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R1512 Rev 1

October 2021

City of Greater Geraldton

Drummond Cove Boat Launching Facility Concept Design

marinas
boat harbours
canals
breakwaters
jetties
seawalls
dredging
reclamation
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1. Introduction

MRA (2013) previously completed an assessment of boat ownership rates, usage of existing boating facilities, and future projections of boat usage within the City of Greater Geraldton (City). The assessment identified that at least 2 new lanes of boat ramp would be required by 2026.

The construction of a boat launching facility within Drummond Cove has been considered for many years as a coastal adaptation option that could serve the dual purpose of providing much needed boating infrastructure, whilst also providing long term protection to this eroding section of coastline.

The proposed facility is understood to have strong community support since it offsets the loss of beach by providing social and recreational benefits associated with the construction of a boat launching facility.

When considered in combination with upgrades to boating facilities at the Abrolhos Islands which are currently underway, and the proposed commercial ferry jetty, a boat launching facility at Drummond Cove would be of benefit to the wider Geraldton community in terms of increased attraction of tourists. The above developments are to promote tourism and provide infrastructure for tourism access to the Abrolhos Islands. A boat launching facility at Drummond Cove would provide boating infrastructure to accommodate tourists bringing their own boats to Geraldton.

The history of this project is outlined below.

- 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 (DoT) 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).

- MRA (2017) completed a review of concept design options developed by the community as well as the previous MRA (2000) option. MRA (2017) also proposed a new concept layout which was selected as the preferred option.

The City have subsequently engaged MRA to prepare a refined concept design and cost estimate for the Drummond Cove Boat Launching Facility. This report presents the concept design and associated investigations.

