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Mission Beach Safe Boating Infrastructure Project

Multi-Criteria Analysis

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Contents

Appendices

Appendix A

Component description

Appendix B

Cost estimates

Appendix C

KPI Results

Appendix D

Component MCA results

Appendix E

Option MCA results

Figures

Tables

1 Introduction

1.1 Background

Aurecon has been engaged by the Department of State Development, Infrastructure and Planning (DSDIP) to identify solutions to enhance the safety of commercial and recreational boating facilities in Boat Bay, Mission Beach. Existing facilities within Boat Bay include the Clump Point Jetty at Narragon Beach and the Clump Point boat ramp and its breakwater and finger pontoon. The study is limited to maritime infrastructure improvements, which have a reasonable delivery period of approximately 18 months and a total budget of approximately $16.3 million, including all fees and preliminaries.

The first key objective of the project is to select a preferred solution. A number of possible project components have been identified. These components would improve the safety of boating facilities in the region. Furthermore, these components have been grouped to form development options. Each option fits within the project budget.

To ensure that a robust and transparent assessment is applied to the selection, of a preferred design solution, a Multi Criteria Analysis (MCA) has been undertaken to compare alternative options against pre-determined themes and criteria measured against a range of key performance indicators (KPI's). The selection process involved collective ranking assessment.

1.2 Purpose of the report

The purpose of this report is to outline the process and results of the MCA which has produced a preferred option to improve safe boating conditions at Mission Beach. Accordingly, this report provides the following:

- A brief description of the project (Chapter 2)
- A description of the methodology undertaken for the MCA assessment, including the rationale, criteria and inputs to the assessment process (Chapter 3)
- Details of KPI assessment (including cost estimates) which were relied upon within the MCA (Chapter 4)
- The results of the MCA, including selection of the preferred option (Chapter 4)
- A description of the preferred option (Chapter 5)

2 Project description

2.1 Subject site

Boat Bay is located at Mission Beach, approximately 100 km south of Cairns and 170 km north of Townsville within the Cassowary Coast of Far North Queensland. The Project site (encompassing Lot 550 NR 7351, Lot 540 NR 7350) is designated as a State reserve for Boat Harbour purposes, and is administered by the Cassowary Coast Regional Council (CCRC) as a trustee on behalf of the State of Queensland.

Figure 1 overleaf illustrates the subject site and location of existing facilities within Boat Bay.

2.2 Project rationale

Clump Point is a northerly facing headland which provides existing infrastructure located in Boat Bay with a level of natural protection from the prevailing south-east winds and waves. The Clump Point public boat ramp is also provided with additional protection from north-easterly winds and waves by a rock breakwater. The Clump Point Jetty is significantly exposed to the elements and in particular, there is no protection from northerly winds.

Accordingly, the safe and efficient use of existing facilities within Boat Bay, by both recreational and commercial users, is currently influenced by weather conditions. As the breakwater at the public boat ramp provides a level of protection in most tidal conditions and because the Clump Point Jetty was being reconstructed following Cyclone Yasi in early 2011, the boat ramp has become the primary point of departure for commercial operators, as well as recreational users over the last few years.

Following recent consultation undertaken by DSDIP with the Mission Beach community, there is recognition that facilities in Boat Bay need to be improved to meet current and future needs, and to address safety concerns associated with the lack of wave attenuation at the jetty.

Figure 1 Project site and existing facilities (Source: State of Queensland 2013)

2.3 Guiding principles

The overall objective of this Project is to identify development solutions to enhance the safety of the existing boating facilities in Boat Bay. To meet this overall objective, a number of guiding principles have been identified, as detailed below:

- The study is limited to maritime infrastructure improvements, which have a reasonable delivery period of approximately 18 months and a total budget of approximately $16.3 million (including all fees and preliminaries)
- The design objective is to identify design or infrastructure solutions to improve the safe transfer of passengers and goods under ambient conditions. The project does not intend to provide facilities to withstand the effects of cyclone events. The Cassowary Coast Regional Council has constructed the re-instated Clump Point Jetty for cyclonic wave loads.
- The project scope is limited to the analysis of structures to enhance the safety of existing facilities within Boat Bay
- The design criteria adopted for the marine infrastructures, including of working life are compatible with engineering standards
- Commercial and recreational facilities are to be separated as far as practicable to avoid operational conflicts and congestion
- The project is intended to provide facilities for the berthing of marine vessels only. No mooring facilities are to be investigated or provided
- A design which involves a significant reclamation (mass of land created in the sea) may trigger the need for a change to the boundaries of the Great Barrier Reef Marine Park, as specified within the *Great Barrier Reef Marine Park Act 1975*. The timeframes to amend this legislation and having it passed by both houses of Federal Parliament are outside the delivery period considered for this project and therefore such works have not been included in the study.

3 Methodology

3.1 Objectives

The objective of the MCA was to apply a qualitative and quantative approach to the assessment and comparison of alternative design components. The MCA incorporated multiple pre-determined criteria simultaneously within the analysis, to arrive at a single robust conclusion based on the rankings. As such, the MCA integrates a range of technical issues, impacts and opportunities, and therefore provided a decision making tool for complex situations.

The MCA aimed to analyse each design component with regards to five pre-determined 'themes' which were relevant to the decision making process for the project. Each theme was weighted accordingly, based on its relative importance to achieving the project objectives. The result of the MCA analysis was a ranking of least preferred to most preferred design components and, ultimately, determination of an option to progress to the preliminary and detailed design stages, and ultimately for construction.

The following section outlines the methodology and inputs of the MCA.

3.2 MCA methodology

The methodology applied for the MCA involved five key stages, as outlined below:

- Stage 1 – Information and data review
- Stage 2 – Selection of alternative design 'components' and concept design
- Stage 3 – Confirmation of MCA inputs and scoring
- Stage 4 – Stakeholder workshop to discuss theme weightings and options retained
- Stage 5 – MCA component analysis and results

A summary of each of these steps is provided below.

3.2.1 Stage 1 – Information and data review

Given the consultation and technical assessment which had been previously undertaken for upgrading facilities in Boat Bay, the first stage of the MCA involved a review and analysis of these earlier studies, technical reports and data. This stage was important in providing the necessary foundations for the MCA, and ensured that design components and subsequent scorings were considered against the unique social, environmental, cultural, regulatory and economic context of the site.

3.2.2 Stage 2 – Selection of design 'components' and concept design

A total of 20 design components were identified for investigation to improve boating safety at Boat Bay, as listed in Table 1 below. Further description of these components, and associated concept sketches, are included in Appendix A.

Table 1 Potential design components

Component	
Clump Point Jetty	
1	Pontoon and connecting gangway
2	Breakwater
3	Piled wave barrier
11	Disabled access
12	Caisson breakwater
13	Floating attenuator
14	Overtopping breakwater
Clump Point Boat Ramp	
4	Detached breakwater extension
5	Drainage and flushing system
6	Dredging of ramp approaches
7	Commercial wharf
8	Re-positioning of existing pontoon
9	Third boat ramp lane
10	Additional car park
15	Offshore additional boat ramps
16	Offshore Pontoon
17	Commercial pontoon
18	Dredging of a sediment trap
19	Land-backed wharf
20	Berthing Pontoon

These 20 components were determined from the 10 initial components listed within DSDIP's 'Invitation to Offer' (numbered from 1 to 10), as well as 10 additional items which were subsequently identified by Aurecon as a means to also improve boating safety.

Prior to the MCA, each of these components was designed to concept level to allow a relative assessment of opportunities, costs and impacts. Concept sketches were developed for each design component. These sketches are provided in Appendix A.

It is noted that each of the above design 'components' was considered in isolation through the MCA, and assessed on its own merits. However, it was recognised that to optimise the design and maximise boating safety at Mission Beach, the preferred design solution was likely to comprise not one single component, but rather a combination of a number of these individual 'components'. These ultimate solutions are therefore referred to as 'options' (as opposed to 'components') and were determined following the MCA analysis.

3.2.3 Stage 3 – MCA inputs and scoring

3.2.3.1 Criteria themes

The basis of the MCA is the ranking of alternative design components against pre-determined 'themes' which are relevant to the decision making process for the project. A description of the themes identified for this project, and the relevant criteria upon which these themes are assessed, is provided in Table 2 below.

Table 2 MCA themes and assessment criteria

MCA Themes and assessment criteria	
1	**Impact**
	The impact or influence of a proposed option is a key consideration, and generally relates to the degree to which an option may change conditions from the status quo (perceived or otherwise defined). Impacts can occur to the environment and to the community. **Assessment criteria:** ■ *Marine biodiversity* – The degree to which the option may impact marine biodiversity at Clump Point, considering the benthic and pelagic species associated with the beach, intertidal flats and the sub-tidal areas ■ *Beach/nearshore biodiversity* – The degree to which the option may impact beach and dune biodiversity (those areas typically above high tide mark), considering suitability to promote dune vegetation (re-vegetation) and the opportunity for re-colonisation by dune animal species ■ *Terrestrial and marine impacts* – The likelihood of the option to impact on terrestrial or marine ecology in the immediate physical footprint ■ *Environmental impacts beyond Clump Point* – Considering the impact of the option on areas farther afield, including the impact on materials source (traffic from quarries), and up/down coastal impacts due to changes in sand supply, siltation, or the generation of plumes ■ *Navigation* – The impact the option might have on safe navigation and/or ability to safely beach boats and other recreational vessels as well as improving the reliability of inter-island ferries and taxis ■ *Construction timing* – The time taken to undertake construction, and also consider the flexibility of timing (i.e. the degree to which external influences may restrict the timing of works) ■ *Non-boating users* – The degree to which the option may impact on non-boating users within the community
2	**Effectiveness**
	The effectiveness of the options to address the safety problem is assessed via a range of criteria. Consideration is given to both the upside (addressing the problem) and downside risk (failure consequence) of each option as well as assessment of option specific uncertainties. **Assessment criteria:** ■ *Longevity of design* – Consideration of design life under typical conditions ■ *Addresses incident wave problem* – Degree to which solution directly attenuates incident waves, creating a reduced wave energy condition at the berth ■ *Failure consequence* – Considers the downside risk of failure of the proposed option, perhaps due to exposure to conditions beyond design criteria, where consequences could include potential loss of life or damage to public/private property and/or infrastructure ■ *Technology challenges* – Provides a measure of the uncertainty associated with proven vs new technology, and considers options proven/suitable for conditions at Clump Point through to new technology unproven in Far North Queensland or elsewhere

MCA Themes and assessment criteria	
3	**Social value**
	The local and extended community of boating users have expectations about the Clump Point Facilities. An important measure of the appropriateness of the proposed solution option is the degree to which the values held by the community can be preserved. **Assessment criteria:** ■ *Visual amenity* – The degree to which the option meets with the community's expectation of what Clump Point should look like, and/or the degree to which an option may detract from such expectations about the boating infrastructure and nearby coast ■ *Boating safety* – Considers issues such as: does the option provide safer boating infrastructure, and provide opportunity for the safe use of recreational water craft? ■ *Sense of place* **–** Degree to which the option may alter the sense of place, cultural heritage, or community connectedness to Clump Point ■ *Suitability of Materials* – Degree to which the community may accept proposed materials, recognising the materials' adaptability for use (or not) for stairs, walkways, informal seating and an assessment of other material specific issues including user-friendliness, colonisation of pests, litter, maintenance and odour
4	**Government processes**
	This theme considers the governmental process challenges associated with each option. **Assessment criteria:** ■ *Roles and responsibilities* – Degree to which various local, state and federal government roles and responsibilities are understood and can be complied with ■ *Compliance with coastal management objectives* – As a guiding principal, the Coastal Protection and Management Act (1994) and GBRMP Act (1975) provide guidance reference for proposed actions at Clump Point. This measure captures the degree to which the option is consistent with coastal policies and objectives ■ *Approvals process/duration* – Considers the requirements and complexity of approving the proposed option, whether secured via existing well understood pathways or requiring significantly more levels of assessment or which may significantly jeopardise the success or viability of the project ■ *Assessment inputs* **–** Recognises the additional time, effort and costs associated with obtaining supporting environmental assessments to obtain regulatory approval. This criterion considers only the additional environmental assessments required, beyond the 'base case' approval inputs
5	**Economics**
	Cost is a major factor in any infrastructure project. Further, it is recognised that the Mission Beach Boating Infrastructure project are subsidised by the Queensland and Federal Governments. Once completed, the works will become part of the portfolio of public assets (likely to be owned and managed by DTMR or CCRC) and accordingly, capital cost is not the only consideration. **Assessment criteria:** ■ *Capital Cost* – In relative dollar terms, the up-front cost of the option, including materials costs, site construction activities, and any environmental (or other) monitoring linked to the option ■ *Maintenance Cost* – The cost of periodic routine maintenance ■ *Lifecycle cost* – The total cost of the asset each year, over its design life

3.2.3.2 Key Performance Indicators (KPIs)

For each of the assessment criteria identified in Table 2 above, a qualitative or qualitative response measure (referred to as a KPI) was provided. KPI's are not intended to be all-encompassing or universal, but gauge the relative opportunities or constraints for each component and theme.

The KPI's identified for the project are identified in Table 3 (indicated in italic) and provided the framework for the initial ranking of each design component.

Table 3 Criteria themes and associated KPI's

Themes				
1: Impact	**2: Effectiveness**	**3: Social Value**	**4: Government process**	**5: Economics**
Marine biodiversity *Underwater surface of impact (m^2)*	Longevity of design *Design working life (years)*	Visual amenity *(Height x area from Alexander Drive)*	Roles and responsibilities *Typical number of approvals (Numerical value)*	Capital Cost *(estimated comparative cost, $)*
Beach and nearshore biodiversity *Nearshore surface of impact (m^2)*	Addresses incident wave problem *Target transmission coefficient (0 – 1)*	Boating safety *Safe boating conditions (Excellent-Adverse)*	Compliance with coastal management objectives *Complexity of approvals process (Ranking – L/M/H/VH)*	Maintenance program *How often, time (Timeframe – 1/5/10/15 years)*
Impacts to terrestrial and marine flora/fauna within or near to the project footprint *Likely proximity/impact to or on significant feature/s*	Failure consequence *Functional loss (low to high)*	Sense of place *Typical origin of new users (regional/local/ interstate)*	Approvals process *Start date of construction* *(Duration of assessment and preparation time – business days)*	Lifecycle cost *(estimated averaged lifecycle cost $/year)*
Environmental impacts beyond Clump Point *Sedimentation, siltation (type of effect)*	Technology challenges *Multi-functionality and flexibility in the use of the asset (low/medium/high)*	Suitability of Materials *Are materials /technology already deployed on site (Y/N)*	Assessment inputs *(Additional environmental studies required beyond the base case[1] to achieve approval – Number e.g. 1-5)*	
Navigation *Increase in boating capacity (%)*	Cyclonic capacity *Wave design standard (Year, Averaged Recurrence Interval (ARI))*			
Construction impact *Typical site work duration (months)*				
Non-boating users *Local road traffic increase (%)*				

A number of technical assessments were prepared to compare the 20 design components, to provide a response to the KPIs listed for each theme. The specific methodology and assumptions relevant to the comparative cost estimates, including unit rates and “additional costs”, are outlined in Appendix B. Cost estimations have been prepared for drawing comparison between components rather than for budgeting the works. During the detailed design phase of the project more accurate cost estimates will be prepared.

The KPI results table is presented in Appendix C.

3.2.3.3 Weightings

Recognising that each theme has varying influence or importance to the decision making process, the Table 4 default weighting convention was applied to the MCA assessment.

Table 4 Default theme weighting

Theme	Weightings %
1: Impacts	25
2: Effectiveness	35
3: Social Value/Community Expectations	20
4: Government Processes	10
5: Economics	10
Total score	**100**

These default weightings may influence the decision making process. Therefore, a sensitivity analysis was undertaken in Section 4.2.2 to vary these weightings and determine the “robustness” of the assessment to alternative weightings. For instance, the project theme “Effectiveness” could be dominant from a boat user perspective, while “Impact” could be a major project consideration from a conservationism point of view.

3.2.3.4 Scoring

Using the MCA inputs listed above, each of the components were scored individually using the scoring convention in Table 5 below. This process was undertaken by DSDIP, DTMR and Aurecon project team members, and the results compiled into the final MCA weighting, including the range of discrepancy in responses from alternative viewpoints and/or objectives.

The scoring process ensured that the responses are compared against project objectives and in a consistent format. Status quo and the ‘do nothing’ approach were weighted as 0 in the proposed scoring scale. The use of “heavy” negative scoring was adopted to penalise actions which are detrimental to the project.

Table 5 Scoring convention

Score	Description (from a decision-maker or stakeholder point of view)
-6	Against objective
-3	Fails objective
0	Does not apply or influence objective
1	Partially satisfies objective
2	Meets objective
3	Exceeds objective

3.2.4 Stage 4 – Stakeholder workshop

Following the MCA scoring, a stakeholder workshop was held on 18 October 2013 with attendees from Aurecon, DSDIP, the Cassowary Coast Regional Council (CCRC) and the Department of Transport and Main Roads (DTMR).

The purpose of the workshop was to analyse and review the responses of multiple stakeholders, and to discuss the integration of design components into a preferred design option/s which could be delivered within the project budget. The preferred option was selected at the conclusion of the first half of the workshop.

The second part of the workshop was dedicated to improving the preferred layout through benchmarking and testing it against a range of alternative viewpoints. This included role-playing discussions with a range of Aurecon specialists in safety, environmental regulations, contractual/construction, geotechnical and structural engineering.

