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R867 Rev 0

February 2017

City of Greater Geraldton

Whitehill Road Boat Launching Facility Concept Investigations

marinas
boat harbours
canals
breakwaters
jetties
seawalls
dredging
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Limitations of this Document

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1. Introduction

A considerable portion of the City of Greater Geraldton's northern shoreline is under erosive pressure and requires mitigation and / or adaptation planning to determine the future management requirements (MRA 2016). One location in particular is the northern portion of Drummond Cove, adjacent to Whitehill Road (refer Figure 1.1).

The shoreline fronting Whitehill Road has experienced a net sediment deficit since 2007 which has resulted in erosion of the shoreline. In 2014 this erosion had significantly depleted the sediment reserves on the beach to the extent that Whitehill Road was impacted. The persistence of this erosion subsequently resulted in the closure of Whitehill Road and the implementation of a temporary sand nourishment regime to limit the loss of the foreshore. While the sand nourishment provides temporary relief from the erosion, longer term adaptation strategies are required.

One such adaptation measure that is currently being investigated is the construction of a boat launching facility. Ideally, this facility would serve the dual purpose of providing much needed boating infrastructure, whilst also providing protection to the vulnerable portion of the foreshore. The option is also understood to have strong community support since it offsets any loss of beach by providing social and recreational benefits associated with the construction of a boat launching facility.

1.1 Background

1.1.1 Shoreline Movement Adjacent to Whitehill Road

Review of information contained within the *Town Beach to Drummond Cove Inundation & Coastal Processes Study* (MRA 2016) suggests that the average rate of shoreline erosion in the period between 2007 and 2014 was 3 m/year. This is the average rate over the length of beach fronting Whitehill Road that has experienced erosion, which is approximately 500 m. Peak average erosion rates over the period have approached 4.3 m/year at the southern end, adjacent to the seawall.

This rapid change in the shoreline position is evidenced in Figure 1.2, which shows the location of the coastal vegetation line in 2007, compared to the location of a comparable demarcation line in 2014. Estimation of the volume of sediment lost during this period requires an estimate of the total vertical elevation of the beach profile that is being eroded.

From review of available survey information in the area, it is estimated that the extent of the profile that has been impacted by the erosion would range from an elevation of -3 mAHD offshore in the vicinity of the nearshore reefs, to 2 mAHD on the shoreline. This would mean that the total height of the profile that is being impacted by erosion would be around 5 m. Consequently, based on an average recession rate of 3 m/year over a length of approximately 500 m of beach, the average rate of erosion for this section of shoreline would be around 7,500 m^3/year.

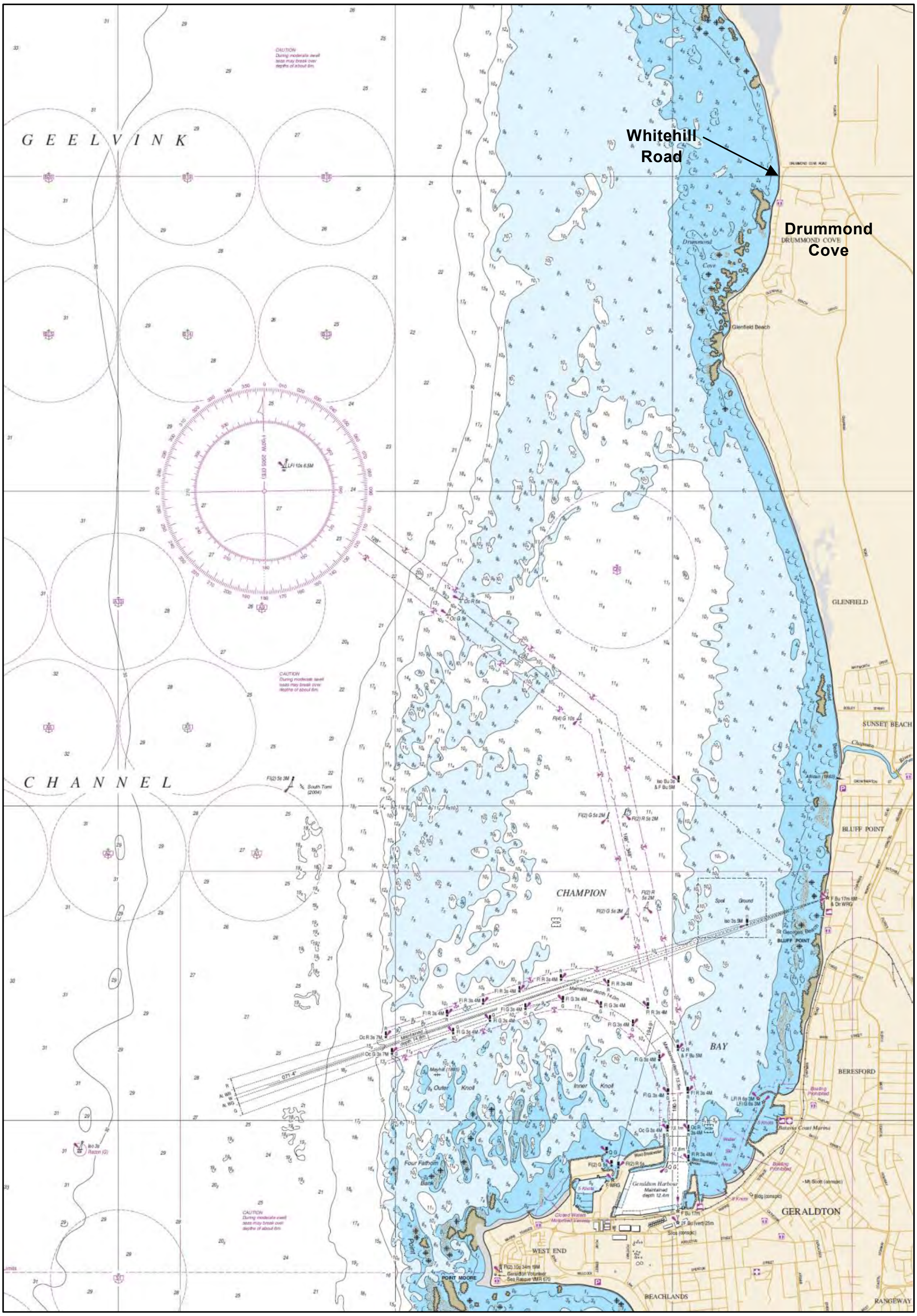

Figure 1.1 Location Diagram (Source: DPI Chart WA 939)

Figure 1.2 Shoreline Movement between 2007 and 2014

1.1.2 Requirement for Boating Facility

The construction of a boat launching facility within Drummond Cove has been considered for almost two decades. The initial idea was developed by the Shire of Greenough (now part of the City of Greater Geraldton) in response to the informal launching and retrieval of vessels over the beach within Drummond Cove. The Department of Transport subsequently completed a boating study for the area (DoT 1998) which confirmed Drummond Cove as a potential site for the development of a boat ramp, with the report recommending that a district boat ramp be developed in this area. Thereafter, M P Rogers & Associates Pty Ltd (MRA) were engaged by the Shire to complete a feasibility study for the Drummond Cove boat ramp, with results of the feasibility study presented in MRA (2000).

Amongst other things, the feasibility study highlighted that any boat ramp constructed within Drummond Cove would require breakwater protection in order to achieve an adequate wave climate for the safe launching and retrieval of vessels.

A more recent assessment on boat ownership rates and usage within the City of Greater Geraldton is presented in MRA (2013) which reviewed the existing capacity of boat launching facilities within the City against the current and future demand. MRA (2013) found that the existing facilities within the City (primarily those at Francis Street and Batavia Coast Marina) were currently at or near their capacity on peak days, with little opportunity for expansion. Review of future projections of boat usage suggested that at least 2 new lanes of boat ramp would be required by 2026 to meet the demand.

1.2 Drummond Cove Boat Ramp Concept Development

Consideration of the potential for the development of a boat launching facility at Drummond Cove prompted the local community to prepare indicative layout plans for the facility. These layout plans propose breakwater protection as well as a range of other potential inclusions, such as a boardwalk, fish cleaning table, etc.

In response to the City's decision to pursue the planning for a boat launching facility within Drummond Cove, the City engaged MRA to complete a review of the existing layout options for the facility. These options are outlined below.

- Option 1 – Community plan including fully enclosed basin (refer Figure 1.3).
- Option 2 – Community plan including partially enclosed basin (refer Figure 1.4).
- Option 3 – Layout plan from the Drummond Cove Boat Ramp Feasibility Study (MRA 2000) (refer Figure 1.5)

The scope of this review is as follows.

- Undertake a pre-feasibility assessment of the three concept drawings attached to provide:
  - A boat launching facility at Drummond Cove.
  - Coastal protection for the Whitehill Road section of coastline.
- Provide an alternative concept that will provide:
  - A boating launching facility at Drummond Cove
  - Coastal protection for the Whitehill Road section of coastline
- In liaison with the City develop one concept into a form suitable for further investigation.
- Undertake a gap analysis on the developed concepts to identify additional information required to inform the detailed design, including the following.
  - data collection
  - modelling
  - approval requirements
  - other work

An informed review of the layout plan for any facility, such as that proposed, first requires review of other factors that are critical to the success of that facility. This includes the relevant design standards, metocean conditions and structural requirements. The results of investigations into these requirements, together with the review of the concept options are presented in this report.