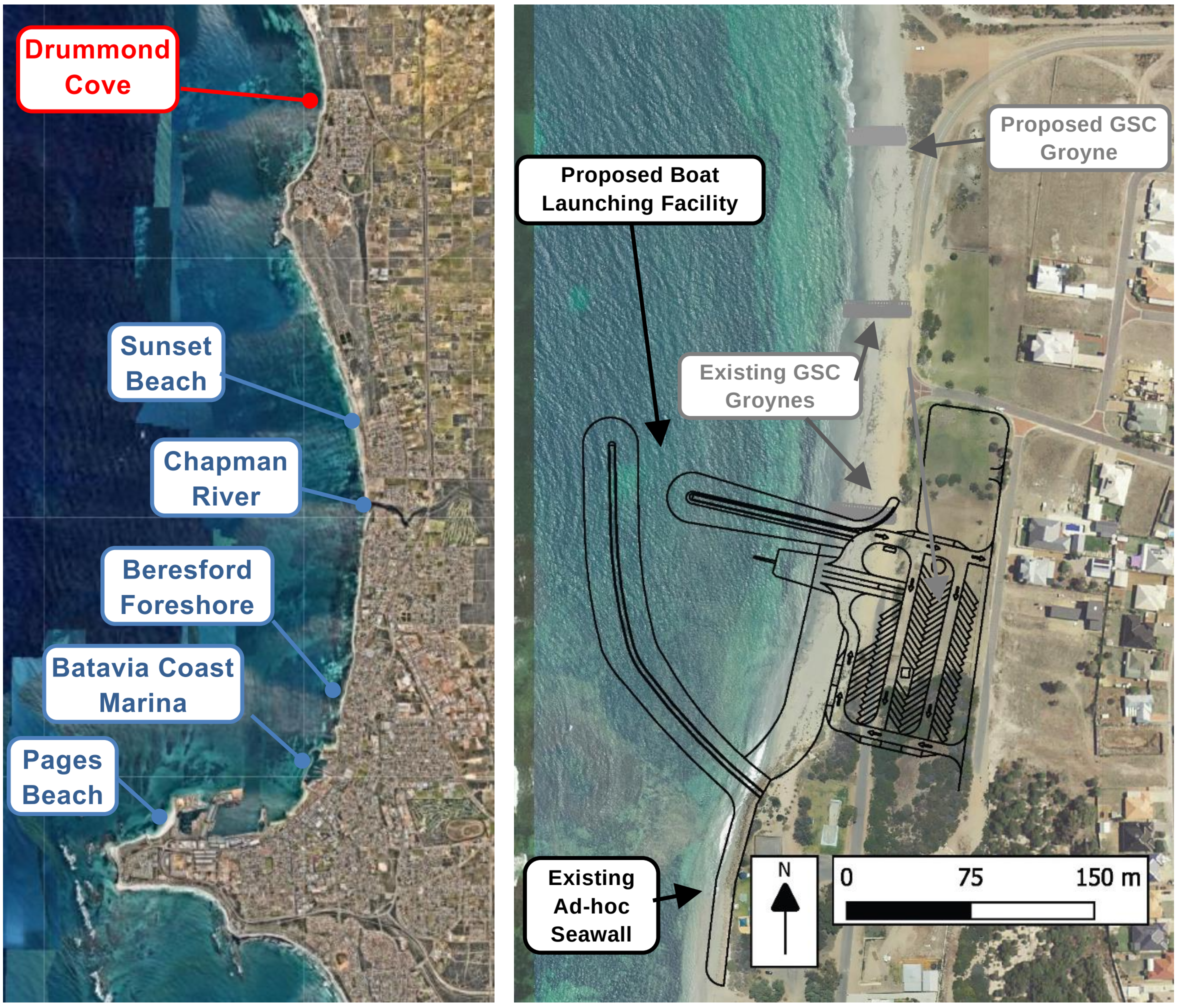

Figure 1.1 Site Location

2. Background

2.1 Site Conditions

Drummond Cove is considered a low energy beach sheltered by a chain of patchy reefs that extend a few hundred metres offshore (Short 2006). These reefs can be seen in the nautical chart excerpt shown in Figure 2.1 below.

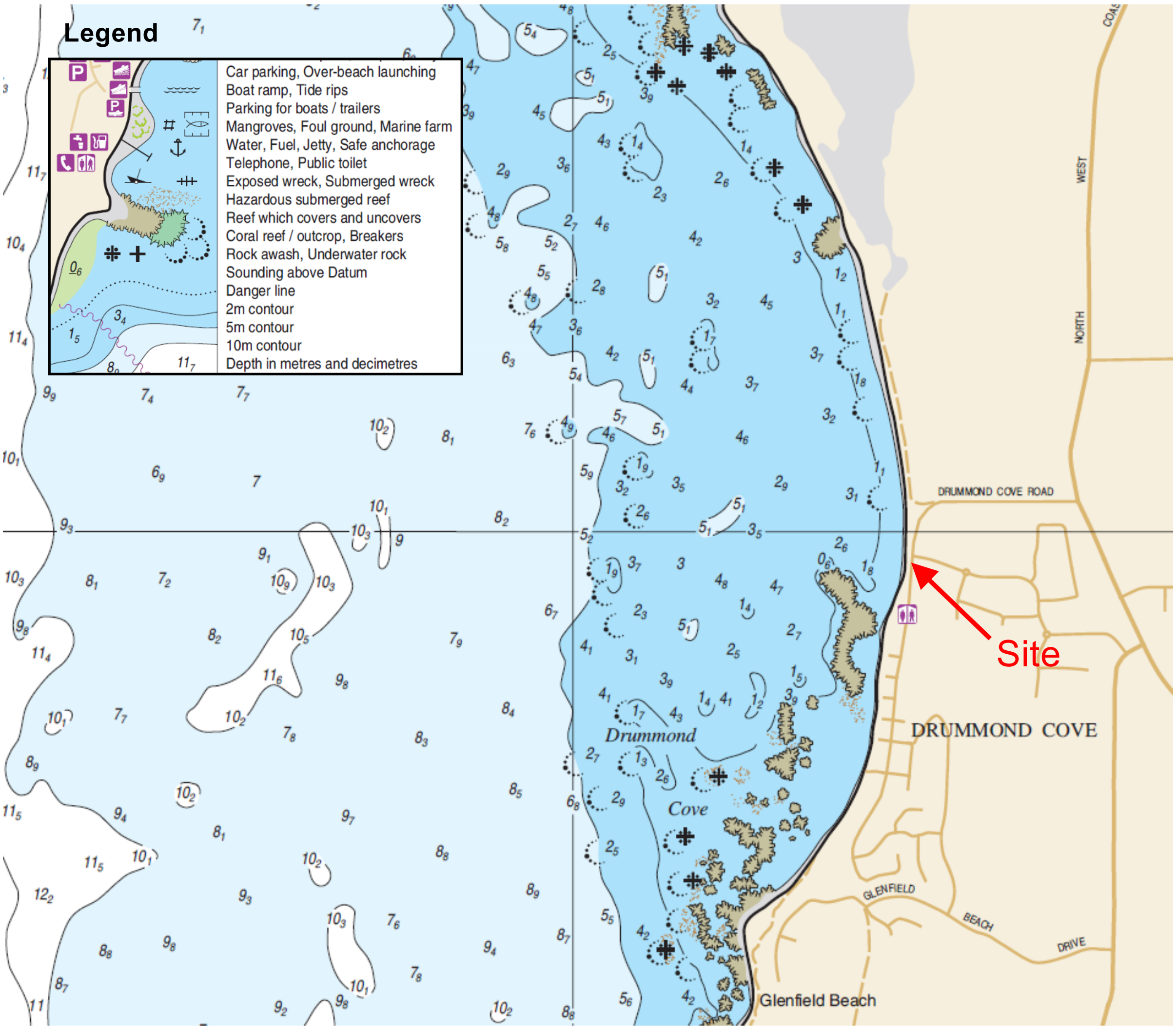

Figure 2.1 Drummond Cove Nautical Chart Excerpt

The beach is a popular recreational area and is generally well used. Since the northern section of Whitehill Road has been removed, the area is closed to vehicles with gates located at the northern and southern ends of the closed section of road.