3.2.4.1 Option definition

A set of 19 development options, incorporating a range of components, were identified for further analysis. These development options are such that the capital cost of each option estimate meets the project budget. These options are identified below:

Table 6 Development options

Option ID	Selected Component						Capital Cost Estimate
A	5	8	9	10	11	14	$9,380,318
B	5	9	10	11	17		$12,764,813
C	6	10	14	19			$14,296,198
D	2	5	9	10	11		$14,871,452
E	5	6	9	10	16		$15,073,177
F	2	5	8	9	10	11	$15,146,052
G	3	5	8	9	10	11	$15,621,393
H	9	10	11	16			$15,751,079
I	5	11	14	19			$15,843,208
J	5	11	14	17			$16,164,827
K	5	10	11	14	19		$16,326,996
L	9	10	11	14	19		$16,607,651
M	5	10	11	14	17		$16,648,614
N	7						$16,872,464
O	9	10	11	14	17		$16,929,270
P	5	9	10	11	14	20	$17,023,148
Q	5	6	10	11	14	19	$17,120,121
R	5	9	10	11	14	19	$17,284,099
S	5	9	10	11	14	17	$17,605,718

3.2.4.2 Components and options refinement

The MCA workshop involved further refining the highest ranking solutions, in order to improve the balance of economic, social and environmental aspects of the development. It became apparent that the higher ranking development option favoured the separation of commercial and recreational facilities. An alternative possible refinement was highlighted, nominally the possibility of having a overtopping breakwater at the jetty combined with a “high tide” berthing/boarding facility at the boat ramp when waves would result in hazardous use of the jetty. Two possible design modifications were identified to align with this operational objective, nominally Components 20 and Component 21 which are described below:

- Component 20: Heavy duty pontoon finger at the boat ramp
- Component 21: High tide land-backed wharf at the boat ramp

Component 20 is a refinement of Component 17 which would allow berthing of commercial vessels to the refurbished boat ramp finger. Component 21 is a refinement of Component 19 which seeks to reduce the scale of reclamation and dredging and only provide high tide access to a land-backed wharf or piled deck wharf structure. A baseline review of Component 21 showed that this development may not be feasible without dredging to provide high tide access for the commercial users. As dredging markedly reduces scorings (refer section 4.1), only Component 20 was added to the MCA process to eliminate unnecessary complexities.

3.2.5 Step 5 – MCA analysis

The MCA scoring results of the workshop participants were tabulated and weighted to provide a final score for each 'component'.

It is recognised that MCA scoring results can be affected by group behaviour and opinions which are not always based on facts. To mitigate these influences, MCA scorings were prepared before the workshop. Also, seven separate scoring assessments were undertaken by representatives of Aurecon, DSDIP, and DTMR. This provided a cross-section of experts in the field of civil and coastal engineering, planning, safety and environmental science. Each of these scoring assessments was tabulated to calculate a collective response to the 20 Components.

These results were then integrated to calculate a final ranking for each design 'option' identified in Table 6 above.

4 Results

4.1 Component ranking

The component ranking are presented in Appendix D for each theme, illustrating the minimum, averaged and maximum response calculated from the seven individual assessments.

Table 7 consolidates the MCA scorings for each component, considering the default theme weighting and the range of responses received over all the scoring assessments.

In this table a colour coding system has been applied separately/independently **to each column**. "Red" colour denotes low scores and "green or blue" colours denote higher scores. White and yellow indicate intermediate scores.

Table 7 Weighted component ranking

ID	Description	Minimum	Average	Maximum	Est. Capital Cost
Clump Point Jetty					
1	Pontoon and connecting gangway	-2.75	-0.72	1.12	$4,082,250
2	Breakwater	-2.04	0.18	2.37	$10,606,638
3	Piled wave barrier	-1.57	0.09	1.98	$11,081,980
11	Disabled access	-2.68	-0.36	1.42	$2,147,475
12	Caisson breakwater	-1.87	0.07	1.99	$13,598,347
13	Floating attenuator	-1.93	-0.24	1.38	$14,700,000
14	Overtopping breakwater	-0.88	0.49	2.05	$4,840,904
Clump Point Boat Ramp					
4	Detached breakwater extension	-2.20	0.14	1.78	$4,652,766
5	Flushing system	-0.80	0.71	1.66	$676,448
6	Dredging	-4.00	-1.33	0.87	$793,125
7	Commercial wharf	-3.58	-0.50	2.17	$16,872,464
8	Re-positioning of existing pontoon	-0.91	0.53	1.50	$274,600
9	Third boat ramp lane	-1.47	0.42	1.60	$957,103

ID	Description	Minimum	Average	Maximum	Est. Capital Cost
10	Additional car park	-1.28	0.35	1.50	$483,788
15	Offshore additional boat ramps	-3.86	-1.02	1.80	$28,623,970
16	Offshore Pontoon	-3.72	-0.66	2.28	$12,162,714
17	Commercial pontoon	-3.36	-0.63	1.79	$8,500,000
18	Sediment trap	-3.83	-1.22	1.00	$1,442,560
19	Land-backed wharf	-3.65	-1.13	1.75	$8,178,381
20	Berthing pontoon	-2.13	-0.05	1.65	$7,917,431

This table reveals that, in isolation, the Components 6, 15, 18 and 19 recorded low scores while individual Components 5, 8, 9 and 10 scored more positively.

Wave attenuation objectives at the jetty were best achieved by Component 14, followed by Component 2, Component 3, Component 12 and Component 13. While Component 14 and Component 2 are similar structure (breakwaters), it is important to consider that Component 2 has lower “minimum score” and higher “maximum score” than Component 14. A breakwater skews the scorings compared to an overtopping breakwater which scores more evenly across all themes.

An upgrade of the boat ramp capacity combining Components 5, 8, 9 and 10 appears warranted as this has a combined high scoring for a relatively low budget. These combined components improve safety for the recreational users. The function of accommodating the commercial fleet at the boat ramp sees Component 20 ranking higher than respectively 17, 16 and 19.

The results also highlight that dredging is less desirable (i.e. Components 6, 15, 18 and 19). This is due to on-going maintenance and the complexity associated with dredging in the Great Barrier Reef Marine Park.

Component 15, provided for comparison, exceeds the project budget and ranked poorly, despite the fact that it would be highly effective for recreational users.

4.2 Option ranking

During the MCA workshop, a number of development options were identified. These options, presented in Table 6, represent the combination of a number of individual components which ranked favourably through the MCA, are consistent with the project objectives, and fit within the budget.

The detailed results of scoring for these options are included within Appendix E for each theme. Table 8 presents the result in a similar color-coded scale as Table 7.

Table 8 Weighted option ranking

Option ID	Component List	Minimum	Average	Maximum	Est. Capital Cost
A	5 ,8 ,9 ,10 ,11 ,14	-1.37	0.30	1.79	$9,380,318
B	5 ,9 ,10 ,11 ,17	-2.89	-0.40	1.69	$12,764,813
C	6 ,10 ,14 ,19	-2.65	-0.54	1.80	$14,296,198
D	2 ,5 ,9 ,10 ,11	-2.01	0.15	2.12	$14,871,452
E	5 ,6 ,9 ,10 ,16	-3.38	-0.53	2.11	$15,073,177
F	2 ,5 ,8 ,9 ,10 ,11	-1.99	0.16	2.11	$15,146,052
G	3 ,5 ,8 ,9 ,10 ,11	-1.66	0.09	1.84	$15,621,393
H	9 ,10 ,11 ,16	-3.36	-0.52	2.10	$15,751,079
I	5 ,11 ,14 ,19	-2.55	-0.45	1.79	$15,843,208
J	5 ,11 ,14 ,17	-2.42	-0.20	1.81	$16,164,827
K	5 ,10 ,11 ,14 ,19	-2.51	-0.43	1.79	$16,326,996
L	9 ,10 ,11 ,14 ,19	-2.52	-0.43	1.78	$16,607,651
M	5 ,10 ,11 ,14 ,17	-2.39	-0.19	1.80	$16,648,614
N	7	-3.58	-0.50	2.17	$16,872,464
O	9 ,10 ,11 ,14 ,17	-2.40	-0.19	1.80	$16,929,270
P	5 ,9 ,10 ,11 ,14 ,20	-1.73	0.13	1.73	$17,023,148
Q	5 ,6 ,10 ,11 ,14 ,19	-2.58	-0.47	1.74	$17,120,121
R	5 ,9 ,10 ,11 ,14 ,19	-2.45	-0.38	1.77	$17,284,099
S	5 ,9 ,10 ,11 ,14 ,17	-2.34	-0.15	1.79	$17,605,718

4.2.1 Results

Table 8 reveals that options allowing commercial vessels near the boat ramp (C, E, H, I, K, L, N, Q and R) scored poorly. This indicates that separating the commercial and recreational boating operations improves safety since the higher ranking options combine both boat ramp and jetty upgrades.

On average, the analysis shows no outstanding improvement. Four options have an averaged cumulative score slightly above zero. This highlights the effect of the "punishing scoring" convention (Table 5) used for the MCA assessment. These options are A, F, D, P and G.

Option A has the highest score. However, if the jetty is affected by waves (when the overtopping breakwater is submerged by waves) there is no safety improvement for commercial users. Option F and D are the highest ranking options which provide all weather berthing and loading, except during cyclones. The ranking shows that option P follows closely. Options D and F are relatively similar to Option P as they include breakwaters at the jetty with various boat ramp facility upgrades.

Option G ranks next in assessment because Component 3 (piled wave screen) scores relatively lower than Component 2 and 14 (breakwaters). Both breakwaters components (2, 14) are cheaper than the piled wave screen (3). The cost difference between the overtopping breakwater (14) and the piled wave screen (3) is significant, however the difference between the breakwater (2) and the piled wave screen (3) is considered to be "within the accuracy" of the MCA cost estimates.

Option P is essentially similar to Option A with the addition of an adverse weather landing at the boat ramp. The berthing pontoon (component 20) is an upgrade of the existing finger floating pontoon and has a neutral effect overall which tends to automatically reduce P's scorings when compared to A.

In summary, Option P is the preferred option, followed by Option G.

4.2.2 Sensitivity analysis

Table 4 default weightings were applied to the MCA assessment above. Alternative weightings were assigned to each theme to test the sensitivity of each option. Four additional alternative weightings, which prioritise each assessment theme in turn (W1, W2, W3 and W4) were compared with the average scores obtained with the default weighting. The resultant scoring for each option is presented in Table 9.

The last column is the calculation of the standard deviation between these five weighting alternatives and is indicative of the variability. A low variability score indicates a resilient option, where the weightings don't influence significantly the option scoring. A high variability score indicates an option which is sensitive to weightings and therefore is less likely to attract a strong support.

Table 9 Alternative weightings and results

	Default Weightings	Alternative Weightings W1	Alternative Weightings W2	Alternative Weightings W3	Alternative Weightings W4	Variability score
Impact	25%	60%	20%	20%	20%	
Efficiency	35%	25%	50%	20%	20%	
Social	20%	5%	10%	40%	20%	
Approval	10%	5%	15%	10%	30%	
Economics	10%	5%	5%	10%	10%	
A	0.30	0.18	0.38	0.25	0.18	0.08
B	-0.40	-0.39	-0.36	-0.34	-0.32	0.03
C	-0.54	-0.89	-0.40	-0.65	-1.08	0.27
D	0.15	-0.26	0.42	-0.06	-0.11	0.26
E	-0.53	-0.95	-0.37	-0.57	-0.74	0.22
F	0.16	-0.25	0.42	-0.05	-0.10	0.26
G	0.09	-0.12	0.30	-0.01	-0.18	0.19
H	-0.52	-0.86	-0.36	-0.58	-0.68	0.19
I	-0.45	-0.70	-0.31	-0.56	-0.88	0.22
J	-0.20	-0.27	-0.11	-0.24	-0.29	0.07
K	-0.43	-0.67	-0.30	-0.53	-0.84	0.21
L	-0.43	-0.67	-0.30	-0.52	-0.83	0.21
M	-0.19	-0.26	-0.10	-0.22	-0.27	0.07
N	-0.50	-0.63	-0.19	-0.74	-0.73	0.23
O	-0.19	-0.27	-0.11	-0.21	-0.27	0.07
P	0.13	0.03	0.20	0.13	0.09	0.06
Q	-0.47	-0.72	-0.36	-0.54	-0.87	0.20
R	-0.38	-0.62	-0.26	-0.47	-0.76	0.20
S	-0.15	-0.23	-0.07	-0.17	-0.22	0.06

Option P (which features the overtopping breakwater) has a high score overall and a low variability score, which indicates that this option performs well for a range of weightings.

Option G (which features the piled wave screen) performs better than Option P in one of these five weightings scenarios. This is the scenario with an increased focus on “efficiency”. Option G exhibits a higher variability than Option P. This seems to indicate that Option P is a less risky alternative as it balances more efficiently the various themes.

Following this sensitivity analysis, Option G and P still remain “high ranking options”, although Option P is less sensitive to varying the weightings.

4.3 Safety review

It is proposed to review which of the two “high ranking options” (G and P), is better suited to the principal project objective, which is to improve boating safety. Boating safety is influenced by maritime infrastructures during the following operations:

- Navigation approaches, including channel and navigation aids
- Berthing and mooring (wave, current, wind conditions at berth and in approaches)
- Vessel boarding for loading and unloading of passengers and goods (e.g. “deck height” and ramps)
- Safety in waiting and transit areas (access road and car park)
- Emergency services (e.g. fire fighting and ambulance access)

In their current form, both Options P and G improve berthing and boarding operations for both commercial and recreational boating.

None of the above components discusses the need or requirement for better navigation aids, better transit area or emergency services. It is understood that car park and/or navaids would be brought back to “existing standards”. Although lifting the “design standard” could be a viable option no requirements regarding navaids has been formulated for these operations at this stage.

Looking in more detail, the recreational berthing and boarding operations in Option P would be preferable to Option G as the boat ramp breakwater will be upgraded. On the other hand the commercial berthing and boarding operations would be less challenging for Option G than for Option P as there would be “less” down-time at the jetty but this is not a clear advantage because:

- The relative improved wave climate behind the piled wave barrier is not sufficient to improve berthing and boarding safety in all conditions. If the jetty is unsafe, there is no alternative berthing option. The berthing pontoon at the boat ramp provides a solution to this problem.
- Secondly, if the jetty or overtopping breakwater are damaged during a cyclone it will be faster to recover a functional pontoon at the boat ramp in the transition period while the jetty is repaired. A piled wave barrier would increase the reconstruction burden, and it does not provide a secondary berthing and boarding alternative.

In summary though the piled wave barrier may allow access to the jetty more frequently than an overtopping breakwater, it does not constitute a significant safety improvement. Based on this safety review, Option P is preferable to Option G.

4.4 Preferred option

From the multi-criteria analysis and safety review, Option P is the preferred over Option G. It is important to consider that the Component 20 is relatively similar to the existing finger pontoon at the boat ramp and consists principally of an upgrade rather than a “new facility” Component 20 is generally neutral in the multi-criteria analysis. Option G, the piled wave barrier, is 9% less costly than Option P and this difference is within the accuracy of the comparative capital cost estimates prepared for the MCA, which highlights that options G and P are similar from a capital cost point of view.

It remains that understanding the difference between Component 3 (piled wave barrier) and Component 14(overtopping breakwater) is critical for decision-making as these are the main “enhancers” of respectively Option G and Option P. Regarding the various themes selected for the assessment, the following comparisons of these two components reveals that:

- **Impact** – The overtopping breakwater has lesser impact in term of sediment transport but more surface of impact than the wave barrier
- **Effectiveness** – The overtopping breakwater is more resilient and durable to cyclones but is not as effective in term of ambient wave attenuation. Overall, it is considered that these two effects neutralise each other since Option G has a similar effectiveness as Option P.
- **Social value** – It was consider that an overtopping breakwater is less visually obtrusive than a piled wave barrier. This is an important consideration as it partially justifies the selection of Option P over option G. The overtopping breakwater will be designed to be as unobtrusive as possible. It should be noted that, except in cyclonic events, a section of the overtopping breakwater will remain above the water line.
- **Government Process** – There are no major differences between the two options as the two options typically would be delivered along a similar type of development application process
- **Economic**s – The overtopping breakwater is less than half the capital cost of the piled wave barrier, and the lifecycle cost of the piled breakwater is 4 times higher than the overtopping breakwater. The piled wave barrier will require specialised equipment. Also, the design of the piled wave barrier is more complex and the “geotechnical risk” is substantially higher for this component. Option P will provide a more equitable distribution of the available project funding between the boat ramp and the jetty than Option G.

Overall, Option P is more durable, resilient and flexible while being less visually obtrusive than Option G. Therefore, Option P is the preferred development option.

4.5 Risk assessment

4.5.1 General Safety matters

The fundamental principle of the Transport Operations (Marine Safety) legislation is that the general safety obligation transfers the responsibility of safety to owners and operators and encourages risk management. The *Transport Operations (Marine Safety) Act 1994* imposes general safety obligations on:

- Ship designers, builders and surveyors about the condition of ships
- Persons involved with the operation of a ship to operate it safely
- Owners and masters about safety equipment.
- All owners and operators, masters and crew members must ensure the ship is:
  - Safe
  - Properly equipped and crewed

– Operated in a safe manner

These general safety obligations prohibit a ship/boat from going to sea if it is not properly built and maintained, equipped, crewed and operated in accordance with its proposed operating environment.