Figure 1.3 Option 1 Layout Plan

Figure 1.4 Option 2 Layout Plan

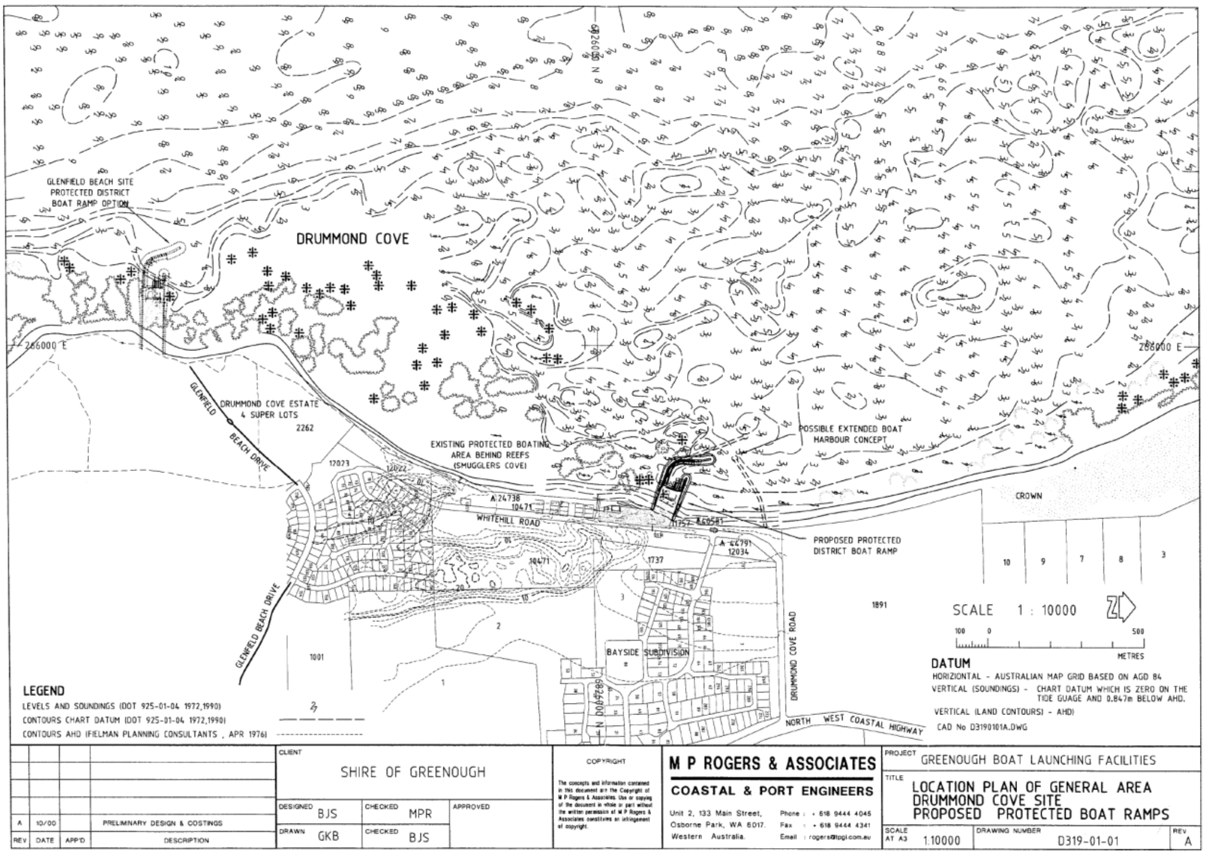

Figure 1.5 Option 3 Layout Plan

2. Design Requirements

The development of a boat launching facility adjacent to Whitehill Road will need to accord to the relevant design standards and policies. This is required to help ensure the safe operation of the facility.

The design of boat launching facilities generally falls under the requirements of the following Australian Standards.

- AS4997-2005 Guidelines for the design of maritime structures.
- AS3926-2001 Guidelines for design of marinas.

DoT has also published a guideline for the design of boat launching facilities.

- Guidelines for the Design of Boat Launching Facilities in Western Australia below the 25th Parallel (DoT 2009).

Where applicable these standards will be used to guide the concept design of the various options. This section presents details of the design criteria used in the development of the concept, as well as details of the assumed design for elements that are common across all options. This includes the following items.

- Breakwaters.
- Boat ramp & finger jetty.
- Car & trailer parking bays.

2.1 Design Criteria

The general design approach and design criteria adopted for the various structures are summarised in the following sections.

Design events are generally expressed in terms of an average recurrence interval (ARI). The ARI is related to the annual exceedance probability (AEP). For example, a wave event with a 50 year ARI has a 1/50 AEP. In other words, there is a 1/50 (or 2%) change of the wave conditions from that event being exceeded in any one year. The term ARI is used in this report when referring to design events.

2.1.1 Breakwaters

There are no specific Australian Standards which apply to the design of rubble mound breakwaters, however the DoT (2009) guidelines outline that facilities should be designed for a functional life of at least 25 years. As a result, it is common practice to design breakwater protection for boating facilities to withstand the 50 yr ARI event. This provides a reasonably low (~40%) chance that the design event will be encountered over the design life of the facility.

The following design criteria have therefore been adopted for the breakwaters.

- Design Life 25 years

  Design Wave Event 50 year ARI (no damage)

- Wave Overtopping Criteria
    - No structural damage during the 50 year ARI storm event.
- Entrance layout to limit wave penetration. The wave climate within the breakwaters is to be "Good" as per AS3962-2001. AS3962-2001 also requires that the boat launching ramp is sheltered from waves larger than 0.2 m. The standard is unclear on the definition or the return period for this wave event. MRA have assumed that the wave conditions at the ramp may exceed 0.2 m several times a year, but under typical conditions the ramp will be sheltered from waves greater than 0.2 m.
- Crest of the breakwater to have sufficient width to accommodate maintenance equipment. This is typically 5 m.

2.1.2 Boat Ramp & Finger Jetty

The design criteria for boat ramps and finger jetties are outlined in AS3962-2001 and DoT (2009). The adopted design criteria are summarised as follows.

- Design Life 25 years
- Design Vessel
    - Length 8 m
    - Weight 5 tonnes
- Number of Ramps 2
- The finger jetty is proposed to be a proprietary floating jetty system to allow high functionality and easy access to vessels.
- The finger jetty is considered to be optional in the first stage to help reduce the initial up front capital cost requirements.

2.1.3 Car and Trailer Park

The key design requirements for the car and trailer parking area are summarised as follows.

- Number of car/trailer spaces:
    - Space for 40 to 60 bays provided initially prior to the finger jetty being constructed (based on 'Rural' ramp with no jetty).
    - Space for 80 bays provided once the finger jetty is provided (based on 'Rural' ramp with a jetty and separate rigging and derigging areas).
    - Half of the car/trailer bays to be provided as gravel parking area in the first stage, the other half of the area to make use of the existing turfed area as peak use parking.
- Minimal lighting to be provided with solar lights. Lights to be suitable for the highly corrosive coastal environment.

- No power or water services are proposed at this stage. Water services for washing down vessels could be added in the future if required.

3. Design Conditions

Understanding the local metocean conditions is critical to the concept design and feasibility assessment of the different layout options. For instance, understanding of the local metocean conditions is required to determine the potential for wave penetration into the protected water body and is also important for the conceptual design of the breakwater structures.

Information on the local wave conditions offshore from Geraldton (known as the Geraldton Outer Channel) has been collected by the Geraldton Port Authority (now Mid West Ports Authority) since 1999 – a period of around 17 years.

Using this data it is possible to complete an extreme value analysis to estimate the ARI associated with different wave heights. The results of this assessment are presented in Figure 3.1, which shows the ARI curve for different wave heights. This ARI curve is described by a Weibull distribution with k=2 and achieves a mean squared deviation (MSD – a measure of statistical fit) of 0.01, which indicates a high level of agreement between the curve and the measured data.

It should be noted that statistically, the estimates of wave height ARI provided in the plot are really only valid up to the 50 year ARI event. This is on the basis that estimates of ARI are really only valid up to around 3 times the period of record (ie 3 x 17 years = 51 years).

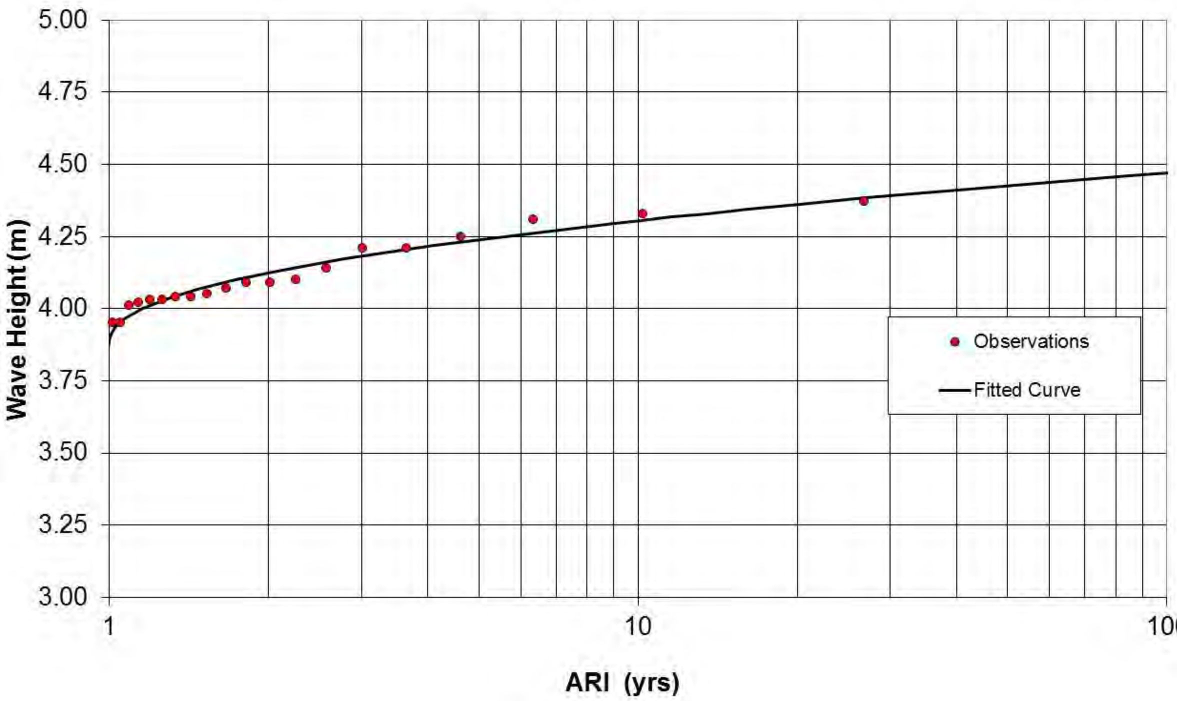

Figure 3.1 Estimates of Extreme Wave Heights at Geraldton Outer Channel

For an area such as Drummond Cove, where significant reef is present in the nearshore area, the direction of wave events is just as important as the offshore wave height itself. This is on the basis that the extent of wave diffraction, refraction and wave breaking over these nearshore reefs is impacted by the offshore incident wave direction.

