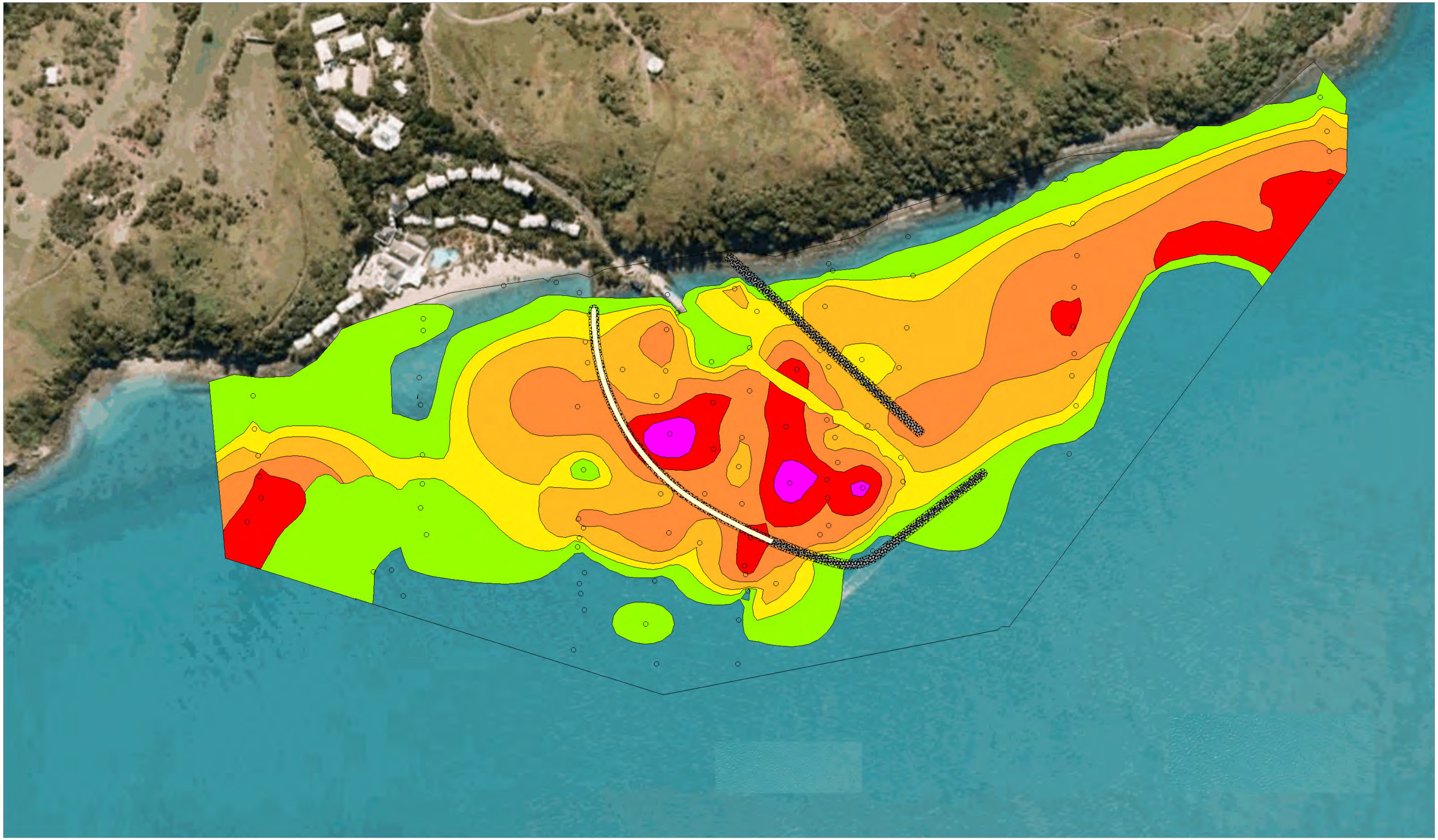
Coral loss represents the most significant impact of the project, given the size of the footprint and the regional significance of the reef surrounding the jetty. It is noted that fringing reefs elsewhere around Lindeman Island are less extensive an have lower cover (generally <10% cover) than around the existing jetty area.