We note the focus of the project is relatively narrow regarding safety since maritime infrastructure improvement is not the only way to improve boating safety. Specifically, from a families/boaties perspective the following safety considerations are also important:

- Pollution/refuge/cleaning/spills (in/out water) Bin/spill kits/notification
- Signage
- Barricading
- Etiquette
- Emergency response/fire extinguisher/first aid
- Tides
- Climatic impact
- General safety
- Hours of operation
- Maintenance
- Policing
- Traffic management (vehicles/boats)
- Parking (access/boats/cars/restrictions)
- Security/video surveillance
- Collisions
- Carbon monoxide (air pollution)
- Legislation/obligations
- Fall protection (children)
- Licencing/safety checks
- Lighting (night)
- Working (construction) and recreational fishing around/over water (vicinity)
- Boat sizes (restrictions)
- Mooring at the boat ramp (vicinity)
- Normal construction risks/H&S obligations
- Designated construction area/s (cordoned off)
- Environment/community/facilities around the jetty/boat ramp
- Toilets

From a safety point of view, it would be beneficial to incorporate into the project some of these aspects. For instance fall protection, lighting, and emergency services could be improved as part of the general boat ramp upgrade. Safe design is a given with general health and safety protocols to meet legislative requirements for this project and this process would assist in identifying any additional measures that become necessary for the project.

4.5.2 Risk review

Table 10 proposes a preliminary abbreviated risk register for Option P. The project hazards will be systematically mitigated with additional data/surveys and modelling during the detailed design phase.

Table 10 Project risk register

No.	Hazard to program	Inherent risk Consequence/ Likelihood	Mitigation measure proposed in the methodology	Residual risk Consequence/ Likelihood
1	Cost escalation	Extreme Disastrous/C	Optimise structure through physical testing to reduce risk of incomplete performance Specialist suppliers engagement through the design work (berthing pontoon) Independent estimate	High Critical/D
2	Unsuitable soil data	Extreme Critical/C	Soil risk could be mitigated through geotechnical investigations	Moderate Serious/D
3	Unclear community expectations	Extreme Serious/A	Community consultations along the project design development stage is necessary Wave measurement is made and model is validated with prior downtime information	Moderate Serious/D
4	Development approval delays and deadlocks	High Critical/D	Consultation with stakeholders and agencies is required for several months to clarify the Development Approval pathway and document sufficient information to justify the project	Moderate Serious/D

5 Conclusion

Through the MCA process it has been determined that Option P is the preferred option, which is presented in Figure 2 and Figure 3. The key factors for selecting this development configuration are:

a) Geographical separation of commercial and recreational boating operations

b) Provision of resilient, durable, yet flexible infrastructure solutions over specialised components (overtopping breakwater versus piled wave barrier, disabled access ramp versus gangway, pontoon)

c) Reduction of the wave climate at the existing Mission Beach boating facilities and improved overall boarding conditions

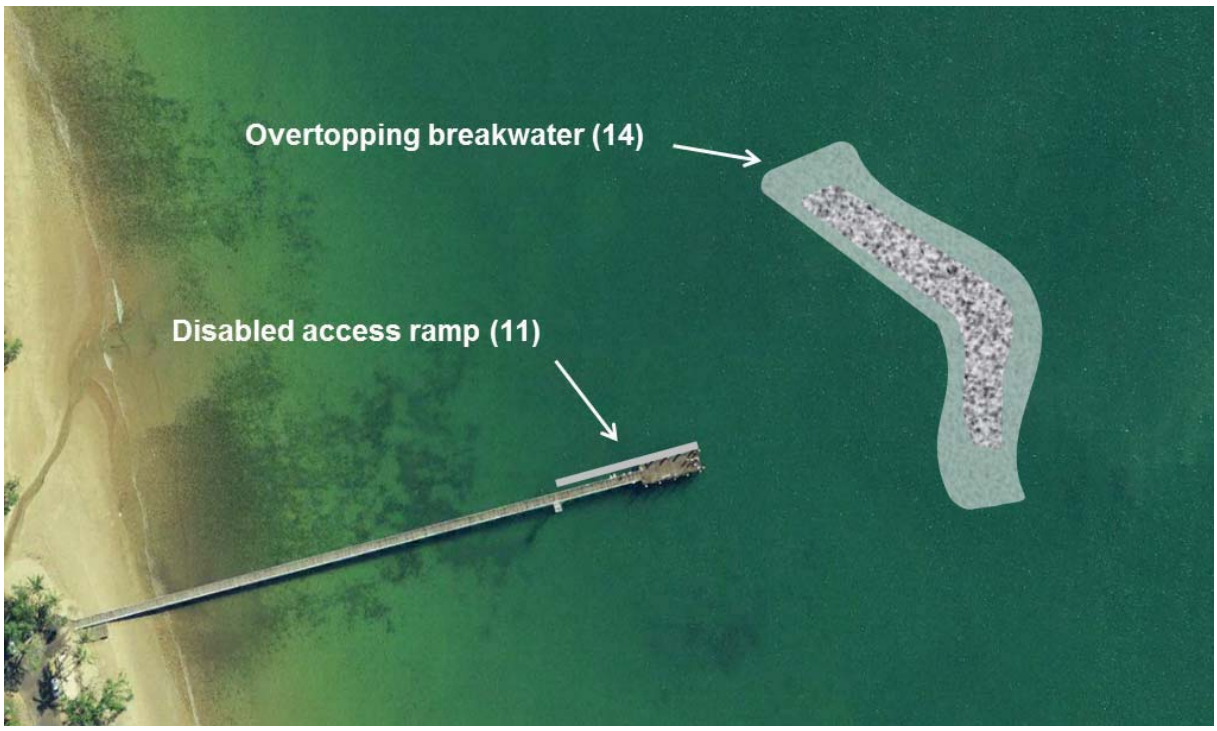

Figure 2 Clump Point Jetty infrastructure upgrade

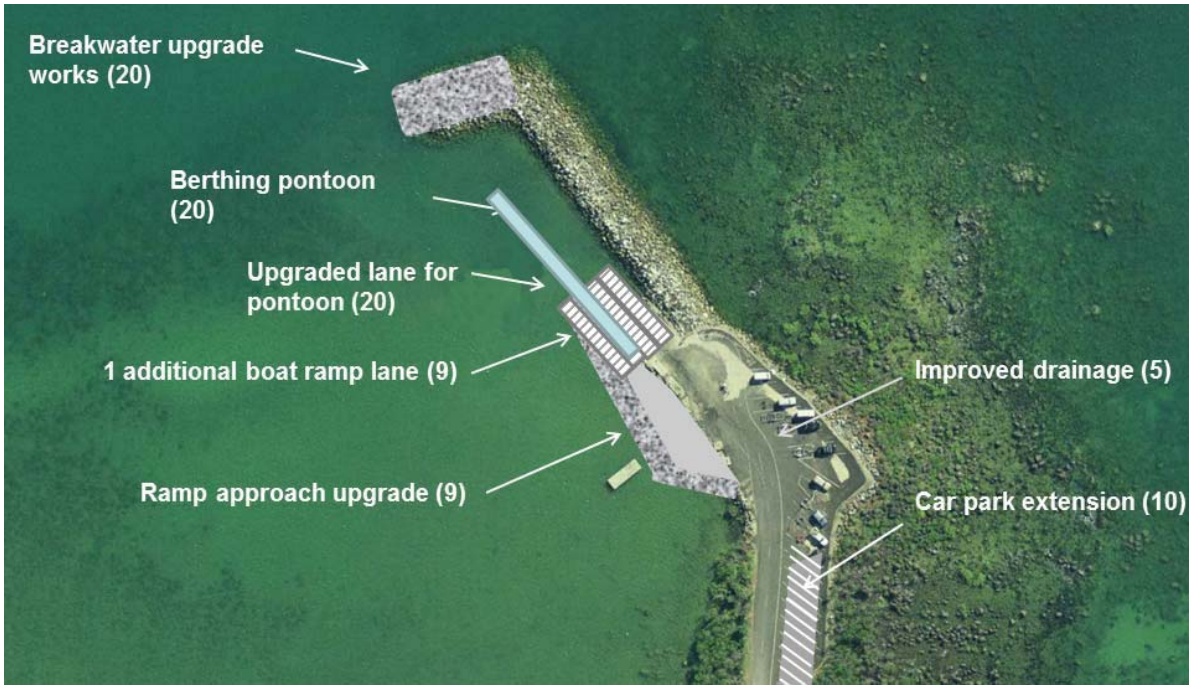

Figure 3 Clump Point Boat Ramp infrastructure upgrade

Appendices

Appendix A
Component description

Component description

The table below provides a brief description of each of the 20 project 'components' investigated through the MCA. Concept sketches for each of these components are included below.

Clump Point Jetty		
1	Pontoon and Connecting Gangway	Component 1 consists of a 35 m gangway linking the existing jetty to a new pontoon. This additional pontoon will facilitate the loading and unloading of passengers from the various connecting ferries. The gangway provides a safe access to the pontoon and provides disabled access.
2	Breakwater	Component 2 is a 120 m long detached breakwater located 60 m east of the existing jetty. The purpose of this breakwater is to have a safer ambient wave climate at the existing jetty, improving conditions for the loading and unloading of passengers and increasing the number of period when the ferry can be berthed at the jetty.
3	Piled wave barrier	Component 3 is a 120 m long wave barrier located 60 m east of the existing jetty. The purpose of this wave barrier is to have a safer ambient wave climate at the existing jetty, improving conditions for the loading and unloading of passengers and increasing the number of period when the ferry can be berthed at the jetty. This component has a similar function as Component 2.
11	Disabled access.	Component 11 retrofits a disabled access ramp at the jetty. The ramp achieves a 1:14 slope.
12	Caisson breakwater	Component 12 consists of a 60 m long caisson breakwater. The purpose of this breakwater is to have a safer ambient wave climate at the existing jetty, improving conditions for the loading and unloading of passengers and increasing the number of period when the ferry can be berthed at the jetty. This component has a similar function as Components 2 and 3 but would have a higher wave transmission coefficient it is shorter to meet the project budget
13	Floating attenuator	Component 13 consists of a 120 m long floating attenuator at the jetty. The purpose of this floating attenuator is to have a safer ambient wave climate at the existing jetty, improving conditions for the loading and unloading of passengers and increasing the number of period when the ferry can be berthed at the jetty. This component has a similar function as Components 2, 3 and 12.
14	Overtopping breakwater	Component 14 is an approximately 120m partially overtopping breakwater. The purpose of this breakwater is to have a safer ambient wave climate at the existing jetty, improving conditions for the loading and unloading of passengers and increasing the berthing operational window for the ferry at the jetty. This component has a similar function as Components 2, 3, 12 and 13.

Clump Point boat ramp		
4	Detached breakwater	Component 4 is an extension of the existing breakwater at the boat ramp. This extension will improve the ambient wave climate at the boat ramp, providing safer sea conditions in ambient conditions. The breakwater would not be attached to the existing structure to prevent a change in GBMPA's boundary which may be triggered if the breakwater is attached to land.
5	Flushing system	Component 5 consists of gully pits and stormwater drains to increase the rainfall and wave overtopping flow catchment area. The water would be discharged at the boat ramp in an open concrete drain. This increased drainage infrastructure would provide a greater flushing flow during rainfall events, assisting in removing deposited sediment at toe of the boat ramp.
6	Dredging	Component 6 involves dredging the boat ramp approaches to -1m LAT. The aim is to improve boating and navigational safety, avoiding any sediment and sand bar to form. This will require yearly maintenance.
7	Commercial Wharf	Component 7 comprises a concrete walkway, a new wharf and a new breakwater head. The pontoon will be protected from waves by the breakwater and will provide safe conditions during ambient climate for the unloading and loading of passengers. The boat ramp will still be fully functional. The walkway will allow disabled access.
8	Re-positioning of pontoon	Component 8 is the re-location of the existing pontoon west from where its current position. This will increase the boat ramp width therefore providing safer boating operation at the boat ramp. It will also improve pedestrian safety for passenger walking on the existing pontoon.
9	Third boat ramp lane	Component 9 consists of the addition of a lane at the existing boat ramp. An extra lane will improve the boat ramp utilisation, improving the current waiting time. It will also improve boating operation safety as it will increase the boat ramp width and available space.
10	Additional car park	Component 10 provides additional car parking at the existing boat ramp. The additional car spaces will improve the boat ramp utilisation, providing safe and legal parking for further boat ramp users.
15	Offshore boat ramp	Component 15 provides an additional 2-lane boat ramp and floating pontoon, doubling the existing capacity. A new breakwater will provide a safe wave climate for this additional boat ramp. In addition, recreational and BBQ areas will be created. Commercial and cultural buildings will be present. Many trailer parking will be provided. This option provides a greater utilisation of the boat ramp and improves the area utilisation and appeal.
16	Offshore pontoon	Component 16 is similar to Component 7 except that the new breakwater is totally detached from the existing structure. In addition a building (ticketing, administration and commercial function) is proposed to be located on the new wharf. The boat ramp remains fully functional.
17	Commercial pontoon	Component 17 consists of a heavy pontoon at the boat ramp for the passenger ferry to be berthed. The gangway allows disabled access. In addition a building (ticketing, administration, commercial functions) is would be located on the new wharf.
18	Sediment trap	Component 18 provides a 2 m pocket to catch any sediment that deposits in the area. This will improve boating safety, avoiding any sediment or sand bar to form.
19	Land backed wharf	Component 19 consists of an additional lane at the existing boat ramp, additional car parking and a land back ferry wharf. In addition a building (ticketing, administration, and commercial function) is proposed to be located on the new wharf.
20	Berthing pontoon	This is an upgraded finger pontoon which can accommodate commercial vessel berthing loads when tide and wave actions at the jetty become unfavourable. This pontoon sits on its own ramp and will allow safe transfer of passengers. A possible upgrade of the boat ramp breakwater has been included to provide additional sheltering.

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
1	Pontoon and connecting gangway		

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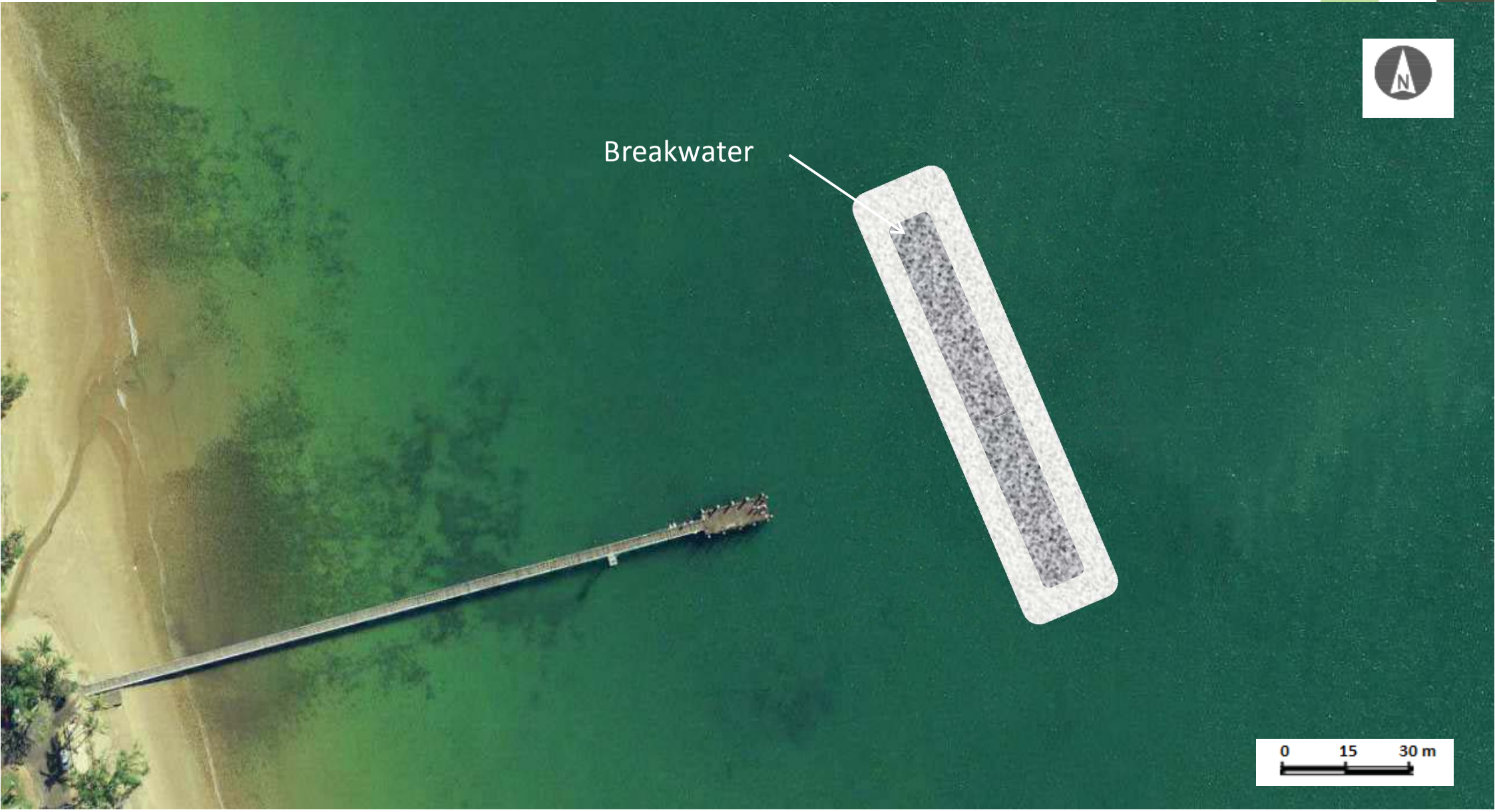