Directional wave data is available from the Geraldton Outer Channel since 2004. To illustrate the relationship between the wave height and direction offshore from Geraldton a cross plot of wave height and direction has been prepared for all directional wave data that was available. This plot is presented in Figure 3.2.

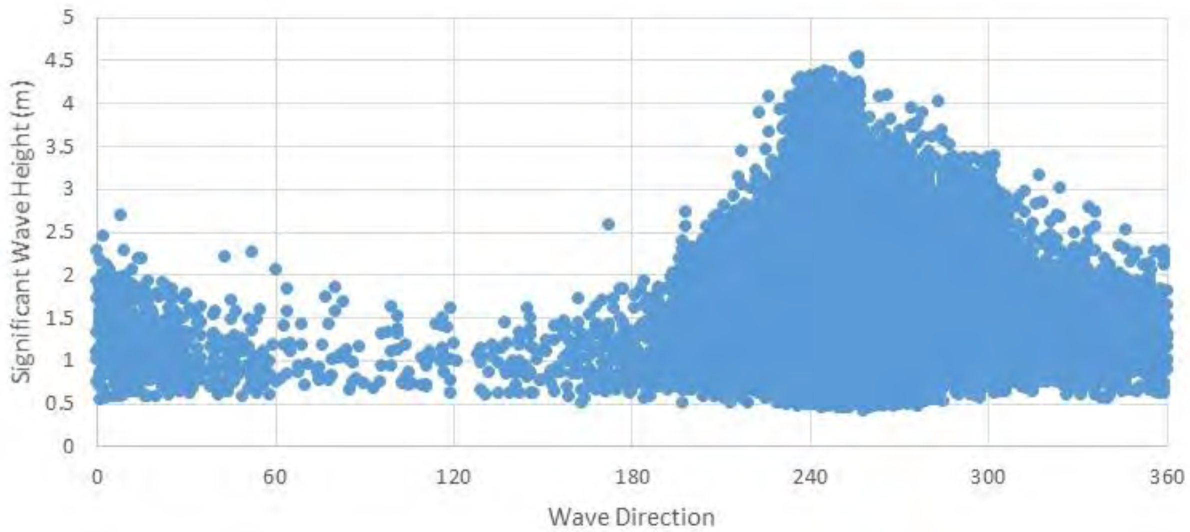

Figure 3.2 Cross Plot of Wave Height versus Direction at Geraldton Outer Channel

Figure 3.2 shows that the most severe wave conditions (H_s circa 4.5 m which corresponds to the 50 year ARI wave height) originate from a direction of around 240 to 255 degrees. However, slightly reduced wave conditions (H_s circa 4.0 m which corresponds to the 1 year ARI wave height) originate from directions of 220 to 285 degrees. This directional distribution of peak wave heights is primarily linked to the passage of cold fronts during the winter months. On the approach of the cold front, winds from the north-west generate waves, however the fetch length and strength of these winds limits the potential wave growth. As the winds shift to the west and west-south-west they become stronger and align with the direction of movement of the cold front. This alignment results in the reinforcement of wave growth and promotes a local peak in wave heights from these directions. Wave heights then reduce as the cold front passes and the winds weaken and become more southerly.

The 1 and 50 year ARI conditions determined above were simulated using the SWAN wave model developed by MRA (2016) in order to review the impact of these offshore wave conditions on the proposed facility. Results of this modelling for the 1 and 50 year ARI events are shown in Figures 3.3 and 3.4 respectively.

The modelling results show that significant wave breaking is expected over the nearshore reefs adjacent to Drummond Cove. This significantly reduces the wave heights compared to those observed offshore.

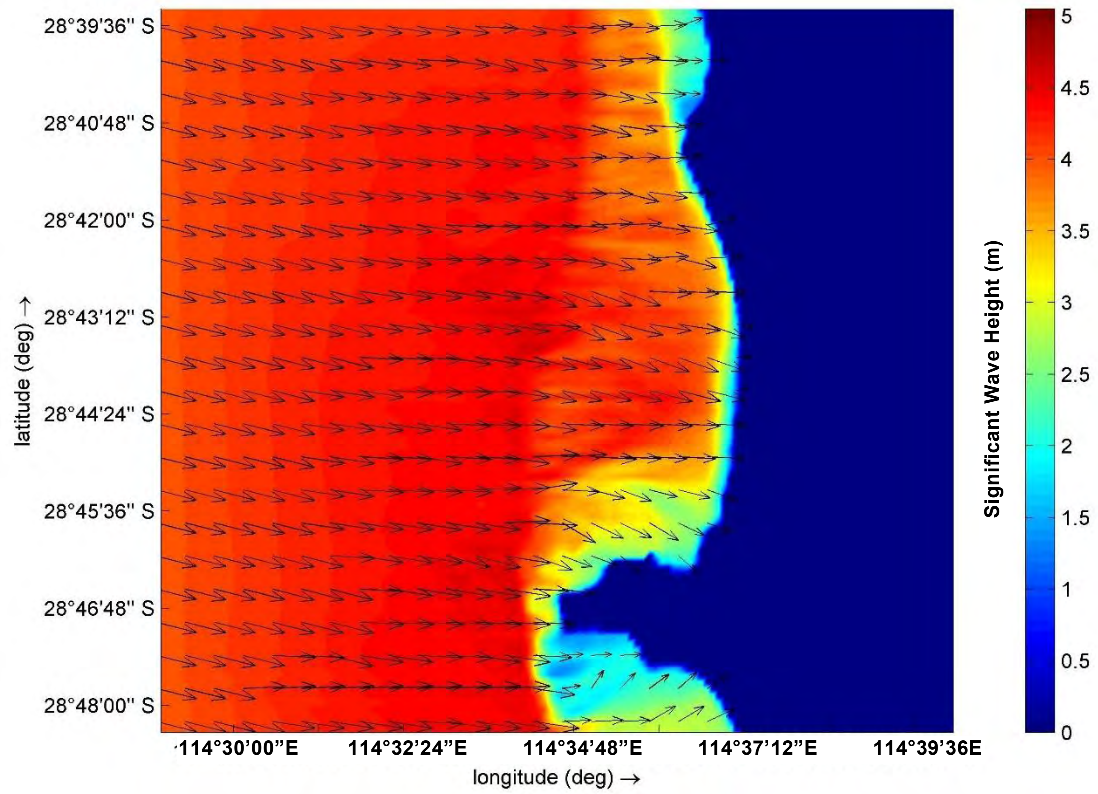

Figure 3.3 Spatial Plot of Wave Conditions during the 1 year ARI Event

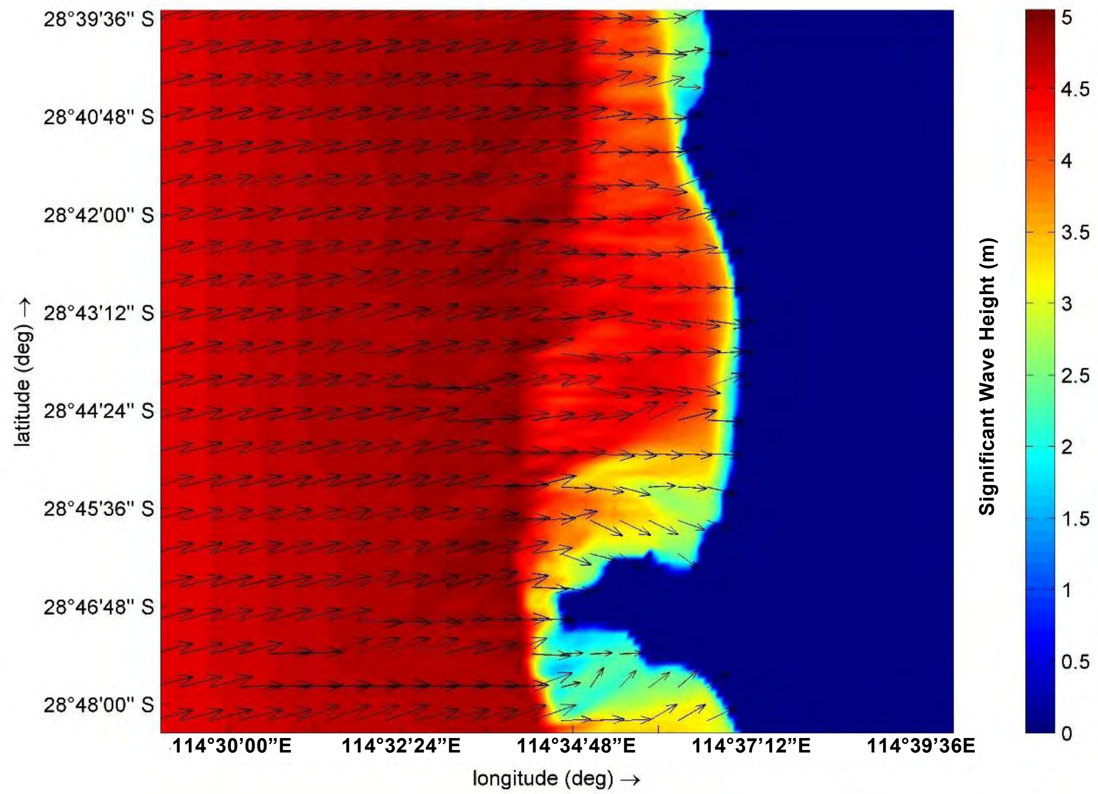

Figure 3.4 Spatial Plot of Wave Conditions during the 1 year ARI Event

Using the results of the wave modelling, the following design wave conditions have been adopted for the concept design of the facility.