Table 5-1 Area of Coral (ha) within Each Safe Harbour Design Option

Coral cover	Option 1	Option 2	Option 3
>75%	0.31	0.04	0
50-75%	1.19	0.55	0.62
25-50%	1.93	1.21	0.37
10-25%	1.55	2.23	0.36
5-10%	1.01	1.28	0.36
1-5%	0.68	1.24	3.31
Total	**6.67**	**6.55**	**5.02**

Direct loss of macroalgal within and adjacent to the proposed marina footprint is not likely to constitute major impacts considering the dominance of this habitat elsewhere on Lindeman Island, and that this habitat represents a disturbed state, signifying the absence of living coral.

Seagrass communities mostly fall outside of the proposed footprint, and those encompassed by it had relatively low biomass, and were composed of early colonising species. Given the low-biomass and cover, they are unlikely to represent significant foraging habitat for marine turtles and dugong at the jetty site. The only substantial meadows observed during this study were located at Boat Port.



LEGEND

○ Survey Point

Coral Cover %

- < 1.00
- 1.00 to 5.00
- 5.00 to 10.00
- 10.00 to 25.00
- 25.00 to 50.00
- 50.00 to 75.00
- > 75.00

Title:

Extent of Living Coral within Option 1 at the Potential Safe Harbour Site

Figure: **5-1**

Rev: **A**

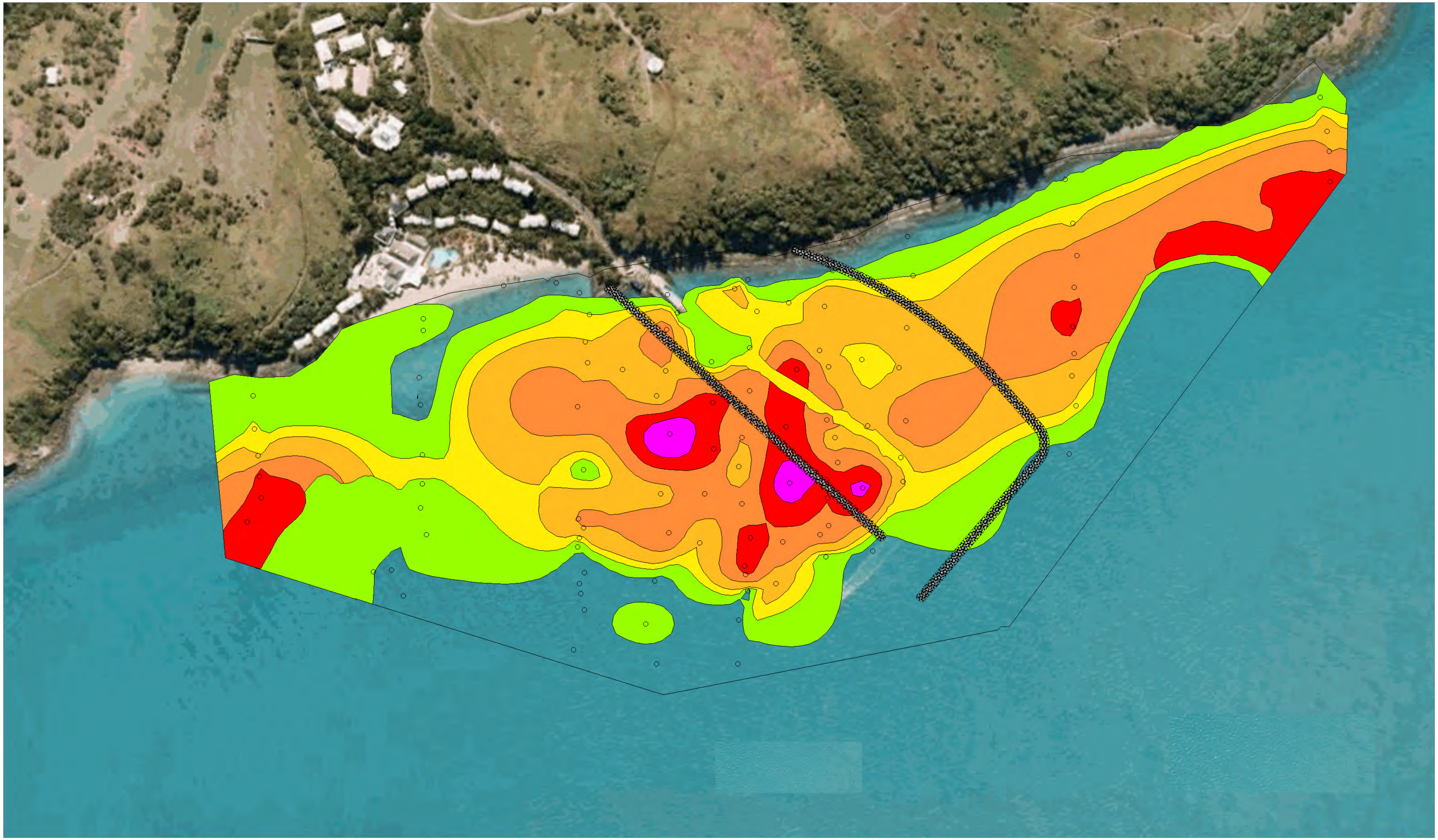
N 0 100 200m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_010c_130917_coral cover_resort_footprint.wor