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
2	Breakwater		

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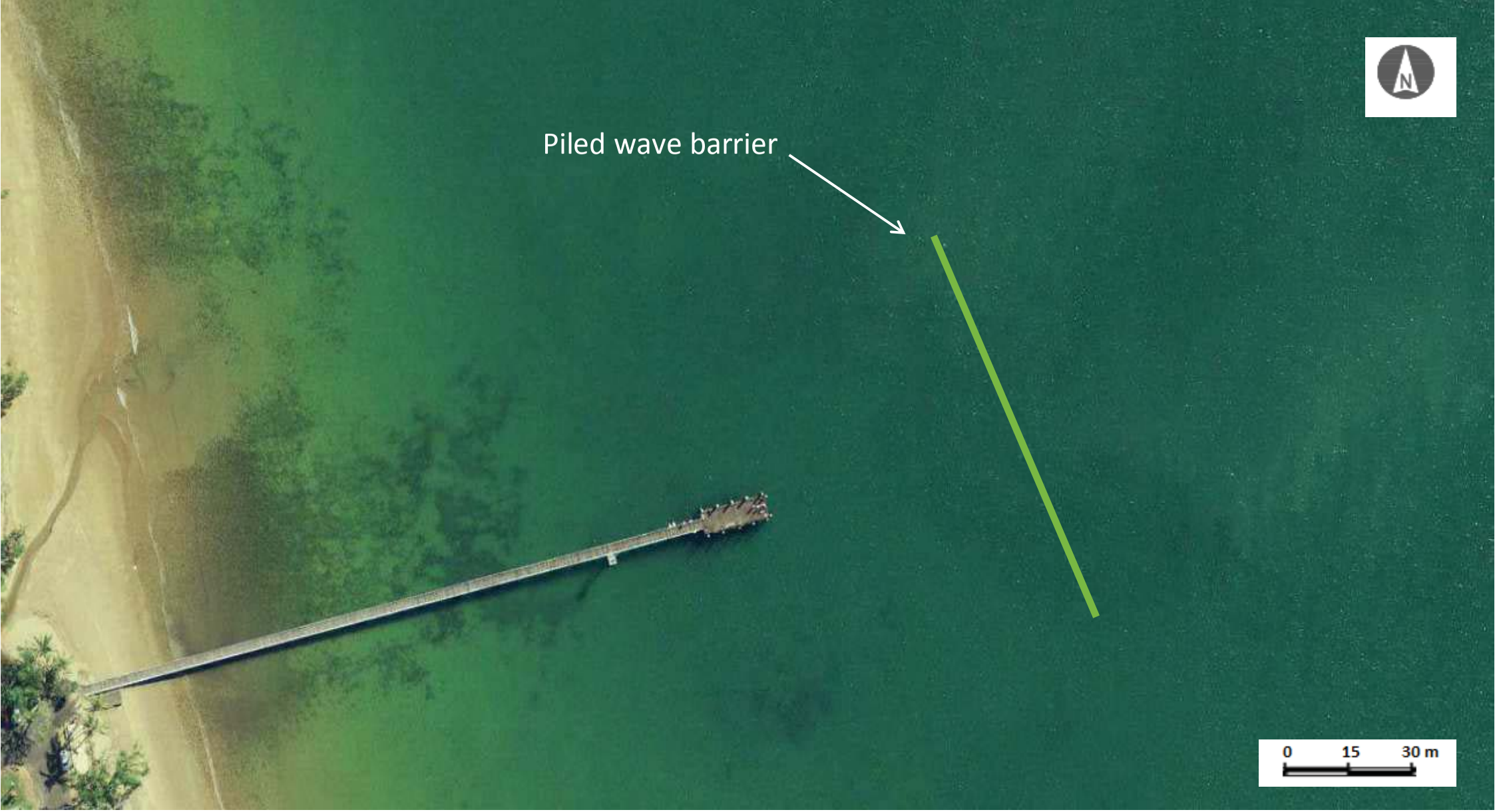

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
3	Piled wave barrier		

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Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
11	Disabled access		

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Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
12	Caisson breakwater		

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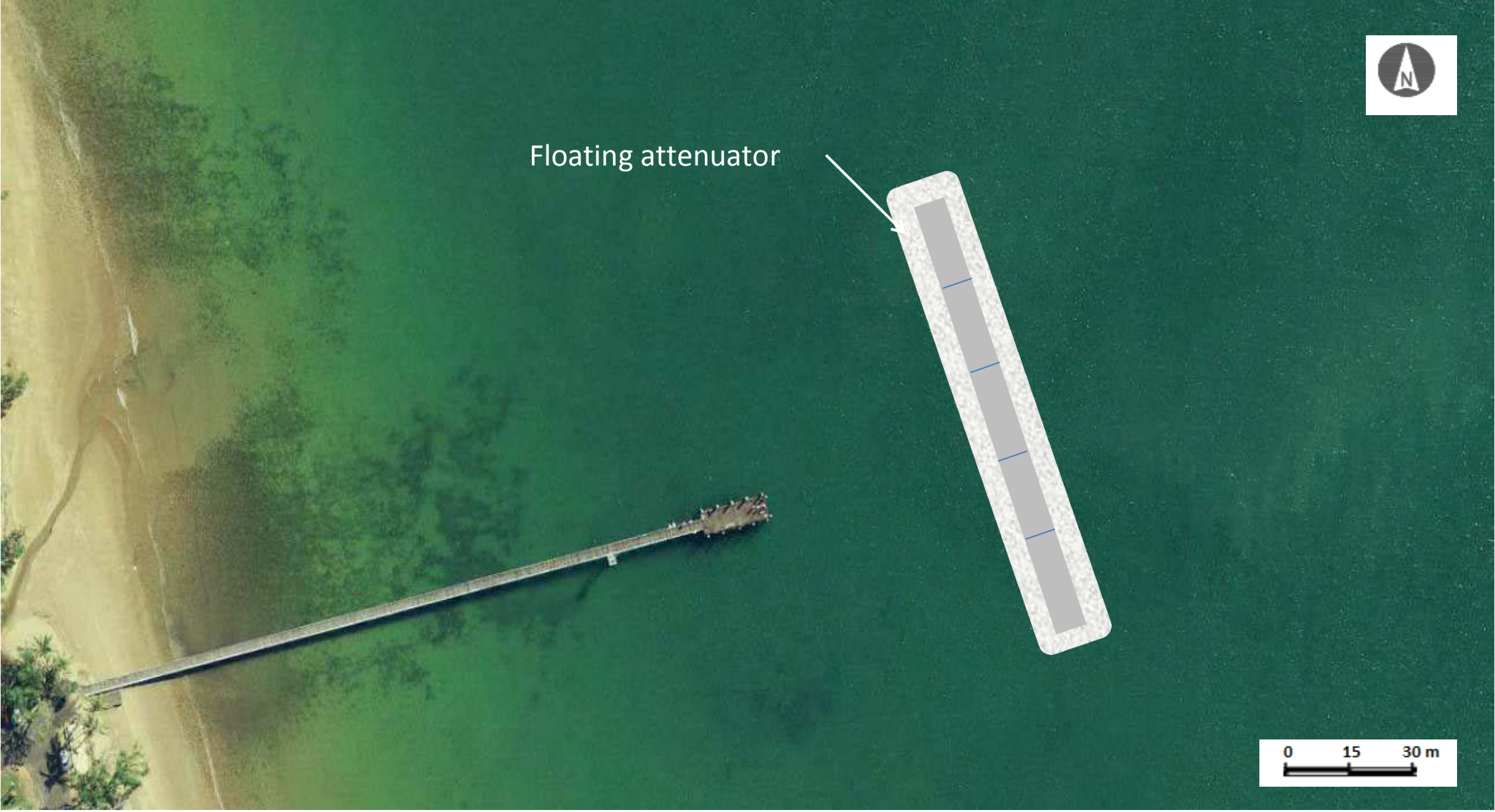

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
13	Floating attenuator		

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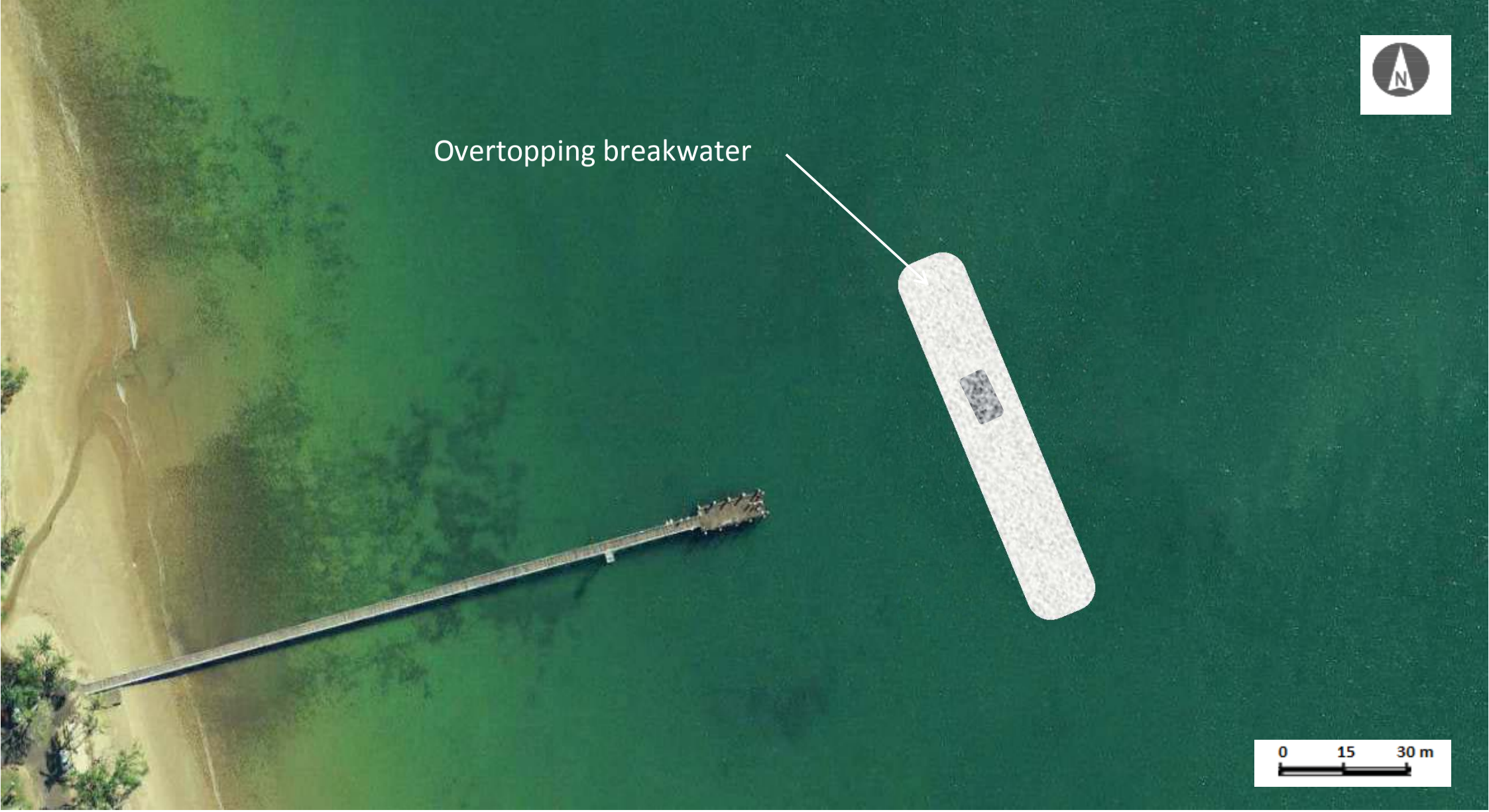

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
14	Overtopping breakwater		

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Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
4	Detached breakwater extension		

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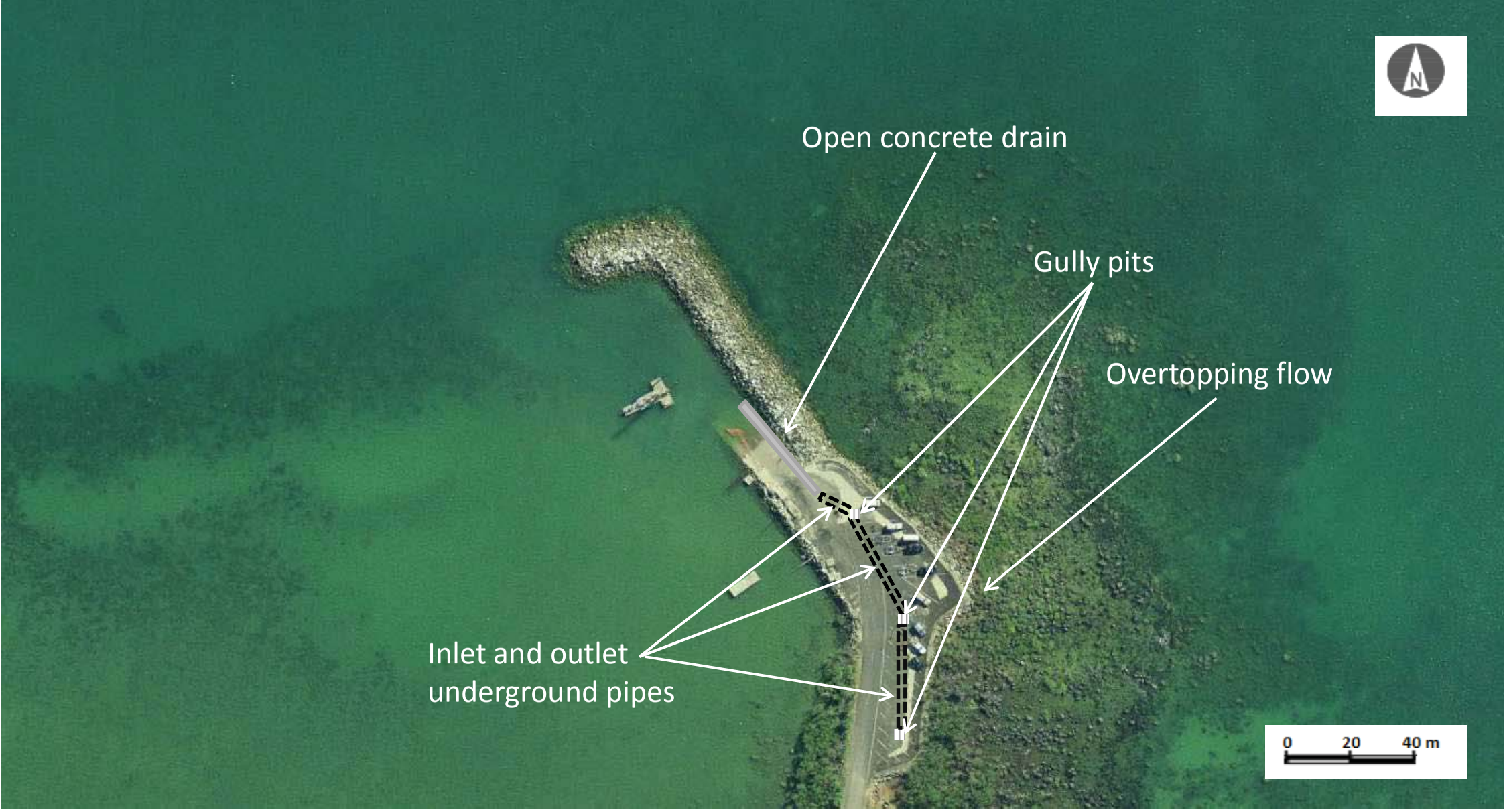