A drone flyover of Drummond Cove was completed by HTD Surveys in April 2020 to capture oblique aerial imagery. Images of the site, ie the southern end of Drummond Cove, captured from this footage, are provided in Figures 2.2 and 2.3.

Figure 2.2 Southern End of Drummond Cove (facing North East)

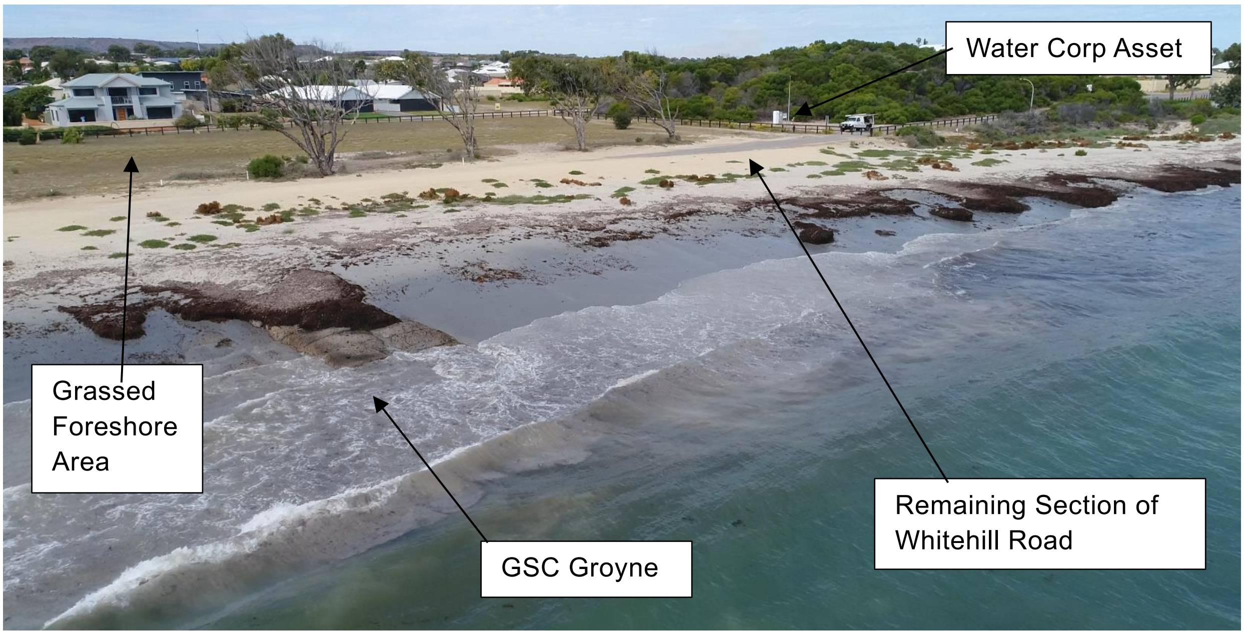

Figure 2.3 Southern End of Drummond Cove (facing South West)

2.2 Sand Nourishment & GSC Groynes

The City have completed numerous sand nourishment campaigns at the site, including in 2016, 2017, 2018 and most recently in October 2020. Sand has been sourced from various locations for these works, including from local quarries and from Pages Beach.

The City also constructed two GSC groynes and completed sand nourishment to saturate the groynes in 2019. The locations of these groynes are shown in Figure 2.2 and 2.3.

Design of a third GSC groyne at the northern end of Drummond Cove is currently underway. Construction of the proposed groyne is planned for early to mid 2021.

2.3 Shoreline Movement

MRA (2018, 2021) have previously analysed shoreline movement at Drummond Cove using the coastal vegetation line mapped from available aerial imagery. MRA (2018) calculated average erosion rates along the southern section of the shoreline of around 3 m/year for the period between November 2014 and December 2016.

Recent vegetation line mapping suggests only minor changes to the shoreline position along the southern section of the shoreline are apparent since 2016. This is likely the result of the GSC groynes and sand nourishment campaigns.