LEGEND

○ Survey Point

Coral Cover %

- < 1.00
- 1.00 to 5.00
- 5.00 to 10.00
- 10.00 to 25.00
- 25.00 to 50.00
- 50.00 to 75.00
- > 75.00

Title:

Extent of Living Coral within Option 2 at the Potential Safe Harbour Site

Figure: **5-2**

Rev: **A**

N

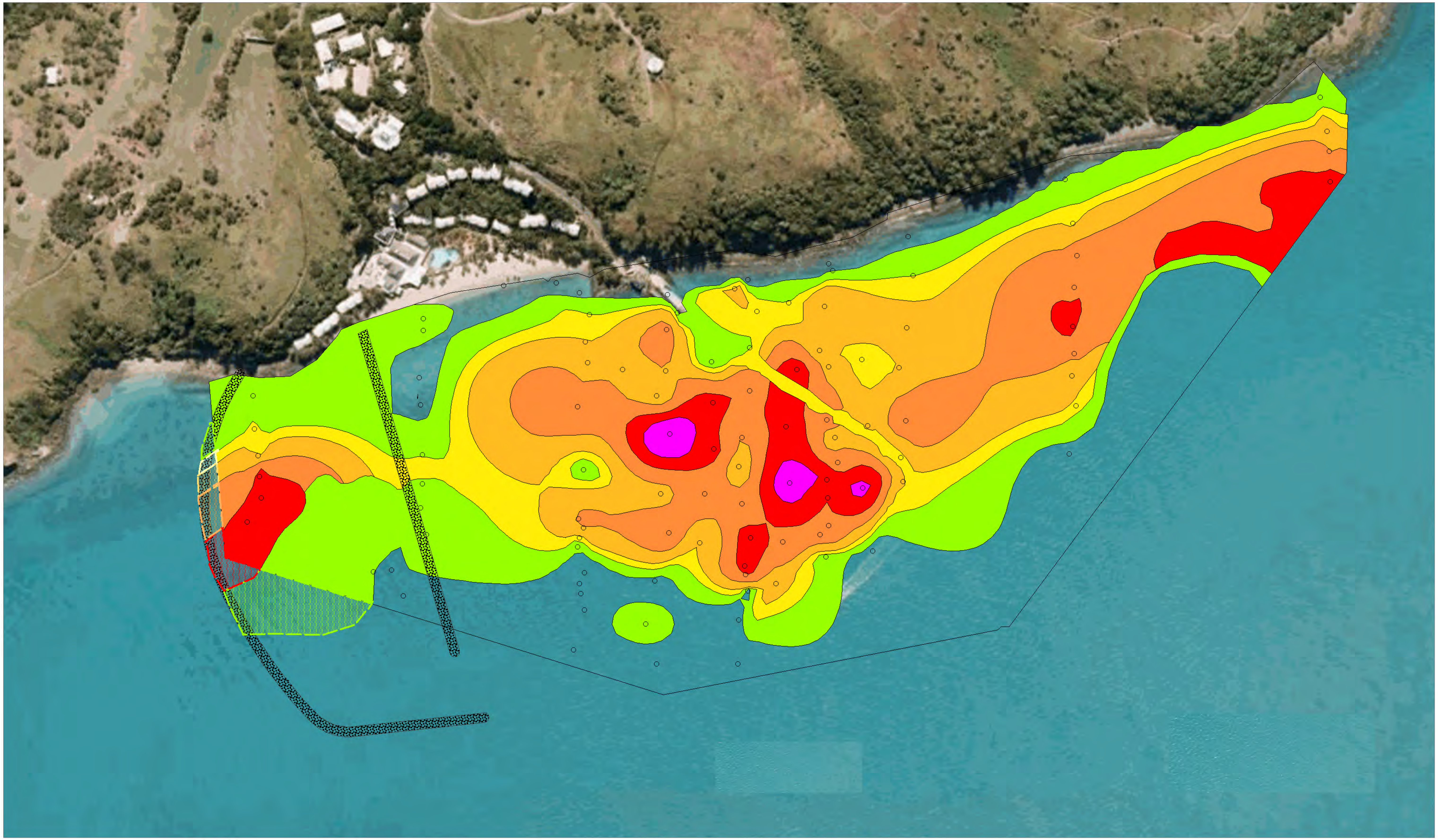
0 100 200m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_015_131004_coral cover_Option2_footprint.wor