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
5	Flushing system		

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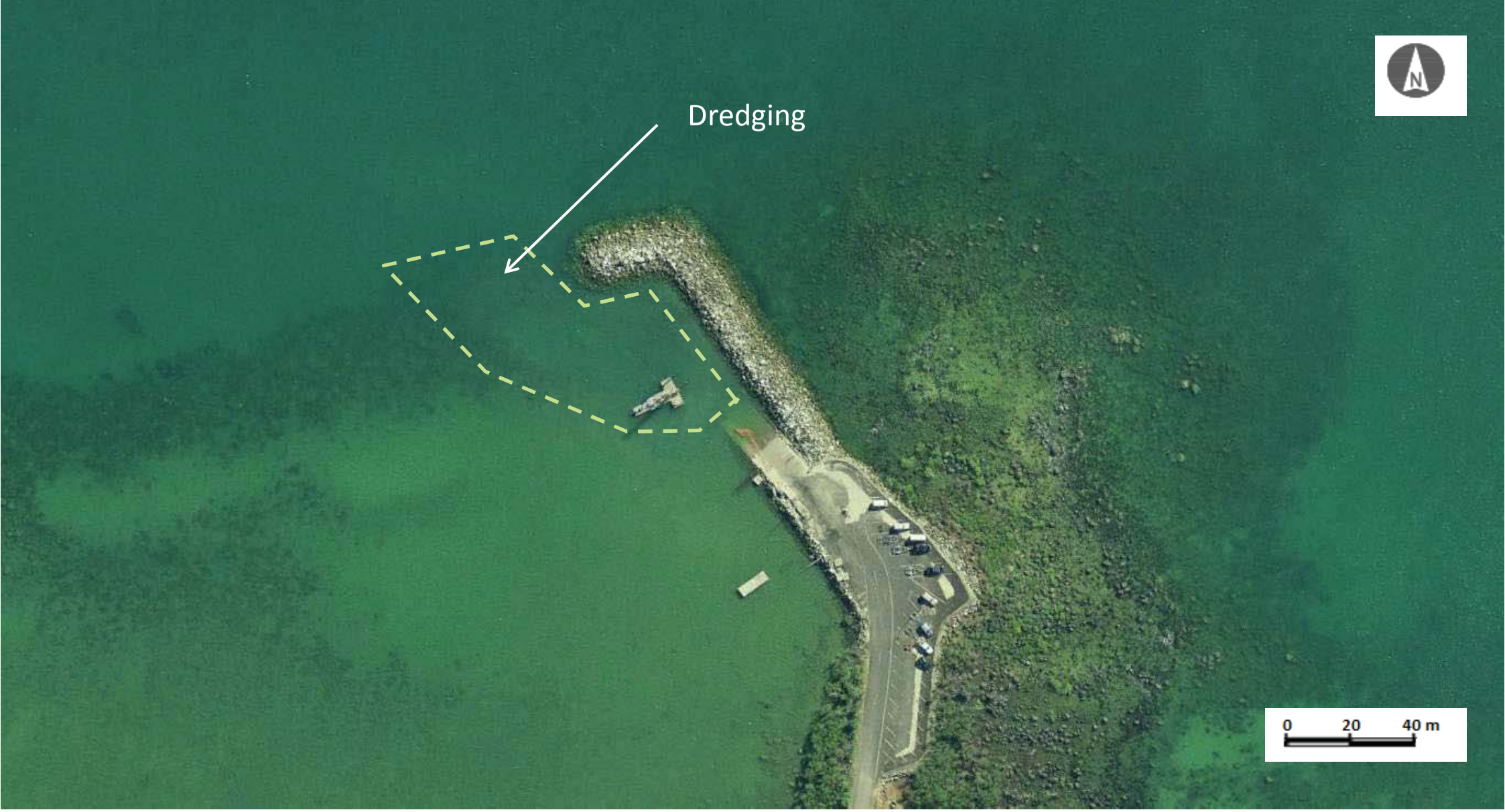

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
6	Dredging		

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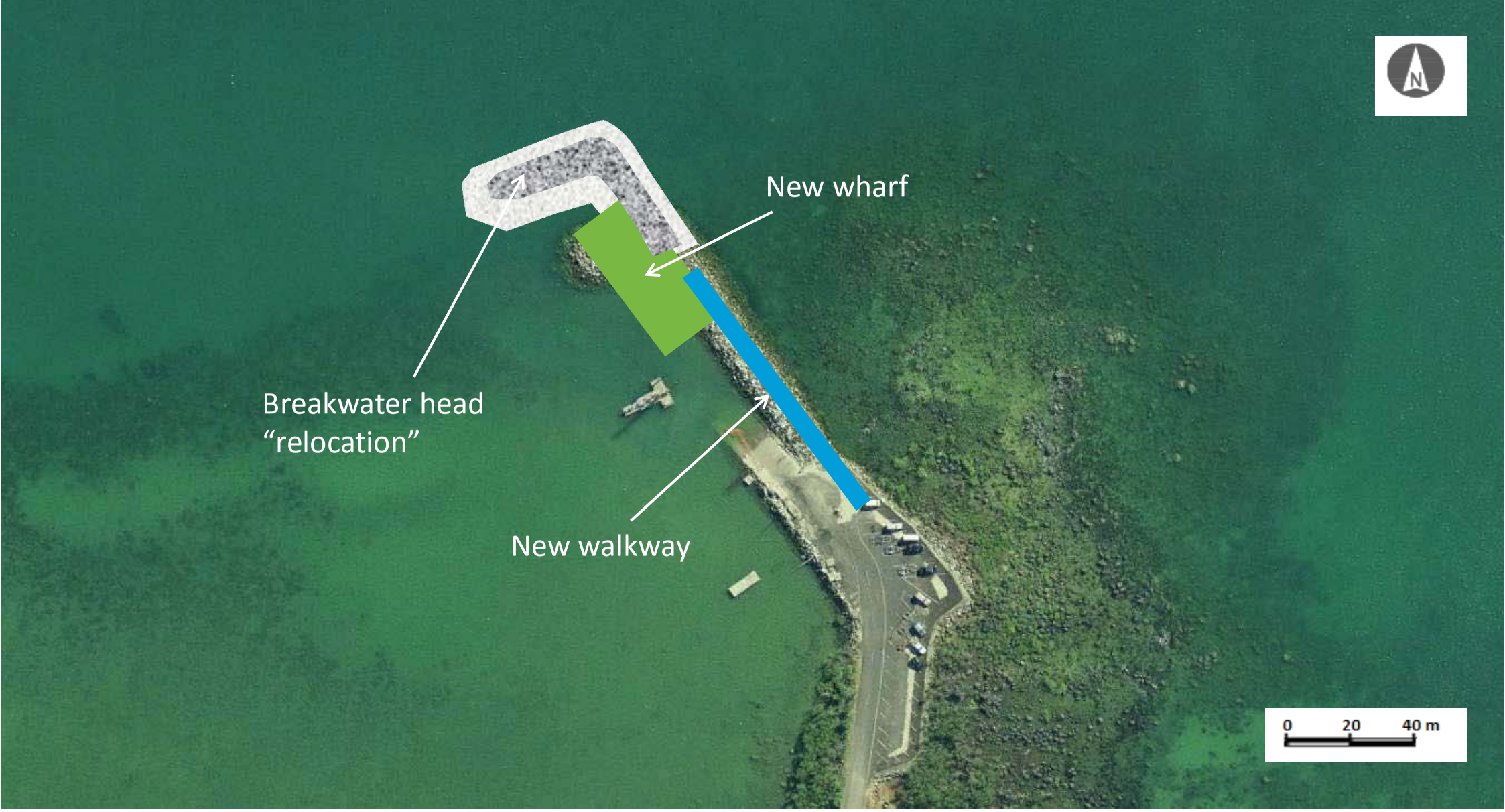

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
7	Commercial wharf		

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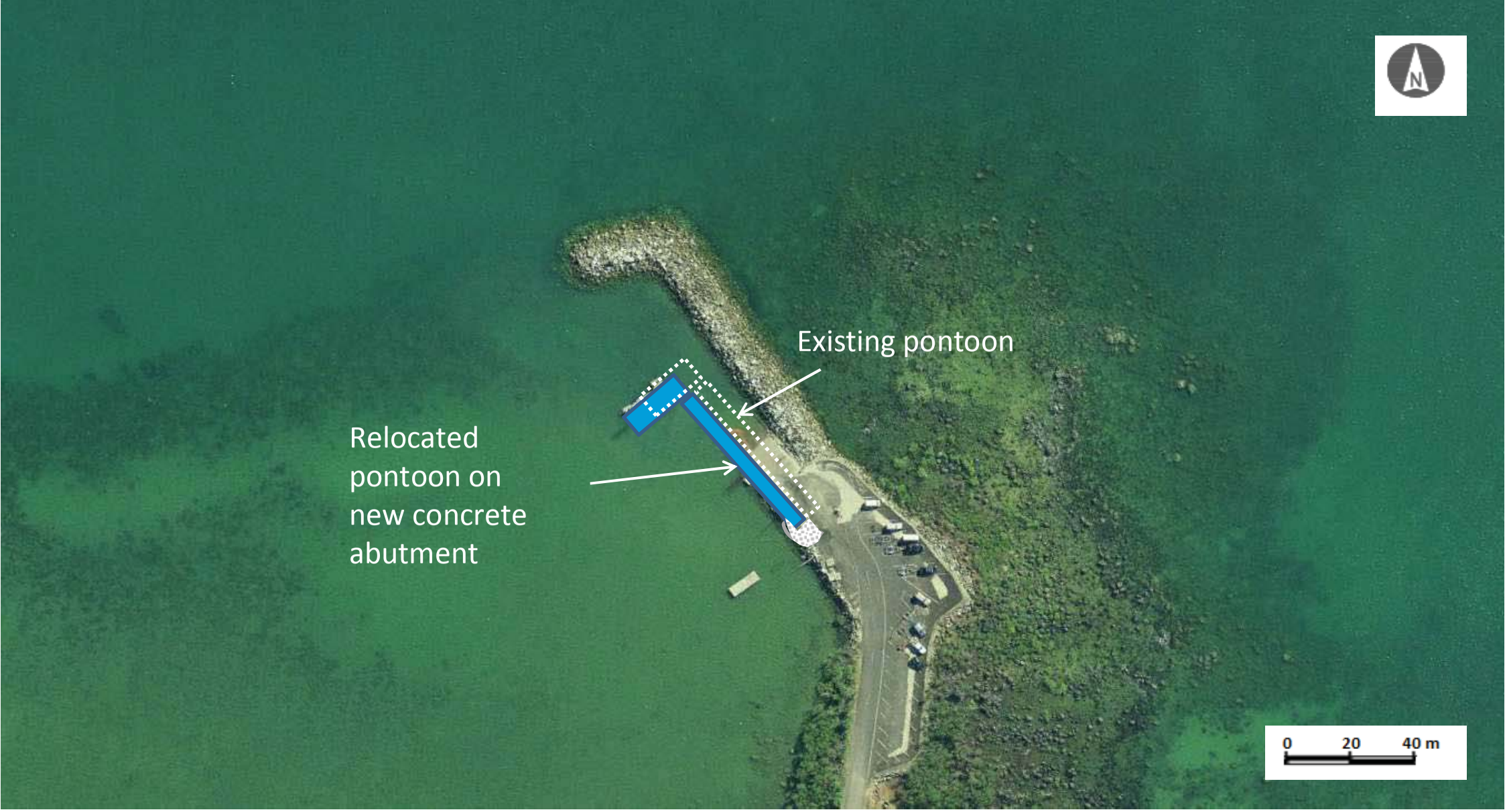

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
8	Re-positioning of existing pontoon		

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Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
9	Third boat ramp lane		

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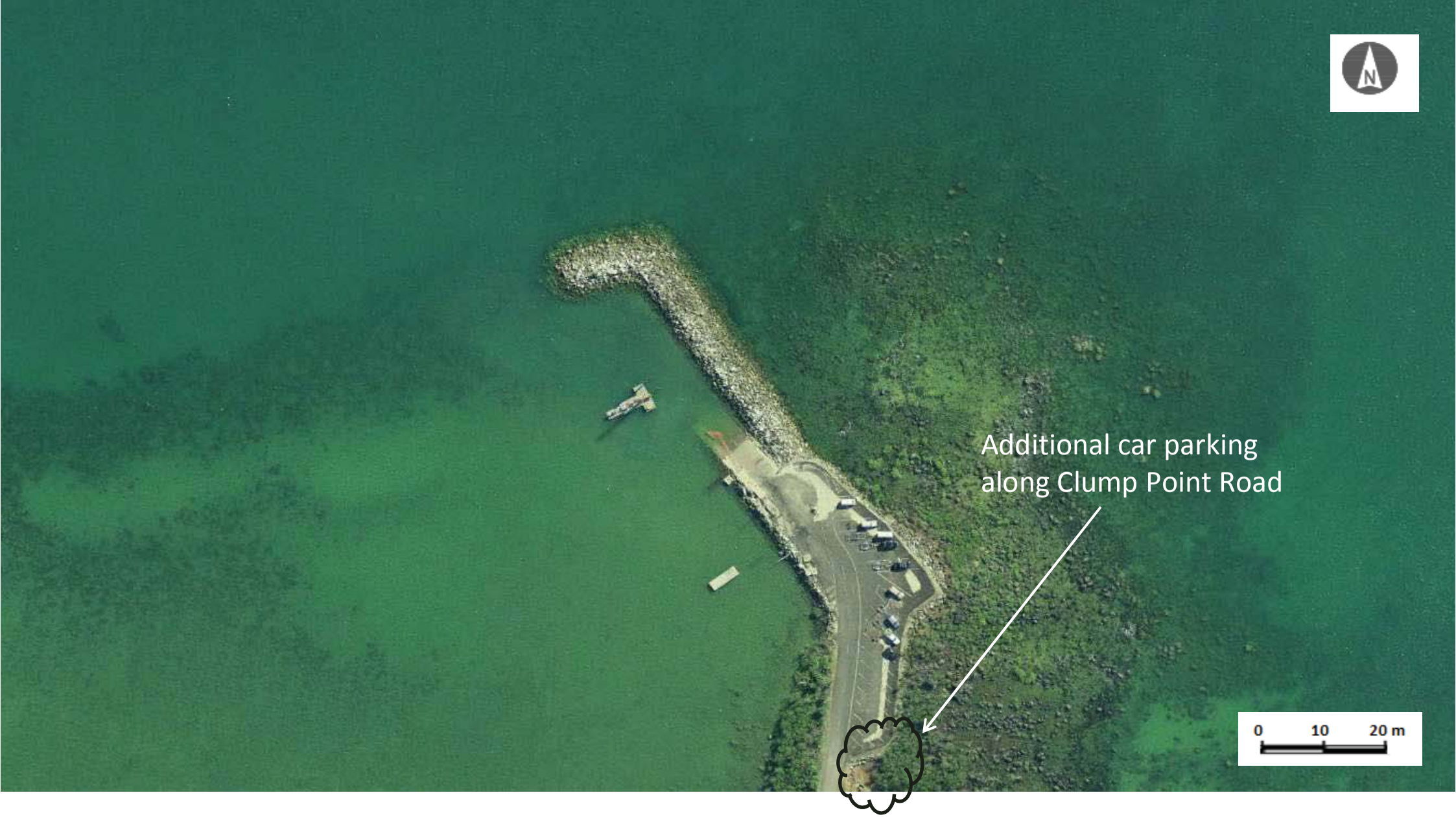

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
10	Additional car park		

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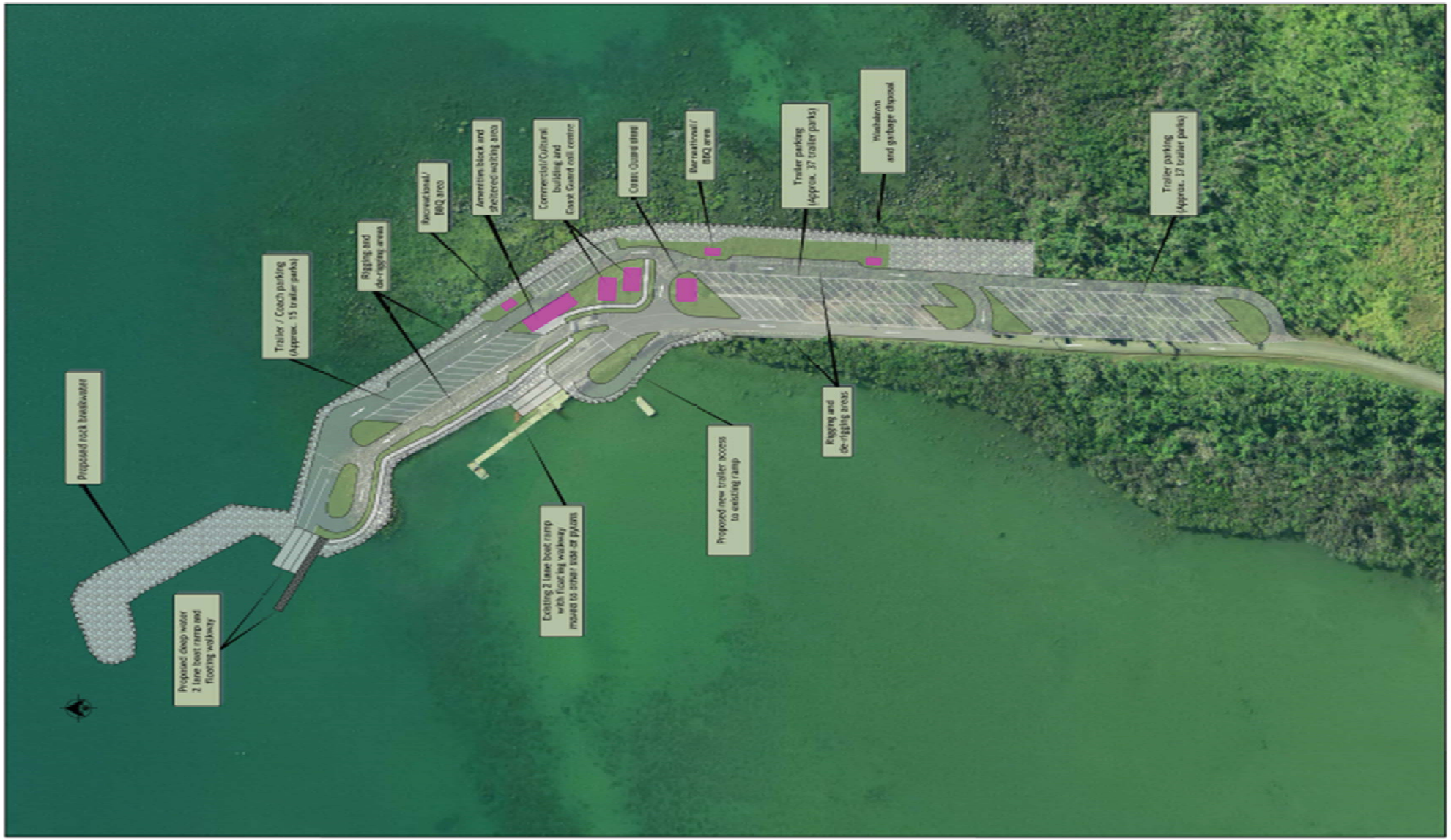