Table 3.1 Summary of Design Wave Conditions

Event	Significant Wave Height (m)	Peak Wave Period (s)	Mean Wave Period (s)	Wave Direction (degrees)
1 year ARI	2.0	13	8.4	270
50 year ARI	2.2	13.7	9.2	267

4. Concept Design

Despite differences in the layouts of infrastructure in each of the 3 options, it is not envisaged that there would be any significant differences in the designs of the various elements across all options. For instance, at a concept design level, it is not anticipated that there would be any difference in the breakwater cross section design, or the design of the boat ramp, car and trailer parking, or other ancillary infrastructure. As a result, the concept designs for each of these elements are discussed below and will be common to all options.

4.1 Breakwater Design

In southern Western Australia, the most cost efficient form of breakwater construction utilises local quarried rock to build rubble mound structures. The key elements that need to be considered in the design of the breakwaters are summarised below.

4.1.1 Armour & Core Design

It is anticipated that the breakwaters will be constructed using rock imported from local quarries in the region. Both granite and limestone rock is available locally, however it is expected that the supply of limestone rock will be more economical. Therefore the concept design presented here has assumed that limestone will be used for the construction. It should be noted that this does not preclude the use of granite, as future design development works should present the construction requirements for both granite and limestone to ensure a cost competitive tender process.

Limestone has been used successfully for a large number of rubble mound marine structures on Western Australia's coastline. However, given the large variability in the strength and durability of limestone rock, care needs to be taken to ensure minimum requirements regarding the strength and durability of the rock are achieved.

For limestone armour rock used in the breakwaters a minimum saturated surface dry density (SSDD) of 2.2 t/m^3 is proposed. For core material a less stringent specification is required, though the SSDD should still be greater than 1.9 to 2.0 t/m^3.

The concept design of the breakwater will incorporate a conventional cross-section including core material protected by 2 layers of armour rock. A slope of 1 vertical to 1.5 horizontal is adopted for the structures. The hydraulic stability of the Armour layer on the exposed side of the breakwater has been assessed using the equations of Hudson (1953, 1959) and van der Meer (1988) as presented in CIRIA:CUR:CETMEF (2007). Using the design conditions previously determined for concept design, the armour on the exposed side of the breakwater, including the breakwater head, will need to be in the range between 2 to 5 t, with 50% greater than 3 t. This armour sizing is on the basis that the nearshore reef systems result in breaking of the larger waves in the wave train, meaning that the ratio of maximum wave height to significant wave height is considerably less than normal. This will need to be confirmed during the detailed design of the structures.

On the internal, or protected, side of the breakwater the hydraulic stability is unlikely to be critical given the small wave climate. As a result, the armour size on the internal side will be governed by stability underfoot and resistance to vandalism, with a minimum armour size of 0.3 t specified. The specification for rock on the internal side of the breakwater would therefore be 0.3 to 0.8 t, with 50% greater than 0.5 t.

Limestone core material will be a well graded run of quarry, with a median diameter of around 0.5 m. The limestone core material will need to incorporate a proportion of quarry fines down to around 0.1 m in diameter in order to ensure that long period swell waves are not transmitted through the breakwater.

4.1.2 Wave Overtopping & Crest Level

The crest level of the breakwaters needs to be set at a level high enough to prevent damage to the structure from wave overtopping. To save capital construction costs, and to keep the structures as low as possible, it is not envisaged that there would be pedestrian access along the crest of the breakwater. From a risk management and public safety perspective, providing a dedicated pedestrian access way along the crest of the breakwater would require much lower wave overtopping levels to be achieved. This would require a higher crest level for the structure. Therefore the preliminary assessment of wave overtopping volumes has not included consideration of pedestrian safety on the structures. Signage and appropriate notifications would therefore be required to inform the public of potential risks if the structure was to be constructed. This should be further reviewed at the detailed design phase.

Critical overtopping discharge criteria therefore relate to the ability of the structure to withstand the wave overtopping levels without damage. The results from EurOtop (2007 and 2016) were therefore used to assess the potential overtopping rates and tolerable overtopping limits. The results of this assessment for a breakwater crest height of 2.7 mAHD are provided in Table 4.1. The assessment also incorporated an appropriate allowance for sea level rise over the coming 25 years, as outlined in DoT (2010), in order to assess the ability of the structure to absorb the effects of rising sea levels.

Table 4.1 Critical Overtopping Discharge

Design Criteria	Mean Overtopping Discharge, q (L/s per m length)	Calculated Mean Overtopping Discharge, q (L/s per m length)
No damage if crest and rear slope are well protected	q < 200	50 year ARI Event in 2017 q = 6 - 45
		50 year ARI Event in 2042 q = 10 - 100

4.1.3 Preliminary Design Sections

The key features of the preliminary design section are summarised as follows.

- Crest level of 2.7 mAHD.
- A running surface 5 m wide on the core to allow access for the construction of the breakwater.
- 2 layers of Armour place on Core with a slope of 1 vertical to 1.5 horizontal.

An indicative sketch of the concept design cross section is presented below.

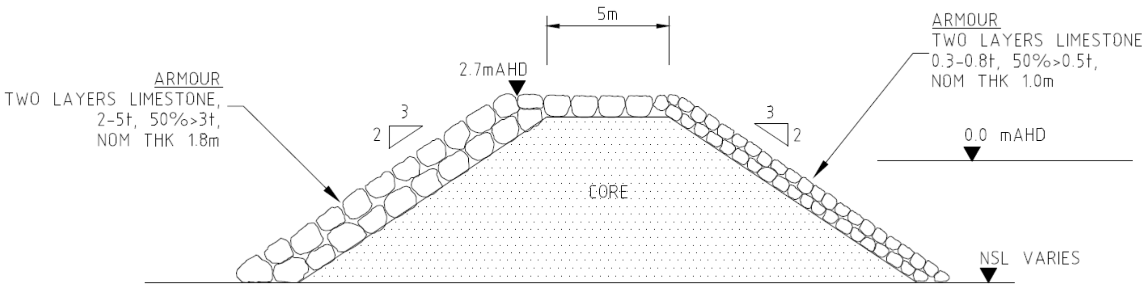

Figure 4.1 Indicative Breakwater Cross Section Design

4.1.4 Layout

When reviewing the different layout options, there are a number of items that need to be considered in order to ensure a safe and efficient facility.

- The key requirement for the breakwaters is to shelter the boat ramp and adjacent shoreline from the prevailing wave conditions at the site. Sufficient closure and alignment of the entrance between the breakwaters is required to prevent large waves from penetrating through the entrance channel to the boat ramps.
- The design of the breakwaters should allow for an entrance channel to the facility that is:
  - aligned to the north to provide protection from the prevailing wave direction, especially during southerly sea breeze events which occur during the peak boating period in summer;
  - a minimum navigable width of 30m; and
  - a water depth of around 4 m at the entrance to minimise the risk of waves breaking over the entrance to the facility and sedimentation within the entrance channel.
- The breakwater layout also needs to allow sufficient water area for manoeuvring of vessels within the protected waters inside the breakwaters. During peak usage periods vessels may need to queue in the water prior to retrieval.
- The breakwaters need to be sufficiently designed to be able to account for potential changes to the shoreline as a result of the construction of the facility. This includes accounting for the potential erosion of the shoreline to the north of the facility as well as accounting for potential changes in sediment dynamics due to the construction of the breakwaters. An example of where such a change has occurred is at Whale World in Albany, where a breakwater was constructed to provide a protected waterway for vessel berthing, however the construction of the breakwater changed the wave pattern (as a result of wave diffraction) which locally altered the alignment of the beach, causing the protected waterway to quickly fill with sand. Images illustrating this change are included in Figure 4.2. The concept design for structures in this facility therefore needs to account for these types of potential changes.