LEGEND

○ Survey Point

Coral Cover %

- < 1.00
- 1.00 to 5.00
- 5.00 to 10.00
- 10.00 to 25.00
- 25.00 to 50.00
- 50.00 to 75.00
- > 75.00

Title:

Extent of Living Coral within Option 3 at the Potential Safe Harbour Site

Figure: **5-3**

Rev: **A**

N 0 100 200m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20346_I_BRH Lindeman LBL\DRG\ECO_013_131004_coral cover_Option1_footprint.wor

5.1.1.2 Indirect Construction Impacts

Indirect impacts (i.e. loss or degradation of habitat outside of the harbour) would be expected as a result of marina construction. Indirect effects of breakwater construction include:

- Reductions in light and smothering of biota and habitats due to the remobilisation of sediments (e.g. by rock wall placement, construction craft, dredging). It is expected that even with the application of management measures (e.g. containing sediments within the harbour), localised short-term impacts to benthic communities would occur immediately adjacent to the construction footprint.
- Noise impacts to fauna. Noise created by either dredging or construction activities (i.e. from vessels, pile driving, or other machinery operation) has the potential to affect marine megafauna, particularly dolphins or dugongs. For example, noise emitted from dredge operation, vessel manoeuvring or sonar equipment could be beyond the tolerance limits of these animals, mask their vocalisations, interfere with dolphin sonar signals or alter their behaviour (i.e. noise avoidance). Piling could also cause physiological damage if inappropriately managed. This is not considered to be a key risk issue given: (i) low abundance of fauna in the area; (ii) management strategies could effectively manage this risk.
- Other water quality impacts. Fuel spills from construction vessels and plant could lead to water quality impacts. Depending on the construction methodology used, tail-water discharges could also lead to impacts (particularly smothering) to receiving environments. Appropriate management strategies will need to be developed to manage these impacting processes.
- Marine turtle entrapment within the harbour during dredging is likely given the number of turtles residing on the reef at the jetty (> 6 individuals observed during field work) and rates of entrapment that have occurred in other similar seawall constructions at the Port of Brisbane and Gladstone. The potential for entrapment will depend largely on construction techniques. None of the beaches surrounding Lindeman Island are especially noted as turtle nesting sites; however, the Mackay and District Turtle Watch (2013) suggest that some nesting occurs in low numbers at a range of mainland beaches and throughout the Whitsundays. Construction of the safe harbour will not likely present a significant impact to turtle nesting on the beach in front of the resort.
- Habitat fragmentation. The harbour walls will partially impede the transit of fauna between the eastern and western sides of the remaining reef flat. The dredged channel currently acts as a partial barrier, as many reef-associated fish will not venture more than several metres onto open substrates away from coral habitat. The harbour walls will require large fauna such as turtles to transit around the front of the harbour opening. Habitat fragmentation is not expected to be a significant impact compared to direct loss of habitat.
- The direct loss of reef flat will reduce the intertidal foraging area for birds, potentially including threatened migratory birds. The potential for significant impact to migratory waders is low considering the type of intertidal habitat to be lost (reef flat). This may require further assessment.