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
15	Offshore additional boat ramps		

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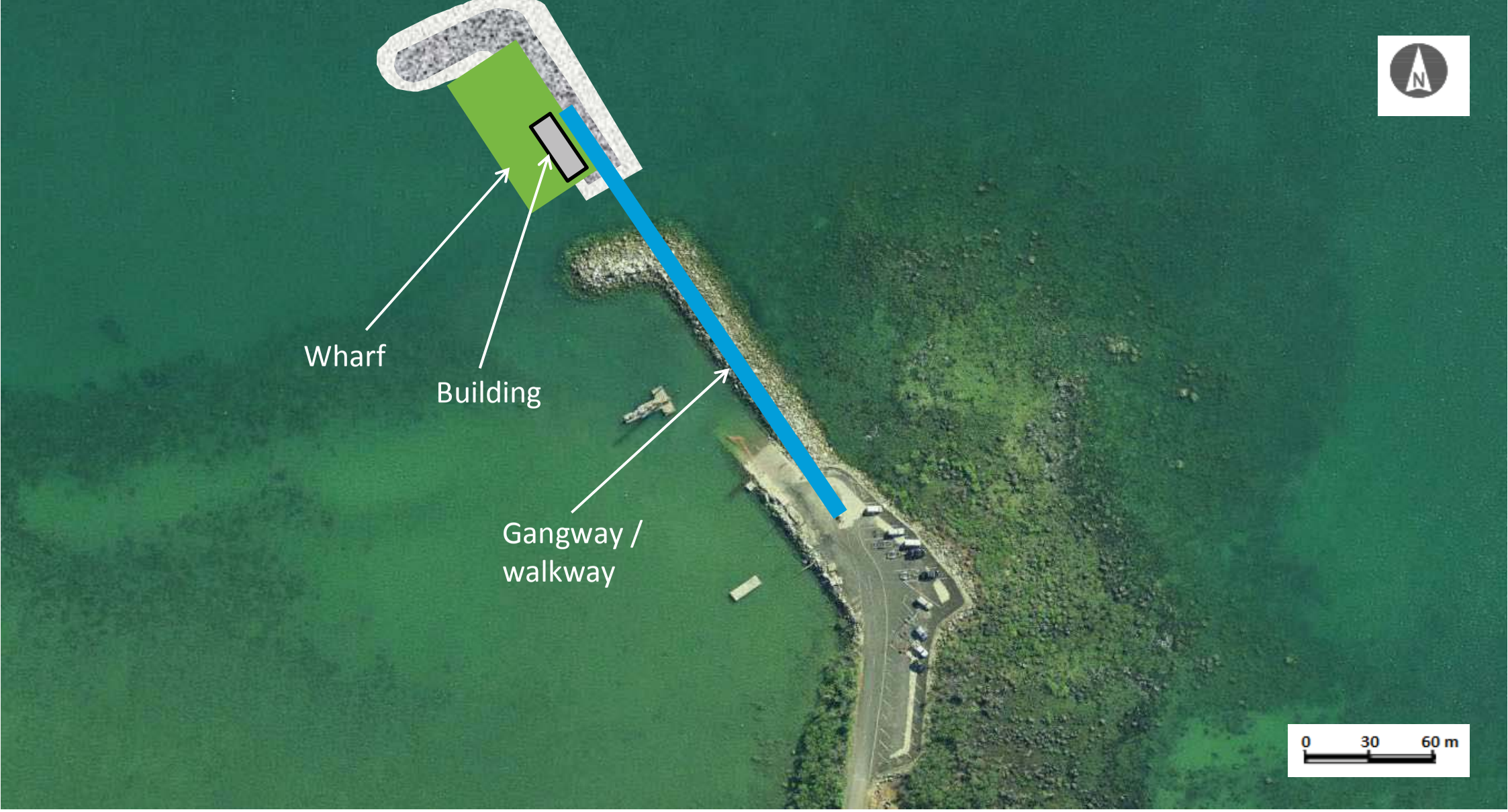

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
16	Offshore pontoon		

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Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
17	Commercial pontoon		

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Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
18	Sediment trap		

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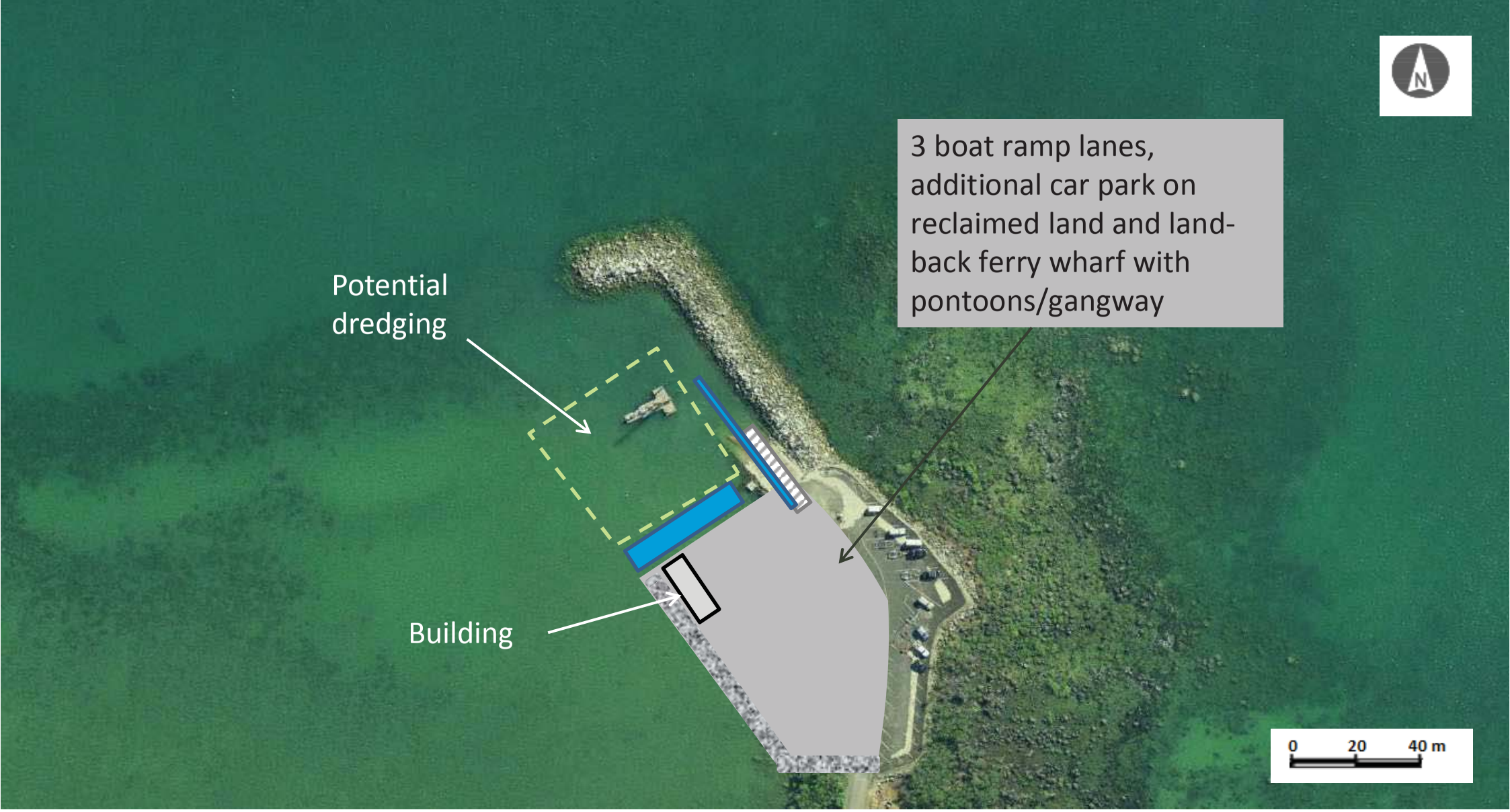

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
19	Land-backed wharf		

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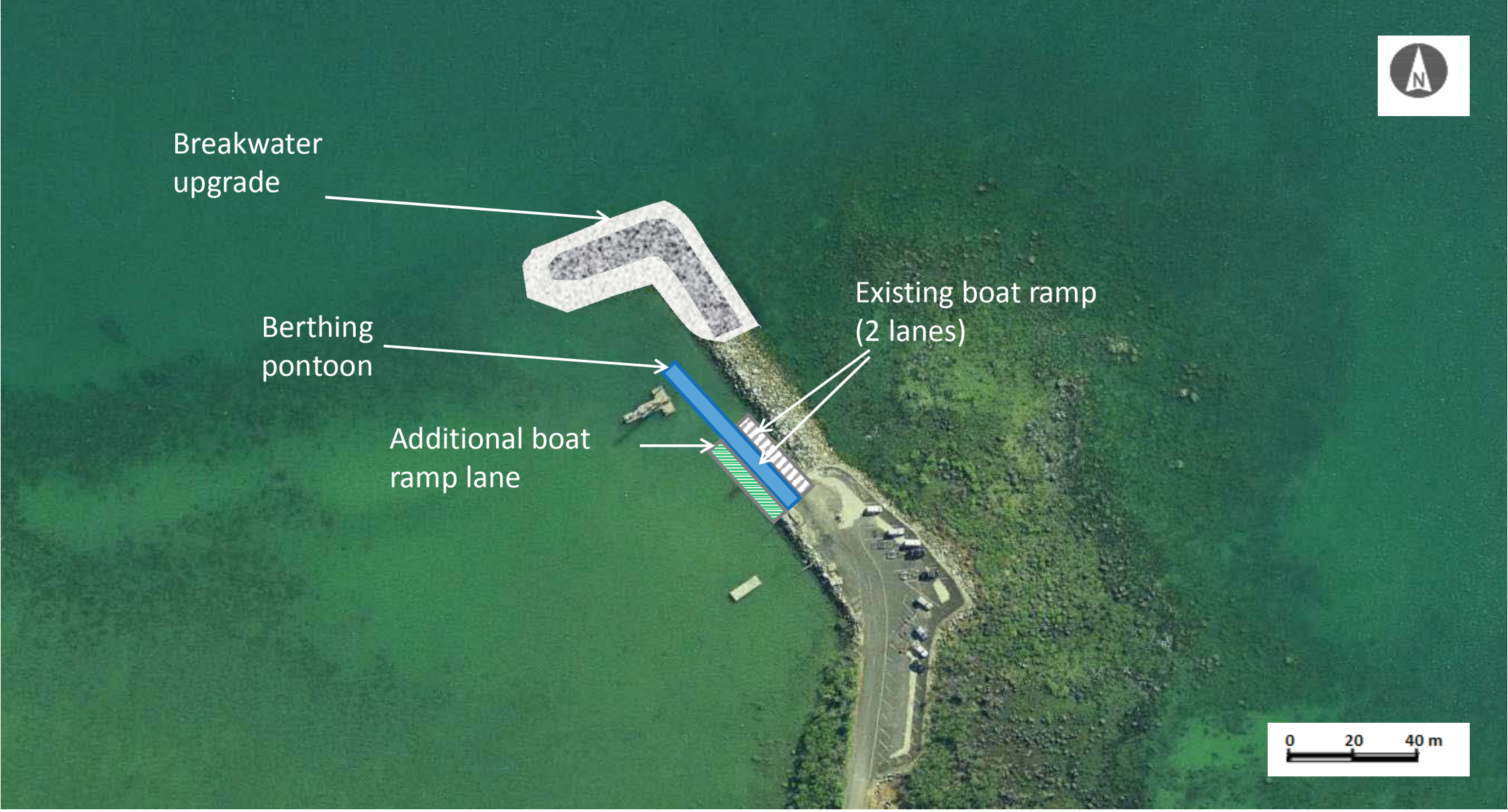

Project Name	Project Number	Date	Revision
Mission Beach Safe Boating Infrastructure	238465	01/11/2013	A
Component number	**Component name**		
20	Berthing pontoon		

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Appendix B
Cost estimates

Assumptions

The economic assessment of each component is principally based upon capital costs. The estimation of comparative capital costs was based on a conceptual estimate of quantities and unit rates on which a number of “additional costs” have been applied. Globally these estimates are not accurate and may not reflect project costs.

Unit rates

Cost estimates have been based on an estimate of quantities and the Table 11 assumed unit rates.

Table 11 MCA unit rate

Item	Unit	Cost
Reinforced concrete	m^3	$2,000.00
Concrete	m^3	$1,500.00
Geotextile	m^2	$35.00
Rock - Primary armour	Tonne	$80.00
Rock - Secondary armour	Tonne	$60.00
Back fill	m^3	$15.00
Marine fill	m^3	$30.00
Car park	m^2	$100.00
Dredging	m^3	$70.00
Mobilisation for dredging	(-)	$200,000.00
Pile structure	m^2	$7,000.00
Pontoon pile	unit	$5,000.00
Gangway	m	$10,000.00
Pontoon/Floating attenuator	m^2	$10,000.00
Building	unit	$700,000.00
Drainage pipe	m	$400.00
Gully pit	unit	$3,500.00

Additional costs

Preliminaries, contingencies and risk allowances are additional costs to the projects and have been included in the capital cost. These additional costs have been taken into account following Table 12 breakdown of category and loading range from the base-case estimate based on quantities and unit rates.

Table 12 Additional costs for comparative cost estimates

Item ID and category		Range
Concept and development stage		
A.1	Surveys and fees	1%-5%
A.2	Design, testing and development approval	2%-5%
A.3	Superintendent / construction management	2%-5%
Risks and opportunity		
B.1	Quarry risk	2%-20%
B.2	Geotechnical risk	5%-30%
B.3	Weather and program risk	0-30%
Contingency and escalation		
C.1	Contingency	30%-100%
C.2	Escalation	0.5%-3%

The cost breakdown for each individual component is provided below for reference.

Lifecycle costs

Lifecycle costs were derived from capital cost, maintenance cost and anticipated design working life. The risk of accidental damage due to weather was also captured in the lifecycle costs by including repair works following the weighted risk of an event above the infrastructure selected design standard.

Component 1: Pontoon and Connecting Gangway

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	25
Footprint on marine environment	m2	360
Footprint on land environment	m2	0
Time of construction (on site)	month	1
Design standard	year ARI	50
Cost	$	$ 4,082,250
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 183,290
Visual amenity	height * area	3 x 15

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	2.5%		$ 51,250.00
A.2	Design, testing and development approval		2%-5%	4.5%		$ 92,250.00
A.3	Superintendent / construction management		2%-5%	3.5%		$ 71,750.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 307,500.00
B1.2	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 1					
B	Gangway	m		35	$ 10,000.00	$ 350,000.00
	Pontoon	m^2		100	$ 10,000.00	$ 1,000,000.00
	Piled gangway abutment	m^2		100	$ 7,000.00	$ 700,000.00
	Subtotal					**$ 2,050,000.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	2%		$ 41,000.00
C.3	Weather and program risk		0-30%	5%		$ 102,500.00
Contingency and escalation						
D.1	Contingency		30%-100%	50%		$ 1,025,000.00
D.2	Escalation		0.5%-3%	2%		$ 41,000.00
Total cost estimate						**$ 4,082,250.00**

Component 2: Breakwater

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	5500
Footprint on land environment	m2	0
Time of construction	months	5
Design standard	year ARI	200
Cost	$	$ 10,606,638.40
Maintenance	cycle in year	5
Lifecycle cost	$ per year	$ 222,739.41
Visual amenity	height * area	2 x 120

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	5.0%		$ 213,528.00
A.2	Design, testing and development approval		2%-5%	3.0%		$ 128,116.80
A.3	Superintendent / construction management		2%-5%	4.0%		$ 170,822.40
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 640,584.00
B1.2	Contractor mobilisation and demobilisation		k$150-k$400			$ 400,000.00
	Component 2					
B	Core material	m^3		16,800	$ 30.00	$ 504,000.00
	Geotextile	m^2		4,200	$ 70.00	$ 294,000.00
	Secondary armour, 400kg and 50kg	t		6,678	$ 120.00	$ 801,360.00
	Rock armour, 500kg	t		3,339	$ 160.00	$ 534,240.00
	Rock armour, 4t	t		13,356	$ 160.00	$ 2,136,960.00
	Subtotal					**$ 4,270,560.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	30%		$ 1,281,168.00
C.2	Geotechnical risk		5%-30%	10%		$ 427,056.00
C.3	Weather and program risk		0-30%	20%		$ 854,112.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 2,135,280.00
D.2	Escalation		0.5%-3%	2%		$ 85,411.20
Total cost estimate						**$ 10,606,638.40**

Component 3: Piled Wave barrier

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	600
Footprint on land environment	m2	0
Time of construction	months	3
Design standard	year ARI	200
Cost	$	$ 11,081,980.00
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 443,279.20
Visual amenity	height * area	1 * 120