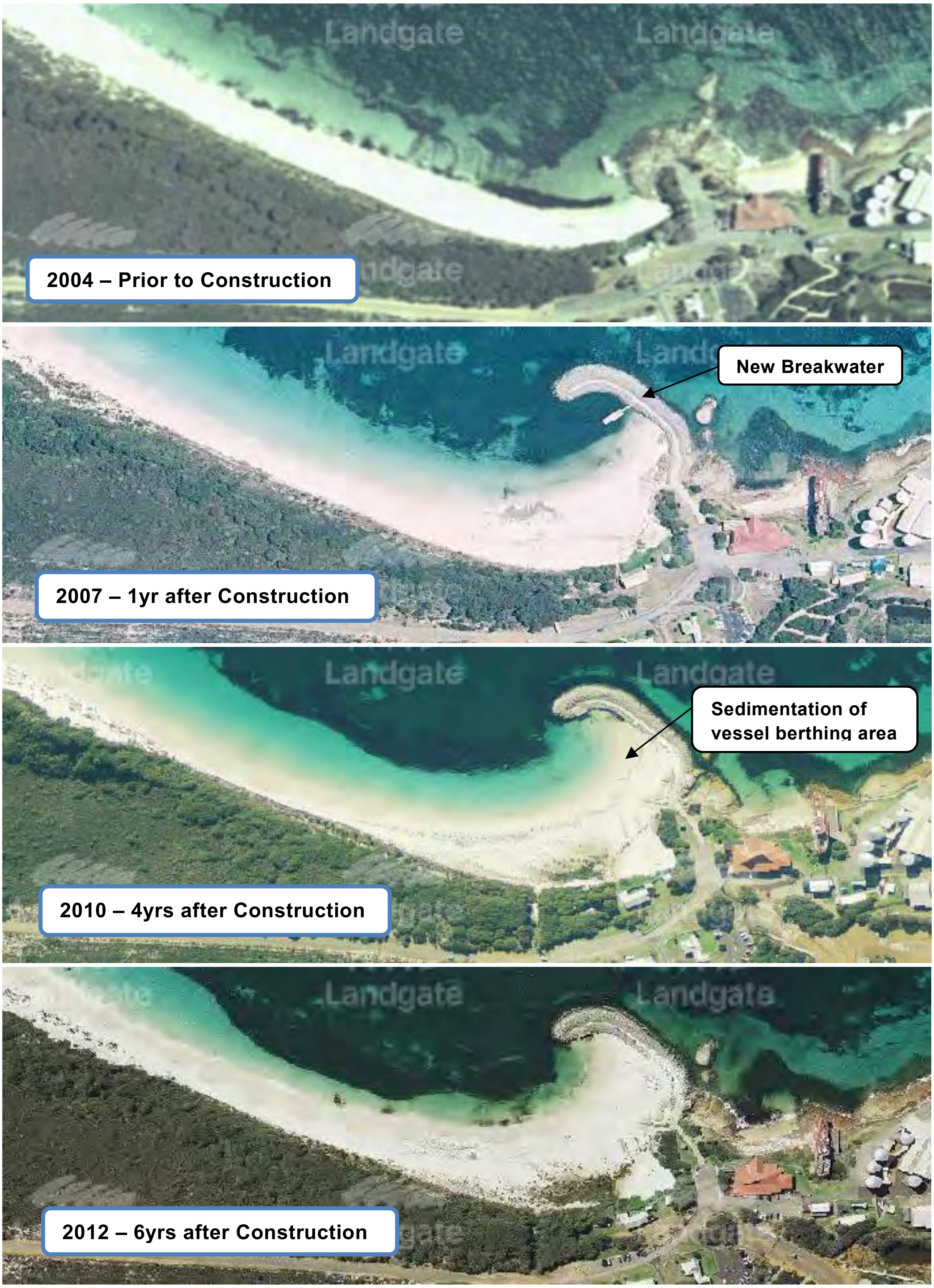

Figure 4.2 Images Showing Change in Beach Alignment behind Whale World Breakwater

4.2 Boat Ramp & Finger Jetty

The boat launching facility will be a two lane precast concrete ramp. It is proposed that a central floating finger jetty be incorporated into the ramp design, however this may not occur in the first stage if funding is not available. An example of a facility similar to that proposed is shown in Figure 4.3.

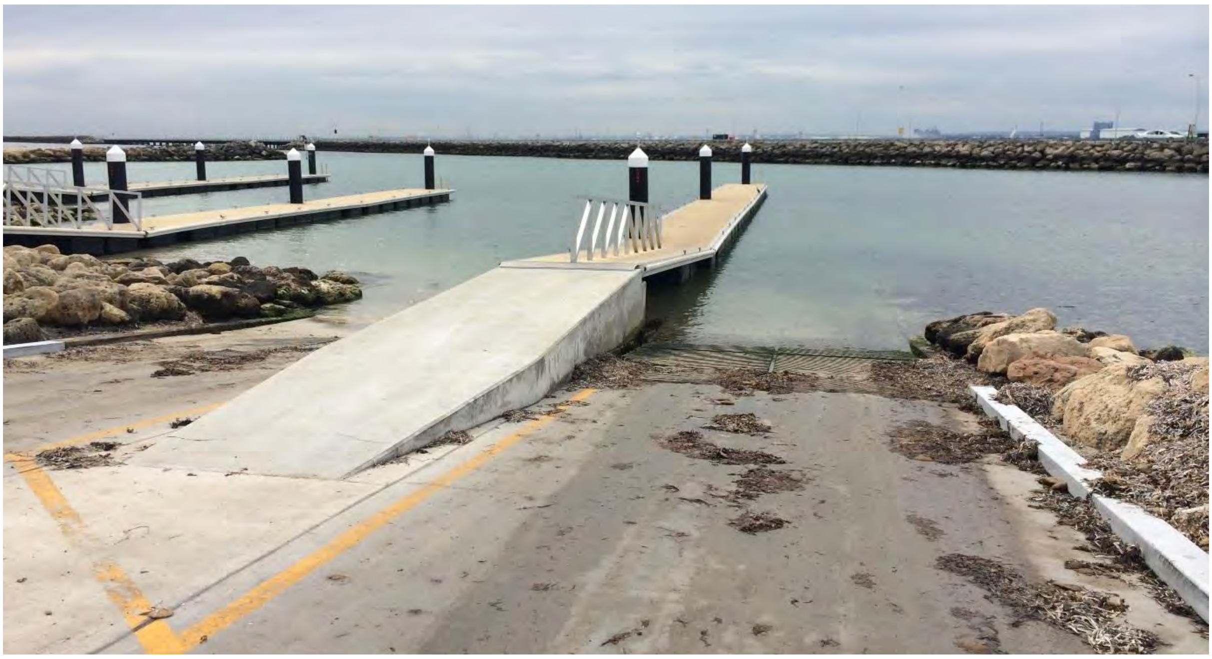

Figure 4.3 Example of Boat Ramp & Floating Finger Jetty

4.3 Car & Trailer Parking Bays

The car and trailer parking area for the facility should be set out in accordance with the DoT guidelines and Australian Standards. The setout of the parking area is beyond the requirements of this initial concept design, which is focused on provision of the correct spatial allocation to enable the layout to be further developed in later stages of the design development.

Based on the standard requirements, a total area of approximately 1.0 ha would be required ultimately to cater for 80 car and trailer parking bays when a finger jetty is provided. Prior to a finger jetty being provided a total area of around 0.7 ha would be required for up to 60 parking bays. In order to reduce the initial capital outlay it is proposed that only half of these bays (0.4 ha including circulation roads and reversing bays) be provided as a gravel parking area in the first stage, with the existing adjacent cleared area able to be used for overflow parking as required. These areas are shown in Figure 4.4 below.

Figure 4.4 Proposed Car and Trailer Parking Areas

5. Assessment of Existing Options

Using the information presented in the previous sections, each of the three existing concept options have been reviewed. This review has included consideration of the cost of each option along with the positive and negative aspects of the layouts. With regard to the potential costs, it should be noted that a range of different construction costs have been observed in Geraldton recently. Specifically, some very competitive rates for rock works were tendered for the Beresford foreshore works. These rates reflect the competitive nature of the construction industry in Western Australia at present and cannot necessarily be expected to continue. Nevertheless, depending on the potential construction timing these recent cost competitive rates cannot be discounted. As a result the opinion of probable cost will be presented for each option, along with a potential saving if the recent cost competitive rates are realised.

5.1 Option 1

Option 1 provides a fully enclosed water area with the apparent intention of providing a sheltered beach within the enclosed water way (refer Figure 5.1). It should be noted that for this option the car and trailer parking area has not been costed for the area shown on the plan, but rather for the area presented in Figure 4.4. The reason for this departure from the plan is to preserve the vegetated dune that is present in this area and to instead locate the parking in the area immediately to the north, which is already cleared and levelled. An analysis of the potential issues and benefits associated with this option are presented in Table 5.1.

Table 5.1 Analysis of Potential Positive & Negative Aspects of Option 1

Positive Aspects	Negative Aspects
■ Creates a large enclosed water area that would provide flexibility for future usage of the waterway. ■ Provides protection to almost the full extent of Whitehill Road – it is unlikely that further erosion mitigation would be required.	■ Creation of a large enclosed water area requires long breakwaters making the construction expensive.

An opinion of probable cost for the construction of the first stage of the Option 1 layout is included in Table 5.2. The estimated cost for this option would be around $4.34 million excluding design and management fees, contingencies and GST (all-inclusive cost $6.20 million). If recent cost competitive rates for rock work were able to be sourced (such as for the Beresford Foreshore works) the total cost could reduce by around $560,000 excluding design and management fees, contingencies and GST. This would reduce the total cost for this option to around $3.77 million excluding design and management fees, contingencies and GST, or $5.40 million all-inclusive.

Future stages associated with this option would include the following.

- Construction of the floating finger jetty - $150,000 excluding design and management fees, contingencies and GST.
- Expansion of the car and trailer parking - $200,000 excluding design and management fees, contingencies and GST.

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OPTION 1 LAYOUT
WHITEHILL ROAD BOAT LAUNCHING FACILITY

SCALE AT A3 1:2,000

JANUARY 2017
SK1397-13/01/2017-1A

Figure 5.1 Option 1 Layout Plan

Table 5.2 Opinion of Probable Cost for Option 1 Layout

Item	Activity	Quantity	Units	Unit Rate	Subtotal	Total for Item
1	**Preliminaries**					**$ 420,000**
1.1	Contractor preliminaries, including mobilisation, demobilisation, insurances, etc.	1	item		$ 420,000	
2	**Breakwaters & Seawalls**					**$ 3,316,500**
2.1	Excavate natural surface to facilitate the construction of the structures through the nearshore area	3,000	m^3	$ 8	$ 24,000	
2.2	Supply and place limestone core material	51,100	tonnes	$ 30	$ 1,533,000	
2.3	Supply and place external limestone armour (2 to 4t; 50% > 3t)	24,100	tonnes	$ 60	$ 1,446,000	
2.4	Supply and place internal limestone armour (0.3 to 0.8t; 50% > 0.5t)	5,700	tonnes	$ 55	$ 313,500	
3	**Boat Ramp & Finger Jetty**					**$ 400,000**
3.1	Supply and install 2 concrete boat ramp lanes with associated scour protection and run on slab.	1	item	$ 400,000	$ 400,000	
4	**Road Realignment**					**$ 32,640**
4.1	Level and compact subgrade.	640	m^2	$ 6	$ 3,840	
4.2	Compacted 150mm limestone sub-base	640	m^2	$ 16	$ 10,240	
4.3	75mm compacted crushed rock base course	640	m^2	$ 14	$ 8,960	
4.4	25mm thick asphalt including primer seal	480	m^2	$ 20	$ 9,600	
5	**Boat Trailer Parking Area**					**$ 147,000**
5.1	Clear, level and compact site for trailer parking area	4,000	m^2	$ 14	$ 56,000	
5.2	Supply, place and compact 150mm limestone sub-base to finish parking area	4,000	m^2	$ 16	$ 64,000	
5.3	Solar lighting within the car park	3	No.	$ 9,000	$ 27,000	
6	**Miscellaneous**					**$ 22,000**
6.1	Signage	1	item	$ 5,000	$ 5,000	
6.2	Navigation aids	2	No.	$ 7,500	$ 15,000	
6.3	Bins	2	No.	$ 1,000	$ 2,000	
	Subtotal 1				**$ 4,338,140**	**$ 4,338,140**
	Design, Management & Construction Phase Services Fees	**5**	**%**		**$ 216,907**	**$ 216,907**
	Contingencies	**25**	**%**		**$ 1,084,535**	**$ 1,084,535**
	Subtotal 2				**$ 5,639,582**	**$ 5,639,582**
	Goods & Services Tax				**$ 563,958**	**$ 563,958**
	Total Estimated Cost				**$ 6,203,540**	**$ 6,203,540**

