REPORT

Albany Artificial Surfing Reef Feasibility Study

Final Report

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Royal HaskoningDHV
Enhancing Society Together

City of Albany

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1 Executive Summary

1.1 Introduction

Haskoning Australia, a division of Royal HaskoningDHV (RHDHV) have prepared this Albany Artificial Surfing Reef Feasibility Study report in response to the City of Albany's (CoA) desire to provide recreational surfing amenity at Middleton Beach, Albany, through the construction of an Artificial Surfing Reef (ASR). The ASR is to be designed specifically for younger and beginner to intermediate surfers;, given the lack of suitable surfing waves close to the town centre and those breaks located at a distance to town tending to present far more challenging conditions.

The CoA has formed the Albany Artificial Surfing Reef Steering Group (SG) to advise, engage and convey information to appropriate members of the Middleton Beach community. In addition to this, the report has undergone several peer and technical reviews.

For ease of reference, two reports have been developed for this feasibility study, namely:

1. Part A: Option Assessment (Appendix A of this report)
2. Part B: Feasibility Design (Appendix B of this report)

Part A: Option Assessment focusses on: the background, numerical modelling, surfing science, lessons learnt, location conditions, outline design and the development of the three ASR options for further consideration and selection.

Part B: Feasibility Report focusses on: design modelling, engineering design, constructability, ecology, approvals, cost and project schedule considerations of the preferred ASR option, as well as overall project conclusions and recommendations.

A Risk Register has been established for the project and included in Appendix C of this report. It is intended that this Risk Register can be updated as the project progresses.

1.2 Objectives

As per The City's brief, the objectives for the project were as follows;

The intent is to create a consistent, surfable wave, which maximises available swell conditions and is central to Albany, driving benefits in tourism, economic development and retention of Albany's younger age demographic.

Objectives:

- Produce a design which encourages surfing and beach tourism, provides promotional opportunities and retains Albany's younger age demographic.
- Identify the type of wave (shape, form and length) that would be suitable for the target users (i.e. beginner to intermediate)
- Maximise opportunities for surfable waves by multiple surfers, by investigating the option for more than once surf break i.e. various peaks to spread crowds.

- Produce a design based on all available technical information and data, thoroughly modelled and tested for a range of design wave conditions, ensuring wave suitability for beginner to intermediate users.
- Design a structure to create a consistent surfable wave, maximising available swell conditions and to complement (i.e. not significantly alter) existing coastal protection processes.
- Produce a design which considers operational and design wave conditions to ensure functionality and structure longevity.
- Produce a design that provides realistic expectations of the expected outcome and that will improve current surfing amenity, benchmarked against local surfing conditions.
- Design a structure that considers staging and the option for future expansion.
- Provide unobtrusive visual amenity.
- Design a solution realistic to funding opportunities and that considers capital and reoccurring costs.
- Provide long term sustainability and stability.
- Require minimal maintenance.
- Address health and safety hazards for all ocean users (i.e. recreational fishing and boating).
- Obtain a report suitable for funding advocacy purposes.

1.3 Part A: Option Assessment

To ensure the objectives of the study were met, RHDHV undertook the following as part of this phase of the study:

a) Analysis and review of available metocean, morphology and ecology data;
b) Spectral wave modelling – To determine nearshore design wave conditions and location for the proposed ASR;
c) Review of relevant literature on submerged structures and lessons learnt;
d) Determination of, and reporting on, key design criteria for the construction of an ASR at Middleton Beach; and
e) Design of three (3) ASR options at Middleton Beach, one of which was selected for the feasibility study (the Part B report).

Whilst Middleton Beach has a relatively low energy wave climate (mean H_s = 0.5-0.75m), the metocean analysis and subsequent spectral wave modelling illustrated that Middleton Beach possesses a number of very unique features that result in ideal conditions for the development of an ASR at this location, such as:

- A micro-tidal environment which will maximise the duration that swell will break on the reef structure;
- An almost unidirectional wave climate (modelling has demonstrated no more than a 5-10 degree direction spread);
- Relatively long period (12-16 sec) wave conditions which would result in significant wave shoaling (increase in wave height) in response to an ASR; and

- Two main areas of wave focussing; Emu Point and 'Surfers Point', the latter which has been identified by the City and SG as the preferred location for an ASR.