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	2.5%		$ 400,000.00
A.2	Design, testing and development approval		2%-5%	4.5%		$ 234,180.00
A.3	Superintendent / construction management		2%-5%	4.0%		$ 208,160.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 780,600.00
B1.2	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 3					
B	Pile structure	m^2		600	$ 7,000.00	$ 4,200,000.00
	Concrete wall and grout	m^3		536	$ 1,500.00	$ 804,000.00
	Timber	m^3		24	$ 8,333.33	$ 200,000.00
	Subtotal					**$ 5,204,000.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	10%		$ 520,400.00
C.3	Weather and program risk		0-30%	15%		$ 780,600.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 2,602,000.00
D.2	Escalation		0.5%-3%	1.00%		$ 52,040.00
Total cost estimate						**$ 11,081,980.00**

Component 4: Detached breakwater extension

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	1750
Footprint on land environment	m2	0
Time of construction	months	3
Design standard	year ARI	200
Cost	$	$ 4,652,766.00
Maintenance	cycle in year	5
Lifecycle cost	$ per year	$ 325,693.62
Visual amenity	height * area	2 x 50

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	5.0%		$ 88,970.00
A.2	Design, testing and development approval		2%-5%	3.0%		$ 53,382.00
A.3	Superintendent / construction management		2%-5%	4.0%		$ 71,176.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 266,910.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 400,000.00
	Component 4					
B	Core material	m^3		7000	$ 30.00	$ 210,000.00
	Secondary armour, 50kg and 400 kg	t		2782.5	$ 120.00	$ 333,900.00
	Rock armour, 4t	t		5565	$ 160.00	$ 890,400.00
	Rock armour, 500kg	t		1391.25	$ 160.00	$ 222,600.00
	Geotextile	m2		1750	$ 70.00	$ 122,500.00
	Subtotal					**$ 1,779,400.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	30%		$ 533,820.00
C.2	Geotechnical risk		5%-30%	10%		$ 177,940.00
C.3	Weather and program risk		0-30%	20%		$ 355,880.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 889,700.00
D.2	Escalation		0.5%-3%	2.00%		$ 35,588.00
Total cost estimate						**$ 4,652,766.00**

Component 5: Flushing System

1.0 Summary - KPI Responses

Criteria	KPI	Response
design life	years	25
Footprint on marine environment	m2	10
Footprint on land environment	m2	115
Time of construction	months	0.5
Design standard	year ARI	-
Cost	$	$ 676,447.50
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 37,057.90
Visual amenity	area from Alex	0 x 0

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	1.0%		$ 2,145.00
A.2	Design, testing and development approval		2%-5%	1.0%		$ 2,145.00
A.3	Superintendent / construction management		2%-5%	1.0%		$ 2,145.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 32,175.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 5					
B	Gully pits		Unit	3	$ 3,500.00	$ 10,500.00
	Drainage pipe		m	60	$ 400.00	$ 24,000.00
	Concrete drain		m^3	120	$ 1,500.00	$ 180,000.00
	Subtotal					**$ 214,500.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	2%		$ 4,290.00
C.3	Weather and program risk		0-30%	5%		$ 10,725.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 107,250.00
D.2	Escalation		0.5%-3%	0.50%		$ 1,072.50
Total cost estimate						**$ 676,447.50**

Component 6: Dredging

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life		25
Footprint on marine environment	m2	2050
Footprint on land environment	m2	0
Time of construction	months	0.25
Design standard	year ARI	-
Cost	$	$ 793,125.00
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 428,287.50
Visual amenity	height * area	0 x 0

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	3.0%		$ 7,890.00
A.2	Design, testing and development approval		2%-5%	1.00%		$ 2,630.00
A.3	Superintendent / construction management		2%-5%	3.00%		$ 7,890.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 39,450.00
B1.2	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 6					
B	Dredging material	m^3		900	$ 70.00	$ 63,000.00
	Dredge mobilisation	Unit		1	$ 200,000.00	$ 200,000.00
	Subtotal					**$ 263,000.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	5%		$ 13,150.00
C.3	Weather and program risk		0-30%	10%		$ 26,300.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 131,500.00
D.2	Escalation		0.5%-3%	0.50%		$ 1,315.00
Total cost estimate						**$ 793,125.00**

Component 7: Commercial Wharf

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	850
Footprint on land environment	m2	240
Time of construction	months	1.5
Design standard	year ARI	200
Cost	$	$ 16,872,463.60
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 354,321.74
Visual amenity	height * area	2 x 40

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	4.0%		$ 278,528.80
A.2	Design, testing and development approval		2%-5%	4.00%		$ 278,528.80
A.3	Superintendent / construction management		2%-5%	3.00%		$ 208,896.60
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 1,044,483.00
B1.2	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 7					
B	Wharf	m2		300	$ 7,000.00	$ 2,100,000.00
	Concrete walkway	m3		1500	$ 1,500.00	$ 2,250,000.00
	Wharf position allowance	unit		1	$ 300,000.00	$ 300,000.00
	Primary armour - 4t	ton		7234.5	$ 160.00	$ 1,157,520.00
	Primary armour - 500kg	ton		1808.625	$ 160.00	$ 289,380.00
	Secondary armour	ton		3617.25	$ 120.00	$ 434,070.00
	Geotextile	m2		2275	$ 70.00	$ 159,250.00
	Core material fill	m3		9100	$ 30.00	$ 273,000.00
	Subtotal					**$ 6,963,220.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	30%		$ 2,088,966.00
C.2	Geotechnical risk		5%-30%	10%		$ 696,322.00
C.3	Weather and program risk		0-30%	20%		$ 1,392,644.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 3,481,610.00
D.2	Escalation		0.5%-3%	2.00%		$ 139,264.40
Total cost estimate						**$ 16,872,463.60**

Component 8: Re-positioning of existing pontoon

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	25
Footprint on marine environment	m2	5
Footprint on land environment	m2	10
Time of construction	months	0.25
Design standard	year ARI	-
Cost	$	$ 274,600.00
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 20,984.00
Visual amenity	height * area	1 x 10

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	2.5%		$ 3,562.50
A.2	Design, testing and development approval		2%-5%	2.0%		$ 2,850.00
A.3	Superintendent / construction management		2%-5%	2.0%		$ 2,850.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 21,375.00
B1.2	Contractor mobilisation and demobilisation		k$150-k$400			$ 1,000.00
	Component 8					
B	Concrete for new abutment	m3		75	$ 1,500.00	$ 112,500.00
	Pile for pontoon	unit		6	$ 5,000.00	$ 30,000.00
	Subtotal					**$ 142,500.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	5%		$ 7,125.00
C.3	Weather and program risk		0-30%	15%		$ 21,375.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 71,250.00
D.2	Escalation		0.5%-3%	0.50%		$ 712.50
Total cost estimate						**$ 274,600.00**

Component 9: Third boat ramp lane

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	25
Footprint on marine environment	m2	100
Footprint on land environment	m2	10
Time of construction	months	0.5
Design standard	year ARI	-
Cost	$	$ 957,103.35
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 48,284.13
Visual amenity	height * area	0.5 x 30

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	2.5%		$ 9,747.63
A.2	Design, testing and development approval		2%-5%	2.00%		$ 7,798.10
A.3	Superintendent / construction management		2%-5%	2.00%		$ 7,798.10
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 58,485.75
B1.2	Contractor mobilisation and demobilisation		k$150-k$400			$ 150,000.00
	Component 9					
B	Fill	m3		600	$ 15.00	$ 9,000.00
	Reinforced concrete	m3		35	$ 2,000.00	$ 70,000.00
	Revetment (m long)					
	Primary armour - 500kg	t		1113	$ 80.00	$ 89,040.00
	Secondary armour	t		1947.75	$ 60.00	$ 116,865.00
	Geotextile	m2		1200	$ 35.00	$ 42,000.00
	Core material fill	m3		4200	$ 15.00	$ 63,000.00
	Subtotal					**$ 389,905.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	10%		$ 38,990.50
C.2	Geotechnical risk		5%-30%	10%		$ 38,990.50
C.3	Weather and program risk		0-30%	15%		$ 58,485.75
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 194,952.50
D.2	Escalation		0.5%-3%	0.50%		$ 1,949.53
Total cost estimate						**$ 957,103.35**

Component 10: Additional car park

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	25
Footprint on marine environment	m2	0
Footprint on land environment	m2	975
Time of construction	months	0.5
Design standard	year ARI	-
Cost	$	$ 483,787.50
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 29,351.50
Visual amenity	height * area	0 x 0

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	1.0%		$ 975.00
A.2	Design, testing and development approval		2%-5%	1.0%		$ 975.00
A.3	Superintendent / construction management		2%-5%	1.0%		$ 975.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 14,625.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 10					
B	Car park	m2		975	$ 100.00	$ 97,500.00
	Subtotal					**$ 97,500.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	5%		$ 4,875.00
C.3	Weather and program risk		0-30%	15%		$ 14,625.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 48,750.00
D.2	Escalation		0.5%-3%	0.50%		$ 487.50
Total cost estimate						**$ 483,787.50**

Component 11: Disabled access

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life		25
Footprint on marine environment	m2	225
Footprint on land environment	m2	0
Time of construction	months	0.5
Design standard	year ARI	-
Cost	$	$ 2,147,475.00
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 95,899.00
Visual amenity	height * area	2 x 10

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	1.0%		$ 9,450.00
A.2	Design, testing and development approval		2%-5%	2.0%		$ 18,900.00
A.3	Superintendent / construction management		2%-5%	2.0%		$ 18,900.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 141,750.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 11					
B	Concrete ramp on pile	m2		135	$ 7,000.00	$ 945,000.00
	Subtotal					**$ 945,000.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	10%		$ 94,500.00
C.3	Weather and program risk		0-30%	15%		$ 141,750.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 472,500.00
D.2	Escalation		0.5%-3%	0.50%		$ 4,725.00
Total cost estimate						**$ 2,147,475.00**

Component 12: Caisson breakwater

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	2400
Footprint on land environment	m2	0
Time of construction	months	2
Design standard	year ARI	200
Cost	$	$ 13,598,347.00
Maintenance	cycle in year	5
Lifecycle cost	$ per year	$ 285,565.29
Visual amenity	height * area	2 x 60

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	4.0%		$ 253,742.40
A.2	Design, testing and development approval		2%-5%	3.0%		$ 190,306.80
A.3	Superintendent / construction management		2%-5%	3.0%		$ 190,306.80
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 951,534.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 12					
B	reinforced concrete	m3		1080	$ 2,000.00	$ 2,160,000.00
	concrete	m3		2700	$ 1,500.00	$ 4,050,000.00
	rock protection	t		1113	$ 120.00	$ 133,560.00
	Subtotal					**$ 6,343,560.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	8%		$ 484,355.80
C.2	Geotechnical risk		5%-30%	10%		$ 634,356.00
C.3	Weather and program risk		0-30%	15%		$ 951,534.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 3,171,780.00
D.2	Escalation		0.5%-3%	2.00%		$ 126,871.20
Total cost estimate						**$ 13,598,347.00**

Component 13: Floating attenuator at the jetty

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	3600
Footprint on land environment	m2	0
Time of construction	months	1
Design standard	year ARI	200
Cost	$	$ 14,700,000.00
Maintenance	cycle in year	5
Lifecycle cost	$ per year	$ 304,000.00
Visual amenity	height * area	1 x 120

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	3.0%		$ 216,000.00
A.2	Design, testing and development approval		2%-5%	3.0%		$ 216,000.00
A.3	Superintendent / construction management		2%-5%	3.0%		$ 216,000.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 1,080,000.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 13					
B	Floating attenuator	m2		720	$ 10,000.00	$ 7,200,000.00
	Subtotal					**$ 7,200,000.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	10%		$ 720,000.00
C.3	Weather and program risk		0-30%	15%		$ 1,080,000.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 3,600,000.00
D.2	Escalation		0.5%-3%	1.00%		$ 72,000.00
Total cost estimate						**$ 14,700,000.00**

Component 14: Submerged breakwater

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	2400
Footprint on land environment	m2	0
Time of construction	months	1
Design standard	year ARI	200
Cost	$	$ 4,840,904.40
Maintenance	cycle in year	5
Lifecycle cost	$ per year	$ 101,658.99
Visual amenity	height * area	0 x 0

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	5.0%		$ 101,814.00
A.2	Design, testing and development approval		2%-5%	3.0%		$ 61,088.40
A.3	Superintendent / construction management		2%-5%	4.0%		$ 81,451.20
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 305,442.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 14					
B	Primary armour 4t	t		5565	$ 160.00	$ 890,400.00
	Primary armour 500 kg	t		2448.6	$ 160.00	$ 391,776.00
	Secondary armour	t		3784.2	$ 120.00	$ 454,104.00
	Geotextile	m2		3000	$ 70.00	$ 210,000.00
	Core material fill	m3		3000	$ 30.00	$ 90,000.00
	Subtotal					**$ 2,036,280.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	15%		$ 305,442.00
C.2	Geotechnical risk		5%-30%	15%		$ 305,442.00
C.3	Weather and program risk		0-30%	15%		$ 305,442.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 1,018,140.00
D.2	Escalation		0.5%-3%	1.00%		$ 20,362.80
Total cost estimate						**$ 4,840,904.40**

Component 15: Offshore boat ramps

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	800
Footprint on land environment	m2	5000
Time of construction	months	5
Design standard	year ARI	200
Cost	$	$ 28,623,969.81
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 601,103.37
Visual amenity	height * area	2 x 80

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	4.0%		$ 519,705.87
A.2	Design, testing and development approval		2%-5%	3.0%		$ 389,779.40
A.3	Superintendent / construction management		2%-5%	3.0%		$ 389,779.40
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 1,948,897.01
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 15					
B	Boat ramps	unit		2	$ 957,103.35	$ 1,914,206.70
	Floating pontoon	m2		150	$ 10,000.00	$ 1,500,000.00
	Road and car park area	m2		5000	$ 100.00	$ 500,000.00
	Building	unit		4	$ 700,000.00	$ 2,800,000.00
	Breakwater					
	Primary armour - 4t	t		8904	$ 160.00	$ 1,424,640.00
	Primary armour - 500kg	t		2226	$ 160.00	$ 356,160.00
	Secondary armour	t		4452	$ 120.00	$ 534,240.00
	Geotextile	m2		2800	$ 70.00	$ 196,000.00
	Core material fill	m3		11200	$ 30.00	$ 336,000.00
	Revetment east					
	Primary armour - 4t	t		27825	$ 80.00	$ 2,226,000.00
	Primary armour 500kg	t		4637.5	$ 80.00	$ 371,000.00
	Secondary armour	t		9275	$ 60.00	$ 556,500.00
	Geotextile	m2		4250	$ 15.00	$ 148,750.00
	Revetment west					
	Primary armour 500kg	t		556.5	$ 80.00	$ 44,520.00
	Secondary armour	t		1113	$ 60.00	$ 66,780.00
	Geotextile	m2		510	$ 35.00	$ 17,850.00
	Subtotal					**$ 12,992,646.70**
Risks & opportunity						
C.1	Quarry risk		2%-20%	15%		$ 1,948,897.01
C.2	Geotechnical risk		5%-30%	10%		$ 1,299,264.67
C.3	Weather and program risk		0-30%	15%		$ 1,948,897.01
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 6,496,323.35
D.2	Escalation		0.5%-3%	3.00%		$ 389,779.40
Total cost estimate						**$ 28,623,969.81**

Component 16: Offshore pontoon

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	50
Footprint on marine environment	m2	1650
Footprint on land environment	m2	600
Time of construction	months	5
Design standard	year ARI	200
Cost	$	$ 12,162,713.96
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 248,119.36
Visual amenity	height * area	2 x 50

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	4.0%		$ 213,742.59
A.2	Design, testing and development approval		2%-5%	3.0%		$ 160,306.95
A.3	Superintendent / construction management		2%-5%	3.0%		$ 160,306.95
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 801,534.73
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 17					
B	Walkway	m3		240	$ 1,500.00	$ 360,000.00
	Building	unit		1	$ 700,000.00	$ 700,000.00
	Wharf	m2		300	$ 7,000.00	$ 2,100,000.00
	Primary armour - 4t	t		6762.501186	$ 160.00	$ 1,082,000.19
	Primary armour - 500kg	t		1690.625297	$ 160.00	$ 270,500.05
	Secondary armour	t		3381.250593	$ 120.00	$ 405,750.07
	Geotextile	m2		2430.3688	$ 70.00	$ 170,125.82
	Core material fill	m3		8506.2908	$ 30.00	$ 255,188.72
	Subtotal					**$ 5,343,564.85**
Risks & opportunity						
C.1	Quarry risk		2%-20%	15%		$ 801,534.73
C.2	Geotechnical risk		5%-30%	15%		$ 801,534.73
C.3	Weather and program risk		0-30%	15%		$ 801,534.73
Contingency and escalation						
D.1	Contingency			50%		$ 2,671,782.42
D.2	Escalation		0.5%-3%	2.00%		$ 106,871.30
Total cost estimate						**$ 12,162,713.96**

Component 17: Commercial pontoon

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	25
Footprint on marine environment	m2	420
Footprint on land environment	m2	10
Time of construction	months	1
Design standard	year ARI	-
Cost	$	$ 8,500,000.00
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 350,000.00
Visual amenity	height * area	2 x 10

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	3.0%		$ 123,000.00
A.2	Design, testing and development approval		2%-5%	3.0%		$ 123,000.00
A.3	Superintendent / construction management		2%-5%	3.0%		$ 123,000.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 615,000.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 18					
B	Building	unit		1	$ 700,000.00	$ 700,000.00
	Pontoon	m2		300	$ 10,000.00	$ 3,000,000.00
	Gangway	m		40	$ 10,000.00	$ 400,000.00
	Subtotal					**$ 4,100,000.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	10%		$ 410,000.00
C.3	Weather and program risk		0-30%	15%		$ 615,000.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 2,050,000.00
D.2	Escalation		0.5%-3%	1.00%		$ 41,000.00
Total cost estimate						**$ 8,500,000.00**