Notes: 1. A potential saving of around $560,000 (excluding design and management fees, contingencies & GST) may be possible based on rates tendered for Beresford Foreshore works.
2. Does not include the cost for future stages, including the provision of a floating finger jetty, expansion of the car park, or construction of a groyne to manage the shoreline.
3. Does not include costs associated with environmental investigations and approvals.
4. Does not include costs associated with boardwalks or other ancillary infrastructure.

5.2 Option 2

Option 2 provides a semi enclosed water area that would provide protection to the southern portion of Whitehill Road (refer Figure 5.2). It should be noted that, for reasons explained in Section 5.1, the car and trailer parking area has not been costed for the area shown on the plan, but rather for the area presented in Figure 4.4. An analysis of the potential issues and benefits associated with this option are presented in Table 5.3.

Table 5.3 Analysis of Potential Positive & Negative Aspects of Option 2

Positive Aspects	Negative Aspects
■ Creates a semi-enclosed water area that would provide an improved wave climate for boat launching compared to current conditions. ■ Provides protection to assets along the southern portion of the site.	■ The semi-enclosed waterway would not provide the necessary level of protection from waves to ensure that the wave climate was suitable for launching and retrieving vessels at all times, as the facility would be vulnerable to waves arriving from the north and swell wave energy diffracting around the breakwater. ■ The absence of a northern shore-perpendicular breakwater would leave the area sheltered behind the main breakwater vulnerable to an accumulation of sediment due to the diffracted wave pattern (similar to what has occurred at Whale World in Albany). ■ Erosion adjacent to Whitehill Road would still be expected to the north of the facility.

An opinion of probable cost for the construction of the first stage of the Option 2 layout is included in Table 5.4. The estimated cost for this option would be around $2.11 million excluding design and management fees, contingencies and GST (all-inclusive cost $3.05 million). If recent cost competitive rates for rock work were able to be sourced (such as for the Beresford Foreshore works) the total cost could reduce by around $230,000 excluding design and management fees, contingencies and GST. This would reduce the total cost for this option to around $1.88 million excluding design and management fees, contingencies and GST, or $2.70 million all-inclusive.

The construction cost for this layout is comparatively low, however the absence of a shore perpendicular breakwater does mean that the facility would not be functional. To rectify this would require an additional expenditure of around $0.5 million (excluding design and management fees, contingencies and GST) to construct a shore perpendicular breakwater. This would increase the total all-inclusive cost for the first stage to be between $3.20 and $3.70 million.

Future stages associated with this option would include the following.

- Construction of the floating finger jetty - $150,000 excluding design and management fees, contingencies and GST.
- Expansion of the car and trailer parking - $200,000 excluding design and management fees, contingencies and GST.
- Construction of a groyne to the north of the facility to manage the shoreline - $280,000 to $350,000 excluding design and management fees, contingencies and GST.

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OPTION 2 LAYOUT
WHITEHILL ROAD BOAT LAUNCHING FACILITY

JANUARY 2017

SCALE AT A3 1:2,000

SK1397-13/01/2017-2A

Figure 5.2 Option 2 Layout Plan

Table 5.4 Opinion of Probable Cost for Option 2 Layout

Item	Activity	Quantity	Units	Unit Rate	Subtotal	Total for Item
1	**Preliminaries**					**$ 225,000**
1.1	Contractor preliminaries, including mobilisation, demobilisation, insurances, etc.	1	item		$ 225,000	
2	**Breakwaters & Seawalls**					**$ 1,287,000**
2.1	Excavate natural surface to facilitate the construction of the structures through the nearshore area	3,000	m^3	$ 8	$ 24,000	
2.2	Supply and place limestone core material	18,200	tonnes	$ 30	$ 546,000	
2.3	Supply and place external limestone armour (2 to 4t; 50% > 3t)	9,750	tonnes	$ 60	$ 585,000	
2.4	Supply and place internal limestone armour (0.3 to 0.8t; 50% > 0.5t)	2,400	tonnes	$ 55	$ 132,000	
3	**Boat Ramp & Finger Jetty**					**$ 400,000**
3.1	Supply and install 2 concrete boat ramp lanes with associated scour protection and run on slab.	1	item	$ 400,000	$ 400,000	
4	**Road Realignment**					**$ 32,640**
4.1	Level and compact subgrade.	640	m^2	$ 6	$ 3,840	
4.2	Compacted 150mm limestone sub-base	640	m^2	$ 16	$ 10,240	
4.3	75mm compacted crushed rock base course	640	m^2	$ 14	$ 8,960	
4.4	25mm thick asphalt including primer seal	480	m^2	$ 20	$ 9,600	
5	**Boat Trailer Parking Area**					**$ 147,000**
5.1	Clear, level and compact site for trailer parking area	4,000	m^2	$ 14	$ 56,000	
5.2	Supply, place and compact 150mm limestone sub-base to finish parking area	4,000	m^2	$ 16	$ 64,000	
5.3	Solar lighting within the car park	3	No.	$ 9,000	$ 27,000	
6	**Miscellaneous**					**$ 22,000**
6.1	Signage	1	item	$ 5,000	$ 5,000	
6.2	Navigation aids	2	No.	$ 7,500	$ 15,000	
6.3	Bins	2	No.	$ 1,000	$ 2,000	
	Subtotal 1				**$ 2,113,640**	**$ 2,113,640**
	Design, Management & Construction Phase Services Fees	**5**	**%**		**$ 105,682**	**$ 105,682**
	Contingencies	**25**	**%**		**$ 528,410**	**$ 528,410**
	Subtotal 2				**$ 2,747,732**	**$ 2,747,732**
	Goods & Services Tax				**$ 274,773**	**$ 274,773**
	Total Estimated Cost				**$ 3,022,505**	**$ 3,022,505**

Notes:
1. A potential saving of around $230,000 (excluding design and management fees, contingencies & GST) may be possible based on rates tendered for Beresford Foreshore works.
2. Does not include the cost for future stages, including the provision of a floating finger jetty, expansion of the car park, or construction of a groyne to manage the shoreline.
3. Does not include costs associated with environmental investigations and approvals.
4. Does not include costs associated with boardwalks or other ancillary infrastructure.

5.3 Option 3

Option 3 provides a fully enclosed water area, however the relatively small facility would provide direct protection to only a small portion of the foreshore (refer Figure 5.3). An analysis of the potential issues and benefits associated with this option are presented in Table 5.5.

Table 5.5 Analysis of Potential Positive & Negative Aspects of Option 3

Positive Aspects	Negative Aspects
■ Creates a fully enclosed water area that would provide a suitable wave climate for launching and retrieving vessels. ■ Provides direct protection to some assets along the southern portion of the site.	■ The small footprint of the facility would only provide direct protection to a small portion of the foreshore. Other erosion mitigation measures would likely be required immediately to the north.

An opinion of probable cost for the construction of the Option 3 layout is included in Table 5.6. The estimated cost for this option would be around $3.15 million excluding design and management fees, contingencies and GST (all-inclusive cost $4.51 million). If recent cost competitive rates for rock work were able to be sourced (such as for the Beresford Foreshore works) the total cost could reduce by around $400,000 excluding design and management fees, contingencies and GST. This would reduce the total cost for this option to around $2.75 million excluding design and management fees, contingencies and GST, or $3.94 million all-inclusive.

Future stages associated with this option would include the following.

- Construction of the floating finger jetty - $150,000 excluding design and management fees, contingencies and GST.
- Expansion of the car and trailer parking - $200,000 excluding design and management fees, contingencies and GST.
- Construction of a groyne to the north of the facility to manage the shoreline - $280,000 to $350,000 excluding design and management fees, contingencies and GST.