Historically, there has been a low success rate of previous MPR and ASR projects, in terms of: surfing; coastal protection; and design outcomes. The review of current and previous ASR projects focusses on two case studies most pertinent to Middleton Beach; Mt Manganui and Cables Station reefs.

Highlighting the importance to learn from past mistakes and draw from the knowledge gained from these undertakings, a number of key parameters that drove the design process from the literature review are as follows:

- Desire to build structures from conventional engineering materials such as rock armour rather than experimental/newer technologies (such as geotextiles);
- Structures with permeable, rough surfaces (such as rock) help to reduce wave reflection, rip currents and localised scour in and around the structure; and
- In terms of surf amenity: a single-direction wave is more desirable (as opposed to an A-frame structure);
- Distance to shore, crest-depth and effective crest-width drive shoreline response in the lee of the structure (erosion/accretion) based on the most up to date research in this area; and
- Localised marine florae and faunae benefited in all instances of submerged structures investigated.

Through this process, Key Design Criteria have been developed for the proposed ASR.

Of these, design crest height was determined to be approximately -0.75mAHD and a gentle sloping front toe slope (a 1:15 slope has been adopted) in order to maximise the generally small wave heights and long wave periods experienced at the site. It was determined that, for this design, wave breaking on the ASR would be expected for 60-80% of the year, with a conservative shoaling coefficient of around 1.5-1.8, which means that the average breaking wave heights are likely to be in the range of H_s = 0.8 – 1.3m (and higher during more significant wave events).

Based upon this significant body of work, three options were proposed for the development of an ASR at Middleton Beach, the option that best aligned with objectives of the project brief was identified as;

Option B provides a longer surfable 'right-hand' wave which would be three times longer (120m) under mean wave conditions at a distance of 180-375m from the shore

On conclusion of this option assessment, RHDHV recommended Option B due to its economic advantages in $/m length of ride as well as for the elimination of negative effects around smaller and multi-oriented structures be progressed to the feasibility stage of the project.

1.4 Part B: Feasibility Design

The recommendation to adopt Option B for the further consideration was accepted by the Advisory Steering Group, albeit with a number of requested modifications for the structure, which included the consideration of:

- the structure to be scalable depending on project funding availability;
- a left breaking wave for visual and safety reasons;
- moving the structure closer to the shore for surfer accessibility; and

- Placing the structure approximately 200m to the south to avoid any potential seagrass impact areas.

Each of these were considered in turn and whilst a number had merit, until further on-site data had been collected and assessed, it was deemed that it would not be possible to confirm that these changes would not impact on the overall performance of the structure or existing shoreline. For this reason, the current Option B ("long right hander") layout and design, as per the Option Assessment (Part A) report, was maintained for the purpose of the feasibility design (Part B) report.

Preliminary wave modelling using a more sophisticated (BOUSS-2D) wave model was undertaken for both the current/existing bathymetry and incorporating the Option B layout. Based on the existing bathymetry, the modelling demonstrated that the existing Middleton Beach would have an overall poor surfing amenity with general close-out conditions across the beach, as expected for a Low Tide Terrace type beach (with mean wave height less than 1m, as at Middleton Beach).

The incorporation of the ASR into the model demonstrated that the structure not only provided for surfing amenity on the ASR itself, but also, by breaking up the incoming swell waves and the superimposition of refracted and incident waves, at least two additional (shorter but faster) breaks in the lee and either side of the ASR. The modelling also demonstrated the occurrence of up to three waves at any one time (during suitable wave conditions) on the ASR structure.