5.1.2 Potential Operational Impacts

Other indirect effects at the jetty site relate mostly to water quality impacts. Safe harbour infrastructure will likely include fuelling facilities, and the increased vessel presence will increase the likelihood that toxicants and nutrients will enter the water. These include copper-based antifoulants passively releasing from vessel hulls inside the harbour, faecal coliforms and nutrient from accidental or incidental sewage release, and minor chemical/ hydrocarbon spills associated with vessel maintenance inside the harbour.

Depending on local hydrodynamics, there is also the potential for sediment accumulation on either side of the breakwaters, which may increase the area of reef indirectly affected by the safe harbour structure. Sediment will also accrete within the safe harbour and require occasional maintenance dredging.

Operation of the harbour will increase vessel traffic in the vicinity of Lindeman Island, in increase the risk of vessel strike for megafauna. Most vessel movements in the area will be relatively slow moving, associated with berthing and docking, and are unlikely to significantly increase vessel strikes. However, the rapid movements of vessel tenders may increase the risk of vessel interactions with turtles.

Increased vessels traffic can also increase the amount of debris entering the water. Litter (e.g. plastic bags or rubbish from vessels) can entangle marine megafauna, resulting in injuries and possible drowning. Turtles, in particular, can also ingest foreign objects that are mistaken as food, which can lead to stomach or intestinal blockages.

Operation of the safe harbour will increase the amount of light emitted into the natural environment. Additional lighting from the resort redevelopment and the safe harbour may affect the navigation of adult turtles attempting to nest, or the emergence of hatchling turtles.

International and interstate vessels transiting to the safe harbour have the potential to introduce exotic species, which can become pests in the marine environment. This can occur through the introduction of sedentary organisms fouling vessel hulls, or in dredging and marine construction equipment. Introducing exotic marine species into new environments can threaten the integrity of natural communities, the existence of threatened species, and the viability of industries based on living industries (e.g. fisheries, tourism) (CSIRO 2008).

Freshwater point-source release into, or adjacent to, the harbour represents the other potential major operational impact. Sudden freshwater release into corals can be lethal and freshwater point-sources are often devoid of corals. Operational impacts of point source freshwater can be mitigated through effective design.

5.2 Temporary Barge Access

Boat Port and Gap Beach are both suitable potential locations for temporary barge access. Both locations already have an access track to the site, which would need to be widened for vehicular access. Sensitive marine communities are set back further from the shore at Boat Port, perhaps making this location less prone to propeller wash disturbance.

Because barge access will only occur during high-tides, construction impacts will consist only of impacts associated with road creation (e.g. potential loss of marine plants dependent on where the road access point meets the beach, stormwater/ sedimentation impacts of road construction). Most impacts at the barge loading site would be operational only. The primary forms of marine impact at the barge loading site would include the impact of propeller wash on coral and seagrass communities, potential vessel interaction with dugong, and vehicular impact to the beach community.

At Boat Port, coral and seagrass communities are set well back from the beach; hence, high tide landings would not likely have a significant effect on these communities. Because the seagrass beds here were the densest of any located during the present study (generally <30% cover), the potential for interaction with dugong and turtle (to a lesser degree) is perhaps highest at Boat Port. Given relatively slow barge approach speeds, sparse cover of the seagrass, vessel interaction in not considered likely to be a significant impact.

At Gap Beach, coral and seagrass communities are closer to shore but still relatively far back from the high tide mark from the beach; hence, high tide landings would not likely have a significant effect on these communities. Given relatively slow barge approach speeds, daily transfer rates, and sparse seagrass meadows at Gap Beach, vessel interaction with megafauna in not considered likely to be a significant risk issue.

Vehicle access to the beach will be required for loading and unloading of the barge, including potentially a set-down area for transported goods. Vehicles accessing the beach have the potential to disturb wader birds, turtle nests, and can reduce the abundance of macroinvertebrates, which in turn provide forage for wader birds, fishes, sharks and rays. Reducing the footprint of the set-down area in the beach and minimising the length of beach transited by vehicles will reduce these impacts as far as practicable. Given proper management of the road construction, beach landing and set down areas, significant impacts to the marine ecology of Boat Port area not expected.