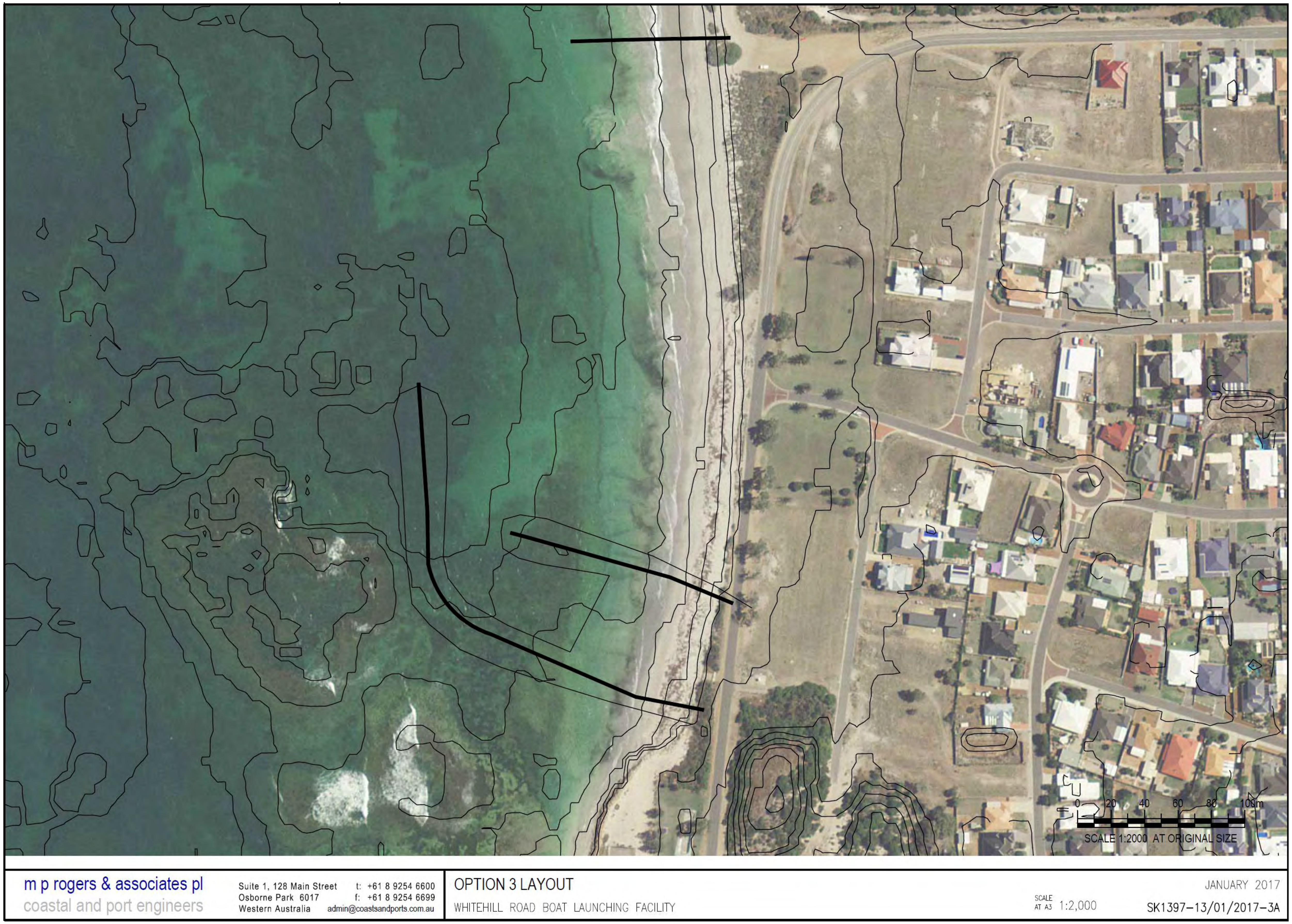

Figure 5.3 Option 3 Layout Plan

Table 5.6 Opinion of Probable Cost for Option 3 Layout

Item	Activity	Quantity	Units	Unit Rate	Subtotal	Total for Item
1	**Preliminaries**					**$ 330,000**
1.1	Contractor preliminaries, including mobilisation, demobilisation, insurances, etc.	1	item		$ 330,000	
2	**Breakwaters**					**$ 2,220,500**
2.1	Excavate natural surface to facilitate the construction of the structures through the nearshore area	3,000	m^3	$ 8	$ 24,000	
2.2	Supply and place limestone core material	32,100	tonnes	$ 30	$ 963,000	
2.3	Supply and place external limestone armour (2 to 4t; 50% > 3t)	17,350	tonnes	$ 60	$ 1,041,000	
2.4	Supply and place internal limestone armour (0.3 to 0.8t; 50% > 0.5t)	3,500	tonnes	$ 55	$ 192,500	
3	**Boat Ramp & Finger Jetty**					**$ 400,000**
3.1	Supply and install 2 concrete boat ramp lanes with associated scour protection and run on slab.	1	item	$ 400,000	$ 400,000	
4	**Road Realignment**					**$ 32,640**
4.1	Level and compact subgrade.	640	m^2	$ 6	$ 3,840	
4.2	Compacted 150mm limestone sub-base	640	m^2	$ 16	$ 10,240	
4.3	75mm compacted crushed rock base course	640	m^2	$ 14	$ 8,960	
4.4	25mm thick asphalt including primer seal	480	m^2	$ 20	$ 9,600	
5	**Boat Trailer Parking Area**					**$ 147,000**
5.1	Clear, level and compact site for trailer parking area	4,000	m^2	$ 14	$ 56,000	
5.2	Supply, place and compact 150mm limestone sub-base to finish parking area	4,000	m2	$ 16	$ 64,000	
5.3	Solar lighting within the car park	3	No.	$ 9,000	$ 27,000	
6	**Miscellaneous**					**$ 22,000**
6.1	Signage	1	item	$ 5,000	$ 5,000	
6.2	Navigation aids	2	No.	$ 7,500	$ 15,000	
6.3	Bins	2	No.	$ 1,000	$ 2,000	
	Subtotal 1				**$ 3,152,140**	**$ 3,152,140**
	Design, Management & Construction Phase Services Fees	**5**	**%**		**$ 157,607**	**$ 157,607**
	Contingencies	**25**	**%**		**$ 788,035**	**$ 788,035**
	Subtotal 2				**$ 4,097,782**	**$ 4,097,782**
	Goods & Services Tax				**$ 409,778**	**$ 409,778**
	Total Estimated Cost				**$ 4,507,560**	**$ 4,507,560**

Notes: 1. A potential saving of around $400,000 (excluding design and management fees, contingencies & GST) may be possible based on rates tendered for Beresford Foreshore works.
2. Does not include the cost for future stages, including the provision of a floating finger jetty, expansion of the car park, or construction of a groyne to manage the shoreline.
3. Does not include costs associated with environmental investigations and approvals.
4. Does not include costs associated with boardwalks or other ancillary infrastructure.

5.4 Review of Existing Options

Each of the three options considered have positive and negative aspects associated with the layout. By far the biggest issue however, was the lack of a shore perpendicular breakwater in Option 2 that would result in an inadequate wave climate and potential infill of sediment. Thus, even though Option 2 would be the cheapest option it would not achieve the minimum key requirements for a boat launching facility and would therefore not be suitable.

Review of Options 1 and 3, show essentially the same configuration, just a difference in the size of the facility. As a result, it is expected that the development of an efficient concept layout that covers a greater shoreline area than Option 3, but is smaller than Option 1 would provide a more optimal outcome.

6. Preferred Layout Option

Based on review of the previous options, it is possible to develop a hybrid option to provide a more balanced outcome in terms of both design functionality and construction cost. This layout option is presented in Future 6.1. This design incorporates the following.

- An outer/main breakwater and a shore perpendicular/secondary breakwater to provide an adequate wave climate within the facility.
- A shore perpendicular/secondary breakwater to provide a barrier to sand transportation into the facility from the north.
- An enclosed water body with sufficient area to allow milling of vessels as they await retrieval.
- An entrance aligned towards the north to protect against the prevailing summer sea breezes.
- An entrance depth of around 4 m (below AHD) to reduce the potential for wave shoaling and breaking at the entrance and to reduce the potential for sedimentation within the entrance channel.
- Future expansion potential should a larger facility be required in the future.

In addition to the expansion potential, a staged approach to the development of the facility is envisaged to help minimise the capital construction costs. It is envisaged that this staging would include the following.

- Construction of half the car and trailer parking area as a gravel car park in the first stage, with the adjacent land area to be used as overflow parking, until such time as it is upgraded as a future stage.
- Construction of a two lane boat ramp initially, with a floating finger jetty to be provided as a future stage.
- Future construction of a groyne to the north of the proposed facility to help manage the shoreline to the north, if required.

An opinion of probable cost for the construction of the preferred layout is included in Table 6.1. The estimated cost for this option would be around $2.76 million excluding design and management fees, contingencies and GST (all-inclusive cost $3.95 million). If recent cost competitive rates for rock work were able to be sourced (such as for the Beresford Foreshore works) the total cost could reduce by around $332,000 excluding design and management fees, contingencies and GST. This would reduce the total cost for this option to around $2.43 million excluding design and management fees, contingencies and GST, or $3.47 million all-inclusive.

Future stages associated with this option would include the following.

- Construction of the floating finger jetty - $150,000 excluding design and management fees, contingencies and GST.

- Expansion of the car and trailer parking - $200,000 excluding design and management fees, contingencies and GST.

- Construction of a groyne to the north of the facility to manage the shoreline - $280,000 to $350,000 excluding design and management fees, contingencies and GST.