This report includes further work on the engineering design, development of preliminary design drawings as well as assessment of constructability aspects for the project. The construction of rock structures using well equipped marine based plant can be undertaken accurately and efficiently, provided that the weather conditions are suitable for the safe operation of the marine plant operations. In general, the period between January and April each year is considered less suitable for such operations due to predominant onshore wind/seas, however, May to December appeared to present, on average, ideal conditions for such operations due to predominant offshore conditions.

Hence, in addition to the unique wave period, direction and tidal advantages offered at this location (as noted previously), there are a number of unique location characteristics which also offer significant advantages for the construction of the ASR at Middleton Beach, such as:

- Albany is located in an area rich in granite rock resources which are ideal for the construction of the ASR structure;
- A relatively long period (some 8 months) during which marine construction activities would be possible with relatively little downtime;
- A significant working port in very close proximity having suitable (berthing, access for loading, vessel support) facilities to support the construction works; and
- Located in a relatively well sheltered embayment with additional protection offered within Princess Royal Harbour, if required.

In addition to enhancing surfing amenity, the ASR substrate will also provide for significantly improved marine ecology at and around the site, which is also largely void of any significant seagrasses (current and historically). This will lead to additional amenity in regards to fishing and diving at the site of the ASR. The ASR will also provide an iconic and unique landmark facility for Middleton Beach.

Various approvals and commercial arrangements will need to be sought for the project to proceed. The preferred option would be to lease the seabed area over and around the structure footprint from the

Southern Ports Authority. Early discussions with the environmental regulators and other stakeholders are also encouraged in order to assist with the necessary approvals for the facility.

Cost and project schedule estimates have also been prepared for the preferred Option B layout.

The cost estimates were prepared by professional Quantity Surveyors, Muller Partnership, who have significant experience in developing robust costs for maritime and coastal projects, as well as recent experience preparing costs for the Grange Southdown Project at Albany. In preparing the estimate, they have identified a number of known and unknown risks as well as contingencies which has the possibility of increasing the cost of the Option B layout from approximately $8M (base design and construct cost) to almost $11M (including all contingencies).

An associated project schedule identifies not only the overall timeline but also the further steps required to progress this project further. Overall, the indicative period for development of the Albany ASR project is likely to be some 140 weeks (33 months / 2.7 years), including all planning, design, approvals and construction activities. The schedule also identifies the potential risk/need for a split construction campaign, which could add further delays and costs to the project, should this be required.

Recognising that, at this stage of the project, a more conservative approach has been taken, an option to shift the structure (retaining the same design parameters) up to 100m shoreward and reduce some of the contingency items has also been explored – referred to as Option B (Nearshore).

The outcome of this analysis has been found provide significant benefits for the project, including:

1. Reducing the overall development costs to $8M (including all contingencies);
2. Reducing the overall project timeframe to some 133 weeks (31 months / 2.6 years) and reducing the risk of a split construction campaign; and
3. Reducing the direct impact on seagrasses.

Once additional on-site data is available, further design work would need to explore this significant opportunity further.

A current project risk register is also included in this report. It is intended to maintain this register in order to keep track of all project risks through the duration of the project.

1.5 Conclusions and Recommendations

From the large body of work that has been undertaken for this study; the following overall conclusions are made:

1. Based on the large body of background research, case studies and numerical modelling undertaken for this study, **the preferred location, layout, materials and design parameters for a potential ASR at Middleton Beach have been determined**, subject to confirmation once further on-site data has been collected as part of the next stage of the project;

2. Despite the relatively small wave climate and poor surfing amenity currently offered at **Middleton Beach, the location has, in fact, a number of significant advantages for the development of an ASR at this location**, including: long wave period; unidirectional wave climate and small tidal range all of which offer considerable advantage for the development of an ASR at Middleton Beach;

3. The design of the ASR seeks to maximise these favourable factors in order optimise the surfing amenity on the structure. It was determined that, for this design, **conservatively wave breaking on the ASR would be expected for 60-80% of the year**, with a shoaling coefficient of around 1.5-1.8, which means that the breaking average wave heights are likely to be in the range of H_s = 0.8 – 1.3m (and higher during more significant wave events);