Component 18: Sediment trap

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	25
Footprint on marine environment	m2	2800
Footprint on land environment	m2	0
Time of construction	months	0.5
Design standard	year ARI	-
Cost	$	$ 1,442,560.00
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 69,242.88
Visual amenity	height * area	0 x 0

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	3.50%		$ 20,720.00
A.2	Design, testing and development approval		2%-5%	1.00%		$ 5,920.00
A.3	Superintendent / construction management		2%-5%	3.00%		$ 17,760.00
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 88,800.00
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 19					
B	Dredging	m3		5600	$ 70.00	$ 392,000.00
	Mobilisation dredge	unit		1	$ 200,000.00	$ 200,000.00
	Subtotal					**$ 592,000.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	0%		$ -
C.2	Geotechnical risk		5%-30%	5%		$ 29,600.00
C.3	Weather and program risk		0-30%	15%		$ 88,800.00
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 296,000.00
D.2	Escalation		0.5%-3%	0.50%		$ 2,960.00
Total cost estimate						**$ 1,442,560.00**

Component 19: Land-backed wharf

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	25
Footprint on marine environment	m2	250
Footprint on land environment	m2	2000
Time of construction	months	2
Design standard	year ARI	-
Cost	$	$ 8,178,381.23
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 343,492.01
Visual amenity	height * area	1 x 70

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	2.5%		$ 91,822.63
A.2	Design, testing and development approval		2%-5%	3.00%		$ 110,187.15
A.3	Superintendent / construction management		2%-5%	3.00%		$ 110,187.15
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 550,935.75
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 20					
B	Boat ramp	unit		1	$ 389,905.00	$ 389,905.00
	Building	unit		1	$ 700,000.00	$ 700,000.00
	Pontoon re-positioning	unit		1	$ 142,500.00	$ 142,500.00
	Road and car park	m2		2000	$ 100.00	$ 200,000.00
	Land-back ferry wharf	m2		150	$ 7,000.00	$ 1,050,000.00
	Dredging	m3		1200	$ 70.00	$ 84,000.00
	Mobilisation	unit		1	$ 200,000.00	$ 200,000.00
	Revetment (m long)					
	Primary armour - 500kg				$ 80.00	$ 222,600.00
	Secondary armour				$ 60.00	$ 333,900.00
	Geotextile				$ 35.00	$ 140,000.00
	Core material fill				$ 15.00	$ 210,000.00
	Subtotal					**$ 3,672,905.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	10%		$ 367,290.50
C.2	Geotechnical risk		5%-30%	15%		$ 550,935.75
C.3	Weather and program risk		0-30%	15%		$ 550,935.75
Contingency and escalation						
D.1	Contingency		0.25	50%		$ 1,836,452.50
D.2	Escalation		0.5%-3%	1.00%		$ 36,729.05
Total cost estimate						**$ 8,178,381.23**

Component 20: Berthing Pontoon

1.0 Summary - KPI Responses

Criteria	KPI	Response
Design life	years	25
Footprint on marine environment	m2	200
Footprint on land environment	m2	0
Time of construction	months	1
Design standard	year ARI	50
Cost	$	$ 7,917,430.73
Maintenance	cycle in year	1
Lifecycle cost	$ per year	$ 332,532.09
Visual amenity	height * area	1 x 40

2.0 Capital Cost Estimate

Item No.	Material Schedule	Unit	Range	Quantity	Rates	Subtotal
Concept and development stage						
A.1	Surveys and fees		1%-5%	2.5%		$ 93,122.63
A.2	Design, testing and development approval		2%-5%	3.00%		$ 111,747.15
A.3	Superintendent / construction management		2%-5%	3.00%		$ 111,747.15
Implementation stage						
B1	**Contractor costs**					
B1.1	Contractor Overheads		10%-30%	15%		$ 558,735.75
B1.3	Contractor mobilisation and demobilisation		k$150-k$400			$ 300,000.00
	Component 20					
B	Boat ramp	unit		1	$ 389,905.00	$ 389,905.00
	Piles	unit		10	$ 5,000.00	$ 50,000.00
	Pontoon	unit		200	$ 10,000.00	$ 2,000,000.00
	Road and car park	m2		50	$ 100.00	$ 5,000.00
	Breakwater extension			16000	$ 80.00	$ 1,280,000.00
	Subtotal					**$ 3,724,905.00**
Risks & opportunity						
C.1	Quarry risk		2%-20%	10%		$ 372,490.50
C.2	Geotechnical risk		5%-30%	5%		$ 186,245.25
C.3	Weather and program risk		0-30%	15%		$ 558,735.75
Contingency and escalation						
D.1	Contingency			50%		$ 1,862,452.50
D.2	Escalation		0.5%-3%	1.00%		$ 37,249.05
Total cost estimate						**$ 7,917,430.73**

Appendix C
KPI Results

Table 13 KPI results

	Theme	(1) Impact							(2) Effectiveness					(3) Social value/community expectations				(4) Government process				(5) Economics		
	Criteria (KPI)	Marine Biodiversity (Surface of Impact)	Beach & nearshore biodiversity (Surface of Impact)	Terrestrial and marine impacts (sensitive location)	Env Impacts beyond Clump Pt (Sedimentation, siltation)	Navigation (Increase in capacity)	Construction impact (time, month)	Non boating users (immediate increase in local road traffic)	Longevity (Design working life)	Addresses wave problem (wave transmittion coefficient)	failure consequence (Functional loss (low to high)	technology challenges (multi-functionality, flexibility)	cyclonic capacity (wave design standard, year ARI)	Visual Amenity (height x area from Alexander Drive)	Safe Boating (Safe Conditions)	Sense of place (typ. location of new users)	suitability of materials (are construction material/technology already on site)	Roles and responsibilities (Number of approvals)	Compliance with coastal management objectives (complexity)	Approvals process/duration (IDAS timeframe, + prep time, Business days)	Assessment inputs (# of additional studies)	Capital cost ($)	Maintenance program (How often, year)	Lifecycle cost ($ per year over design life)
ID	**Clump Point Jetty**																							
1	Pontoon and connecting gangway	360	0	Unlikely	neutral	none	1	negligible	5	1	medium	Low	50	3 x 15	Adverse	similar	no	8	L	85	0	$4,082,250	1	$183,290.0 0
2	Breakwater	5500	0	Likely	tombolo	indirect	6	minor	50	0.15	low	Fair	200	2 x 120	Excellent	regional	no	8	H	115	0	$10,606,638	5	$222,739.4 0
3	Piled wave barrier	600	0	Likely	tombolo	indirect	4	minor	50	0.2	high	Fair	200	1 x 120	Excellent	regional	some	8	H	115	1	$11,081,980	1	$443,279.20
11	Disabled access	225	0	Unlikely	neutral	none	0.5	negligible	5	1	medium	Low	50	2 x 10	Adverse	similar	Yes	7	L	85	0	$2,147,475	1	$95,899.0 0
12	Caisson breakwater	1200	0	Likely	tombolo	indirect	2	minor	50	0.5	low	Good	200	2 x 60	Moderate	regional	some	8	H	115	1	$13,598,347	5	$285,565.3 0
13	Floating attenuator	3600	0	Unlikely	neutral	indirect	1	minor	25	0.5	high	Low	200	1 x 120	Moderate	regional	no	8	H	115	0	$14,700,000	5	$304,000.0 0
14	Overtopping breakwater	2400	0	Likely	Intermediate	indirect	4	minor	50	0.3	low	Fair	200	1 x 20	Good	regional	some	8	H	115	0	$4,840,904	5	$101,659.0 0
	Clump Point Boat Ramp																							
4	Detached breakwater extension	1750	0	Likely	increased	indirect	3	negligible	50	0.15	low	Fair	200	2 x 50	Excellent	similar	yes	8	H	155	3	$4,652,766	5	$325,693.6 0
5	Flushing system	10	115	Unlikely	decreased	none	0.5	negligible	25	1	low	Low	50	0 x 0	Excellent	similar	yes	4	L	45	0	$676,448	1	$37,057.9 0
6	Dredging	2050	0	Likely	increased	none	0.5	negligible	5	0.8	medium	Low	none	0 x 0	Excellent	similar	-	9	H	155	3	$793,125	2	$428,287.5 0
7	Commercial wharf	850	240	Likely	increased	200%	9	250%	50	0.3	High	Good	200	2 x 40	Excellent	interstate	some	8	H	85	1	$16,872,464	1	$354,321.70
8	Re-positioning of existing pontoon	5	10	Unlikely	neutral	none	0.5	negligible	25	1	low	Low	50	1 x 10	Excellent	similar	yes	8	L	85	0	$274,600	1	$20,984.0 0
9	Third boat ramp lane	100	10	Unlikely	neutral	50%	2	30%	25	1	medium	Low	50	0.5 x 30	Excellent	local	yes	8	L	85	0	$957,103	1	$48,284.1 0
10	Additional car park	0	975	Likely	neutral	none	2	10%	25	1	medium	Low	50	0 x 0	Excellent	similar	yes	5	L	110	0	$483,788	1	$29,351.5 0
15	Offshore additional boat ramps	800	5000	Likely	increased	250%	9	50%	25	0.15	high	Good	200	2 x 80	Excellent	regional	some	11	VH	280+	6	$28,623,970	1	$601,103.4 0

16	Offshore Pontoon	1650	600	Likely	increased	200%	6	250%	25	0.15	high	Fair	200	2 x 50	Excellent	interstate	no	8	H	155	2	$12,162,714	1	$248,119.4 0
17	Commercial pontoon	420	10	Likely	neutral	200%	3	250%	25	1	high	Fair	50	2 x 10	Excellent	interstate	no	8	M	115	0	$ 8,500,000	1	$ 350,000.0
18	Sediment trap	2800	0	Likely	increased	none	0.5	negligible	5	0.9	medium	Low	none	0 x 0	Excellent	similar	-	11	M	115	3	$ 1,442,560	2	$ 69,242.9
19	Land-backed wharf	250	2000	Likely	increased	200%	4	250%	50	1	high	Fair	200	1 x 70	Excellent	interstate	no	11	VH	115	3	$ 8,178,381	1	$ 343,492.0
20	Berthing Pontoon	200	10	Likely	Neutral	indirect	1	negligible	25	1	medium	Good	50	1 x 40	Excellent	similar	yes	8	L	115	0	$ 7,917,430	1	$ 332,532

Appendix D
Component MCA results

Table 14 Component MCA results

ID	Component Description	Minimum results					Average Results					Maximum Result				
		Impact	Effectiveness	Social	Process	Economics	Impact	Effectiveness	Social	Process	Economics	Impact	Effectiveness	Social	Process	Economics
1	Pontoon and connecting gangway	-0.1	-1.2	-0.7	-0.3	-0.5	0.1	-0.5	-0.2	0.2	-0.2	0.2	0.2	0.5	0.6	0.0
2	Breakwater	-3.1	0.9	-2.4	-1.9	-1.7	-1.0	1.4	-0.3	-0.7	-0.1	1.0	1.8	1.9	1.5	1.3
3	Piled wave barrier	-1.5	0.3	-1.8	-2.0	-2.2	-0.6	1.2	0.1	-0.9	-1.3	0.8	1.8	2.0	0.9	0.0
11	Disabled access	0.0	-0.7	-0.4	-0.2	-0.3	0.1	-0.2	-0.1	0.1	-0.1	0.1	0.2	0.2	0.3	0.0
12	Caisson breakwater	-2.6	0.4	-2.9	-2.5	-2.2	-0.7	1.5	-0.6	-1.1	-0.5	1.2	2.2	1.4	1.1	1.6
13	Floating attenuator	-2.6	0.2	-2.7	-2.7	-3.6	-0.1	0.6	-1.0	-0.9	-1.0	0.9	1.2	1.0	2.1	1.8
14	Overtopping breakwater	-0.7	0.3	-0.3	-0.9	-0.5	-0.1	0.5	0.1	-0.3	0.1	0.4	0.8	0.6	0.7	0.6
4	Detached breakwater extension	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Flushing system	-0.2	0.0	-0.1	-0.2	-0.1	-0.1	0.1	0.0	-0.1	0.0	0.0	0.1	0.1	0.0	0.1
6	Dredging	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1
7	Commercial wharf	-5.4	-5.1	0.0	-3.8	-5.8	-1.6	-2.0	0.7	-2.8	-1.0	0.8	0.7	2.3	-1.4	1.4
8	Re-positioning of existing pontoon	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Third boat ramp lane	0.0	-0.1	0.0	-0.1	-0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1
10	Additional car park	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
15	Offshore additional boat ramps	-2.8	-2.6	0.0	-2.6	-3.5	-0.1	0.1	2.1	1.4	0.3	1.3	2.3	3.9	4.0	2.9
16	Offshore Pontoon	-3.9	-2.2	-1.8	-4.4	-2.9	-1.6	0.4	0.1	-3.5	-1.8	2.2	2.0	1.7	-2.7	0.0
17	Commercial pontoon	-2.3	-2.1	-1.4	-1.9	-1.4	-1.0	0.3	-0.3	-0.7	-0.7	1.3	1.4	1.4	0.9	0.0
18	Sediment trap	-0.4	-0.3	-0.2	-0.1	-0.3	-0.1	0.0	0.0	0.0	-0.2	0.2	0.1	0.2	0.2	0.0
19	Land-backed wharf	-2.6	-2.5	0.0	-1.8	-2.0	-0.8	-0.9	0.3	-1.1	-0.5	0.2	0.7	1.1	-0.4	0.2
20	Berthing Pontoon	-1.2	-1.1	-0.7	-1.0	-0.7	-0.5	0.2	-0.2	-0.4	-0.4	0.7	0.7	0.7	0.4	0.0

Appendix E
Option MCA results

Table 15 Options MCA results

Option ID	Minimum results					Average Results					Maximum Result				
	Impact	Effectiveness	Social	Process	Economics	Impact	Effectiveness	Social	Process	Economics	Impact	Effectiveness	Social	Process	Economics
A	-1.7	-1.0	-1.5	-2.4	-1.9	-0.2	0.9	0.2	-0.4	-0.2	1.1	2.2	2.0	2.0	1.4
B	-3.3	-3.7	-2.5	-3.1	-2.5	-1.2	0.3	-0.3	-0.8	-1.1	2.0	2.4	2.4	1.7	0.3
C	-3.8	-2.7	-0.4	-3.1	-3.0	-1.0	-0.4	0.6	-1.5	-0.5	0.8	1.8	2.1	0.6	1.0
D	-3.6	0.1	-3.3	-2.7	-2.5	-1.0	1.5	-0.3	-0.6	-0.2	1.3	2.5	2.7	2.2	1.7
E	-4.5	-2.6	-2.2	-5.1	-3.6	-1.7	0.6	0.3	-3.7	-2.0	2.6	2.5	2.3	-2.7	0.3
F	-3.6	0.0	-3.2	-2.7	-2.5	-1.0	1.5	-0.3	-0.7	-0.2	1.4	2.5	2.7	2.2	1.6
G	-1.9	-0.5	-2.5	-2.7	-3.0	-0.6	1.2	0.1	-0.8	-1.6	1.2	2.4	2.7	1.5	0.2
H	-4.1	-3.1	-2.4	-4.9	-3.5	-1.5	0.3	0.1	-3.4	-2.0	2.5	2.5	2.2	-2.3	0.1
I	-3.6	-3.0	-0.8	-3.2	-3.0	-0.9	-0.5	0.4	-1.5	-0.6	0.8	1.8	2.1	0.6	0.9
J	-3.2	-2.5	-2.3	-3.2	-2.3	-1.1	0.8	-0.3	-1.1	-0.8	1.9	2.6	2.3	1.8	0.7
K	-3.5	-2.9	-0.8	-3.1	-2.9	-0.9	-0.5	0.4	-1.4	-0.6	0.8	1.8	2.1	0.7	0.9
L	-3.3	-2.9	-0.7	-3.0	-2.9	-0.8	-0.5	0.4	-1.2	-0.5	0.8	1.8	2.1	0.8	0.9
M	-3.2	-2.4	-2.2	-3.2	-2.3	-1.0	0.7	-0.2	-1.0	-0.7	1.8	2.5	2.3	1.9	0.7
N	-5.3	-5.0	0.0	-3.8	-5.7	-1.6	-2.0	0.7	-2.8	-1.0	0.8	0.7	2.3	-1.3	1.3
O	-3.0	-2.5	-2.1	-3.0	-2.2	-1.0	0.7	-0.2	-0.8	-0.7	1.8	2.5	2.3	2.0	0.7
P	-2.0	-1.5	-1.5	-2.3	-1.7	-0.5	0.6	-0.0	-0.6	-0.4	1.2	1.9	1.7	1.5	0.8
Q	-3.4	-2.8	-0.8	-2.9	-2.9	-0.8	-0.4	0.4	-1.2	-0.5	0.9	1.8	2.1	0.7	0.9
R	-3.3	-2.8	-0.8	-3.0	-2.9	-0.8	-0.4	0.4	-1.3	-0.5	0.8	1.8	2.1	0.7	0.9
S	-3.0	-2.4	-2.1	-3.1	-2.3	-1.0	0.7	-0.2	-0.9	-0.7	1.8	2.5	2.3	1.9	0.8

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