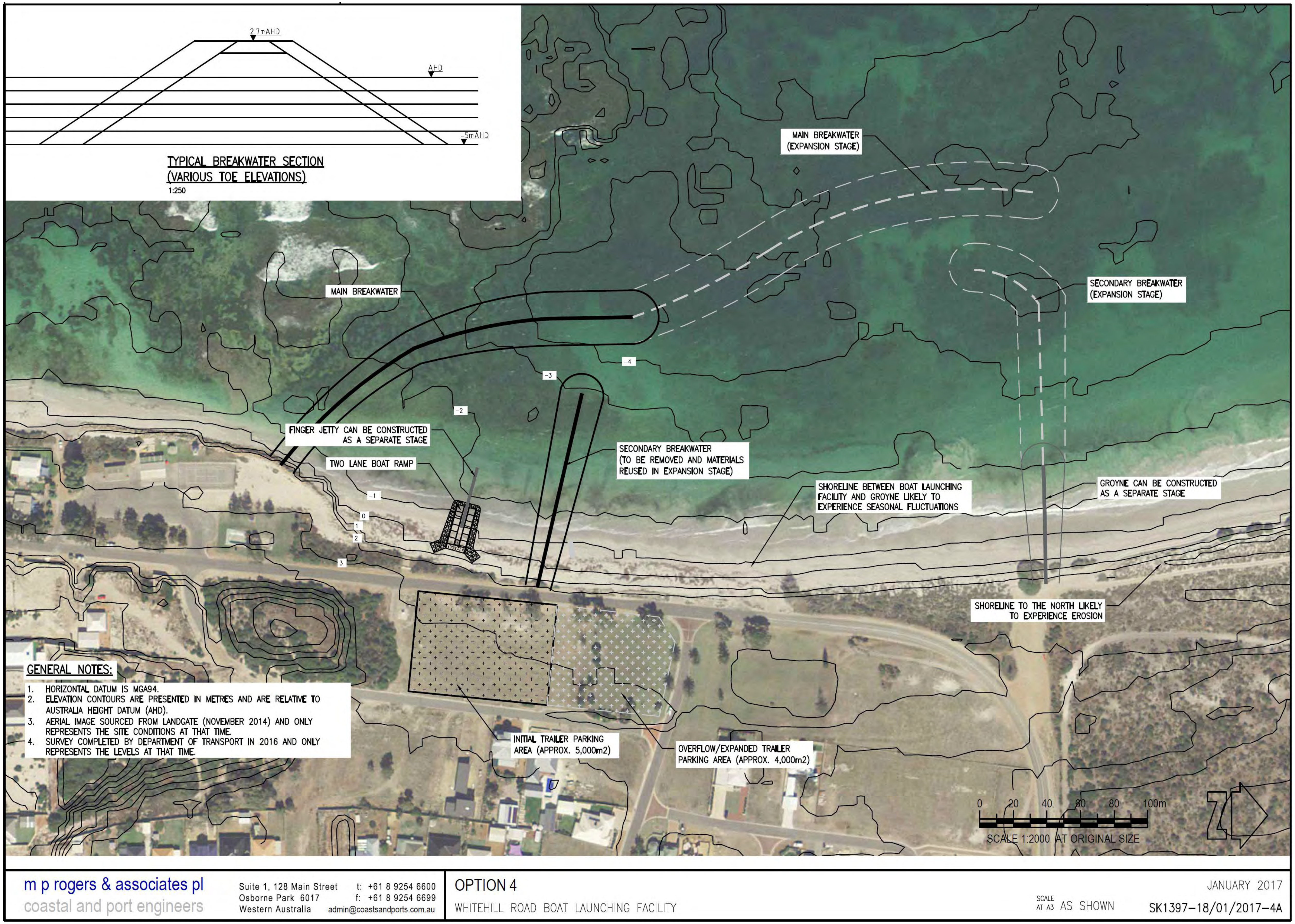

Figure 6.1 Layout Plan for the Preferred Concept

Table 6.1 Opinion of Probable Cost for Preferred Layout

Item	Activity	Quantity	Units	Unit Rate	Subtotal	Total for Item
1	**Preliminaries**					**$ 300,000**
1.1	Contractor preliminaries, including mobilisation, demobilisation, insurances, etc.	1	item		$ 300,000	
2	**Breakwaters**					**$ 1,860,000**
2.1	Excavate natural surface to facilitate the construction of the structures through the nearshore area	3,000	m^3	$ 8	$ 24,000	
2.2	Supply and place limestone core material	26,800	tonnes	$ 30	$ 804,000	
2.3	Supply and place external limestone armour (2 to 4t; 50% > 3t)	13,900	tonnes	$ 60	$ 834,000	
2.4	Supply and place internal limestone armour (0.3 to 0.8t; 50% > 0.5t)	3,600	tonnes	$ 55	$ 198,000	
3	**Boat Ramp & Finger Jetty**					**$ 400,000**
3.1	Supply and install 2 concrete boat ramp lanes with associated scour protection and run on slab.	1	item	$ 400,000	$ 400,000	
4	**Road Realignment**					**$ 32,640**
4.1	Level and compact subgrade.	640	m^2	$ 6	$ 3,840	
4.2	Compacted 150mm limestone sub-base	640	m^2	$ 16	$ 10,240	
4.3	75mm compacted crushed rock base course	640	m^2	$ 14	$ 8,960	
4.4	25mm thick asphalt including primer seal	480	m^2	$ 20	$ 9,600	
5	**Boat Trailer Parking Area**					**$ 147,000**
5.1	Clear, level and compact site for trailer parking area	4,000	m^2	$ 14	$ 56,000	
5.2	Supply, place and compact 150mm limestone sub-base to finish parking area	4,000	m^2	$ 16	$ 64,000	
5.3	Solar lighting within the car park	3	No.	$ 9,000	$ 27,000	
6	**Miscellaneous**					**$ 22,000**
6.1	Signage	1	item	$ 5,000	$ 5,000	
6.2	Navigation aids	2	No.	$ 7,500	$ 15,000	
6.3	Bins	2	No.	$ 1,000	$ 2,000	
	Subtotal 1				**$ 2,761,640**	**$ 2,761,640**
	Design, Management & Construction Phase Services Fees	**5**	**%**		**$ 138,082**	**$ 138,082**
	Contingencies	**25**	**%**		**$ 690,410**	**$ 690,410**
	Subtotal 2				**$ 3,590,132**	**$ 3,590,132**
	Goods & Services Tax				**$ 359,013**	**$ 359,013**
	Total Estimated Cost				**$ 3,949,145**	**$ 3,949,145**

Notes: 1. A potential saving of around $332,000 (excluding design and management fees, contingencies & GST) may be possible based on rates tendered for Beresford Foreshore works.
2. Does not include the cost for future stages, including the provision of a floating finger jetty, expansion of the car park, or construction of a groyne to manage the shoreline.
3. Does not include costs associated with environmental investigations and approvals.
4. Does not include costs associated with boardwalks or other ancillary infrastructure.

7. Knowledge Gaps & Next Steps

7.1 Engineering Design

The detailed engineering design of the structure will require a more detailed assessment of the design (wave and water level) conditions. This should include a review of the potential joint probability of extreme wave heights and water levels given the prominence of the nearshore reef systems and the likely importance of depth limited wave breaking in reducing the incident wave climate. This assessment will be enhanced by the collection of local wave data at the site, which is programmed to occur throughout February and March.

Further to the review of wave and water level conditions for design, further work will also likely be required to determine the potential impact of the facility on the local sediment dynamics. It is expected that a reasonably detailed assessment will be required to help determine the potential down-drift effects of the structures. This will also be important given the dual purpose of the facility is to provide coastal protection as well as boat launching. The potential shoreline response must therefore be known in some detail.

7.2 Approvals

Approvals will be required prior for the construction of the facility. The main approvals that will be required will be the environmental approvals as well as a jetty licence. Other approvals that may be needed could include approvals from the Department of Aboriginal Affairs (a Section 18 approval), as well as approvals from Mid-West Ports, given the proposal lies within Port waters.

The jetty licence will need to be obtained from the Department of Transport. This licence will only be provided if the facility is considered to be adequately designed to ensure that it meets all safety and maintenance standards and does not interfere with navigation. Completion of a rigorous detailed design process, including early consultation with DoT, in particular DoT marine safety, will help to ensure an efficient jetty licencing process.

The environmental approvals process is somewhat harder to predict. The requirements of this process will vary depending on the level of assessment that is required. The level of assessment will ultimately be decided by the Environmental Protection Authority (EPA). In this regard, early consultation with the EPA will be crucial to understanding the approval requirements given the context of the proposal, the environmental issues and the potential management options.

It is expected that construction of the boat launching facilities would require a Section 38 approval under the Environmental Protection Act 1986 (EP Act). This approach has been used for other similar marina and boating facilities in Western Australia and assumes that a scheme amendment is not required.

Ultimately the environmental approval process could require the following to be completed/prepared.

- A description of the proposal and any alternatives considered with a view to minimising environmental impacts.

- A description of the receiving environment and key ecosystem processes, and discussion of their significance in a regional setting. This would focus on those elements of the environment that may impact or be impacted by the proposal.

- Placing the proposal in a regional setting in relation to existing biophysical impacts and future cumulative impacts.

- Identification of the key issues (and list the environmental factors associated with these issues) and their relative significance.

- Discussion of the impacts of the proposal, both of the footprint and in the context of the regional setting, and description of the management arrangements and commitments to ameliorate those impacts to the most practical extent possible.

- Provision of information as to the extent that best practice will be adopted in the pursuit of the proposal and discussion how the principles of sustainability have been incorporated.

- Details of public and regulatory authority consultation.

- Presenting a case as to why the EPA should find the proposal environmentally acceptable, and demonstrate the proposal would be implemented adopting best practicable measures to minimise the potential impacts on the environment.

In its entirety, depending on the level of assessment required, the environmental approvals process could take up to around 2 years and could cost up to $150,000 to $300,000. Given this potential time and cost, it is critical that early consultation be completed with the EPA to understand the parameters associated with the approval requirements.

8. Conclusions

The development of a boat launching facility within Drummond Cove has long been considered as part of the planning for the region. This includes the strategic requirement to deliver expanded boat launching facilities to meet the needs of the region both now and into the future. The recent rapid erosion of the shoreline adjacent to Whitehill Road has provided an opportune time to investigate the provision of a launching facility that serves the dual purpose of also helping to provide protection to adjacent infrastructure. The case for construction of a boat launching facility in this area is further strengthened by the apparent community support for the development of such a facility.

Different layout options have been considered within this report, with the preferred option seeking to provide a cost efficient and functional facility. The construction cost of the facility will vary depending on the contractor's rates that have been used. Recent projects completed in Western Australia, and in particular in Geraldton, have seen very cost competitive rates for construction of maritime facilities. As a result, it is an opportune time to proceed with the planning for the construction of such a facility.

A large amount of work is still required however. This includes obtaining the necessary approvals, as well as the completion of the detailed design for the facility. With regard to the approvals, it is expected that the environmental approvals will be most critical. It is difficult to predict the requirements for a facility such as this, therefore it is recommended that early consultation be completed with the EPA to determine the requirements for this development and to prepare an agreed methodology for the collection, collation and presentation of data that will be necessary to support the approval.

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