Other impacts of regular barge landing include visual amenity and noise impacts to campers utilising the campground. This is not considered part of the marine ecology scope, but is noted nonetheless.

6 Recommendations

While it is recognised that legislative, engineering, and other constraints make the jetty location the only viable option for safe harbour development, the present design will impact one of the highest-density hard coral communities on Lindeman Island. The most significant impact of safe harbour creation is this habitat loss. The extent of significant living coral communities present within the proposed footprint at the jetty location (Figure 5-1) will likely represent a point of concern for GBRMPA given their emphasis on the preservation of significant/ sensitive habitats (GBRMPA 2010).

Impacts will need to be addressed through an environmental management framework of avoid, mitigate, and offset. Close consultation will be required with the Australian and Queensland Government agencies to determine the appropriate framework to be adopted for the project and to ensure approvals can be obtained.

6.1 Avoidance of Impacts

Some direct impacts of habitat loss can be avoided through re-configuration of the safe harbour design, in liaison with government departments. Options 1 and 2 are advantageous, in that, the disturbance created by the existing dredged channel, jetty, and ramp infrastructure fall within their footprints. To not utilise at least part of the existing disturbance footprint will increase the amount of disturbance to previously undisturbed benthos. It is recommended that consultation with GBRMPA should occur prior to any further re-configuration or field work to determine their preferences for design modification, mitigation, or offsetting within the realised limitations of the project (prohibitive construction costs and restricted available locations).

6.2 Mitigation of Impacts

Apart from direct habitat loss, other construction and operational impacts can foreseeably be mitigated and are not likely to represent significant challenges to the project. Some forms of construction impact mitigation include:

- Development and implementation of Environmental Management Plans (EMPs) for harbour construction and operation, maintenance and capital dredging.
- Minimising the area of impact through construction methodologies, including:
  - building seawalls prior to commencement of dredging;
  - using sediment fencing or bunding;
  - using a mechanical bucket or grab dredge where possible to minimise plume generation; and
  - onshore placement of material.
- Minimising the severity of impacts through monitoring:
  - Marine megafauna presence during dredging and construction;
  - Water quality via a monitoring program developed and implemented in accordance with a Long Term Dredging and Disposal Management Plan (LTDDMP); and

- Noise emissions if pile driving.

The effects of harbour operation on water quality, marine debris, and introduced marine pests can be mitigated by ensuring that operational procedures follow appropriate EMPs and best management practices for septic discharge, ballast and rubbish management. Lighting impacts on nesting turtles can be mitigated by restricting the intensity, height, direction, and timing of lighting (seasonally). The effects of sedimentation and coastal processes should be investigated using coastal process modelling. Mitigation of coastal process impacts will depend on the nature of predicted changes, and these should be considered within the LTDDMP. Impacts of point-source stormwater discharges on coral communities can be mitigated by effective stormwater retention and design, which should consider the proximity of release point to coral communities and diffusive potential of surrounding seawater.

6.3 Offsets for Residual Impacts

Residual impacts of habitat loss may be offset in a variety of ways, by using habitat forming construction materials, by creating new reef habitats elsewhere, and by relocating structural elements of habitat away from the intended footprint. Harbour construction materials consisting of pre-fabricated armour structures such as “x-bloc” can increase the rugosity of the seawall structure and provide additional habitat. Structures such as x-bloc and “reef balls” (Figure 6-1) can be used to form new areas of reef over adjacent bare sand habitat. Corals from the footprint area could be transplanted onto these structures, or used to increase coral cover over the surrounding reef outside of the footprint. The appropriateness of these measures as offsets will need to be discussed with GBRMPA.