4. **The design of the ASR has also been developed to minimise any impact on the existing coastline and coastal processes** based on: distance to shore, crest-depth and effective crest-width driving shoreline response in the lee of the structure (erosion/accretion) based on the most up to date research in this area;

5. Option B (**a right-hand wave with a crest length or minimum ride length of 120m**) was deemed to provide the preferred and most cost effective option for the development of an ASR at Middleton Beach. The recommendation was accepted by the Steering Group, albeit with some further design preferences, which could be taken into further consideration in future detailed design, once more on-site information was available;

6. Preliminary, sophisticated wave modelling over and around the structure has demonstrated that not only will the structure itself **generate surfable waves** but, due to wave interactions and focussing, **improved conditions for surfing inshore will also be created**, suiting a variety of surf enthusiasts at this site;

7. A method for **construction of the ASR using rock materials**, based on methods used for similar structures has also been proposed. This work can be undertaken accurately and efficiently, as long as suitable weather and wind/sea conditions exist, which at Middleton Beach generally occur during May to December each year. The sheltered conditions; existence of a working port in close proximity; as well as an abundance of granite resource in the area make the location an attractive place for the development of an ASR at this location;

8. The creation of the rock structure in an area largely devoid of similar substrate and seagrass materials is likely to **significantly enhance marine ecology in and around the reef** which would add to its attraction, especially for snorkelling/diving based activities during smaller to medium wave conditions. These structures are also popular with fishing based activities and active management would need to take place to ensure there was no conflict between user groups. Given periods when the wind/wave conditions may be less than ideal for surfing (typically

coinciding with onshore winds from January to April each year) some fishing based activities could be considered during this time if it helps to diversify its attraction and add wider support to the project;

9. In order to create consistent and surfable wave conditions, **the structure needs to be of sufficient size to initiate and maintain a surfable wave** along its crest. This will require a significant volume of materials to be placed on the seabed. The cost of creating such as structure ranges from **$8-11M for the preferred Option B design**. Optimisation of this design, including the possibility to shift the structure further shoreward, may result in further savings for the project and should be explored further.

10. A detailed project schedule has been developed with tasks required to progress the project further, including technical studies and approvals/commercial aspects for further consideration. Overall, it is expected that **a period of between 2.5 and 3.0 years would need to be allowed for the overall development of this project.**

Following the outcome of this study, the following are recommended for further consideration:

1. In order to progress further design studies, it is essential to collect further on-site data on wind, waves, currents and water levels. Ideally, the deployment of an ADCP/AWAC at the site for a period of between 6 and 12 months would provide much of this information, substituted by ongoing wind measurements (currently being collected at Emu Point);

2. Whilst considered relatively low risk at this location, understanding of geotechnical issues and risks are always critical in the development of marine infrastructure. In this case, excessive settlement of the structure could impact overall performance. Given the significant geotechnical investigations already undertaken in the area for port development, it may not be necessary for any additional on-site investigations but, at the very least, a geotechnical desktop study amalgamating all known geological and geotechnical information should be undertaken as well as an assessment of the possible settlement risk for the structure, post-construction, to assess if any further investigations may be warranted. Some relatively less expensive and non-invasive investigations, such as geophysical surveys, may also be undertaken which could be correlated to similar investigations undertaken offshore;

3. Investigations into the supply of granite rock materials for the project should also be considered. Consideration for alternative quarry sites in the area for the project is highly recommended, especially given the cost risks of relying on a single commercial quarry; The volume of the rock that would be required is in the order of $50{,}000m^3$.

4. Close liaison with the Southern Ports Authority at Albany in regards to not only securing the seabed lease but also physical and commercial arrangements for the future stockpiling of materials and support of proposed construction activities should also be progressed; and

5. Early liaison with the various approvals authorities and other stakeholders in order to facilitate any required approvals for the works should also be progressed.

This further work is outside the scope of the current study.

1.6 Artists Impression