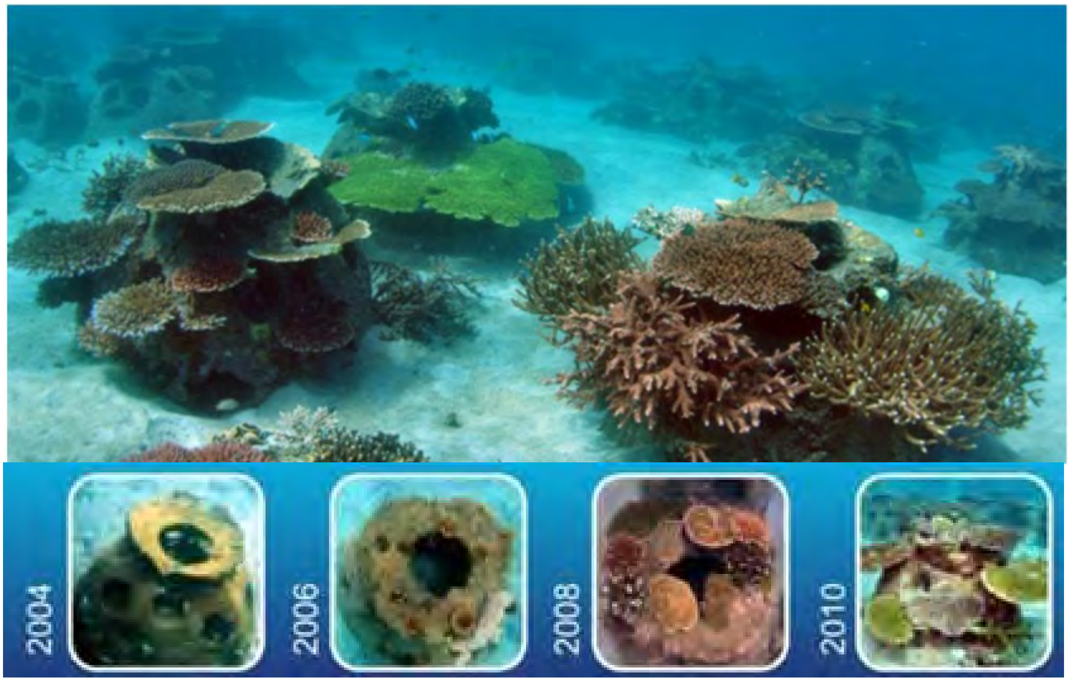


Figure 6-1 Example of “Reef Balls” used as artificial reefs

Seagrass and coral communities of Boat Port (and Gap Beach to a lesser degree) are situated offshore from beach landing sites and would not likely be degraded by a regular high-tide barge service. While there will need to be management of impacts to turtle nesting and human users of the site, the distribution of seagrasses and corals, and the derived bathymetry at Boat Port are not prohibitive to the establishment of the high-tide barge access. Depending on where the road access point meets the beach, there may be some marine plant disturbances (mangroves) required. If marine plant disturbances are relatively minor, financial offsetting or rehabilitation may the most appropriate offsets.

7 References

BMT WBM (2013) Lindeman Island Resort Safe Harbour – Engineering Aspects. Report prepared for White Horse Australia, October 2013. R.B20436.003.00Engineering.pdf

CSIRO (2008) CSIRO Research: Introduced Marine Pests. Online publication by the Commonwealth. Scientific and Industrial Research Organisation (CSIRO), Canberra. http://www.marine.csiro.au/crimp

GBRMPA (2010) Dredging and Spoil Disposal Policy. Available online: http://www.gbrmpa.gov.au/__data/assets/pdf_file/0019/3844/gbrmpa_DredgingandSpoilDisposalPolicy_2004.pdf

Hyland SJ, Courtney AJ, Butler CT (1988) Queensland Seagrass Meadows 1984-1988, Queensland Department of Primary Industries and Fisheries.

Mackay and District Turtle Watch (2013) http://www.mackayturtles.org.au/

Smith JN, Grantham HS, Gales N, Double MC, Noad MJ, Paton D (2012) Identification of humpback whale breeding and calving habitat in the Great Barrier Reef. Marine Ecology Progress Series 447: 259-272.

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.bmtwml.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.bmtwml.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	1st Floor, International House St Katherine's Way London E1W1TW Email london@bmtwbm.co.uk Web www.bmtwbm.com.au
BMT WBM Mackay	Suite 1, 138 Wood Street Mackay 4740 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	Suite 6, 29 Hood Street Subiaco 6008 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 V6E 3W1 Canada Tel +1 604 683 5777 Fax +1 604 608 3232 Email vancouver@bmtwbm.com.au Web www.bmtwbm.com