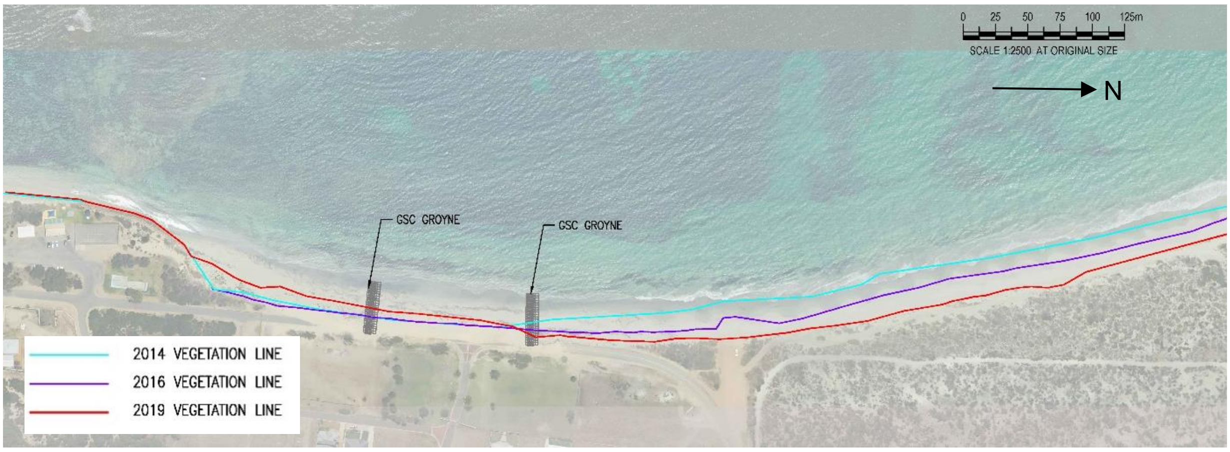

Figure 2.4 Excerpt from Shoreline Movement Plan

2.4 John Batten Hall Ad-Hoc Seawall

An approximately 200m long seawall lies at the southern end of the site. MRA understands that this seawall was constructed in around 2012 and is ad-hoc in nature, with no clear evidence that the seawall has been designed for erosion protection. This seawall fronts the John Batten Hall. This seawall is herein referred to as the Ad-Hoc Seawall.

Figure 2.5 Ad-Hoc Seawall (Facing South)

3. Design Considerations

3.1 Purpose

The intended primary purpose of the design is to provide a safe facility for the launching and retrieval of vessels. As noted above, the facility is also likely to provide the secondary benefit of local long-term protection to the eroding section of coast encompassed by the proposed development.

3.2 Concept Design Items

The concept design includes the following items.

- Boat launching facility to include:
    - Two lanes of concrete boat ramp and a centralised finger jetty.
    - Rubble-mound breakwaters comprised of granite armour rock.
    - Car and trailer parking of approximately 60-80 bays and a separate overflow/derigging area.
    - Waste facilities.
    - Fish cleaning tables.
    - Miscellaneous other items including, line marking, service locations, kerbing and drainage connection with the boat ramp.
- Re-alignment of Whitehill Road.
- Upgrades to the Ad-Hoc Seawall.

3.2.1 Design Standards & Guidelines

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

- AS4997-2005 Guidelines for the design of maritime structures.
- AS3962-2020 Marina Design.
- PIANC RecCom Report 149/Part II – 2016: Guidelines for marina design.

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).

The concept design has been prepared based on the above standards and guidelines.

3.3 Design Criteria

The general design approach and design criteria adopted for the various structures were previously outlined by MRA (2017) and are noted below.

- Design Life 25 years.
- Design Event 50 years average recurrence interval (ARI).
- Design Vessel Length: 7.5 m.

  Weight: 5 T.

  Beam: 3.4 m (AS 3962-2020) .

3.4 Breakwater & Seawall Design Wave Conditions

Design conditions have previously been determined by MRA (2017). For this project, the wave modelling completed by MRA (2017) was interrogated to determine design conditions at various locations. The design conditions and the relevant locations are outlined in and Table 3.1 below.

Table 3.1 Design Conditions

Location	50 Year ARI Design Conditions				1 Year ARI Design Conditions			
	Significant Wave Height (m)	Peak Wave Period (s)	Mean Wave Period (s)	Wave Direction (º)	Significant Wave Height (m)	Mean Wave Period (s)	Mean Wave Period (s)	Wave Direction (º)
Outer BW	2.2	13.7	9.2	267	2	13.7	8.4	270
Inner BW	1.6	13.7	9.2	267	1.4	13.7	8.4	270
Ad-Hoc Seawall	1.4	13.7	9.2	267	1.35	13.7	8.4	270

3.4.1 Locally Generated Seas

In addition to the westerly swell conditions outlined in Table 3.1, the facility is subject to locally generated seas. Given the orientation of the facility entrance, seas generated as a result of northerly winds would be the most severe in terms of penetration into protected waters of the facility.

MRA have completed an extreme analysis of measured northerly seas wave heights at the Geraldton Outer Channel AWAC. This extreme analysis is presented in Figure 3.1.

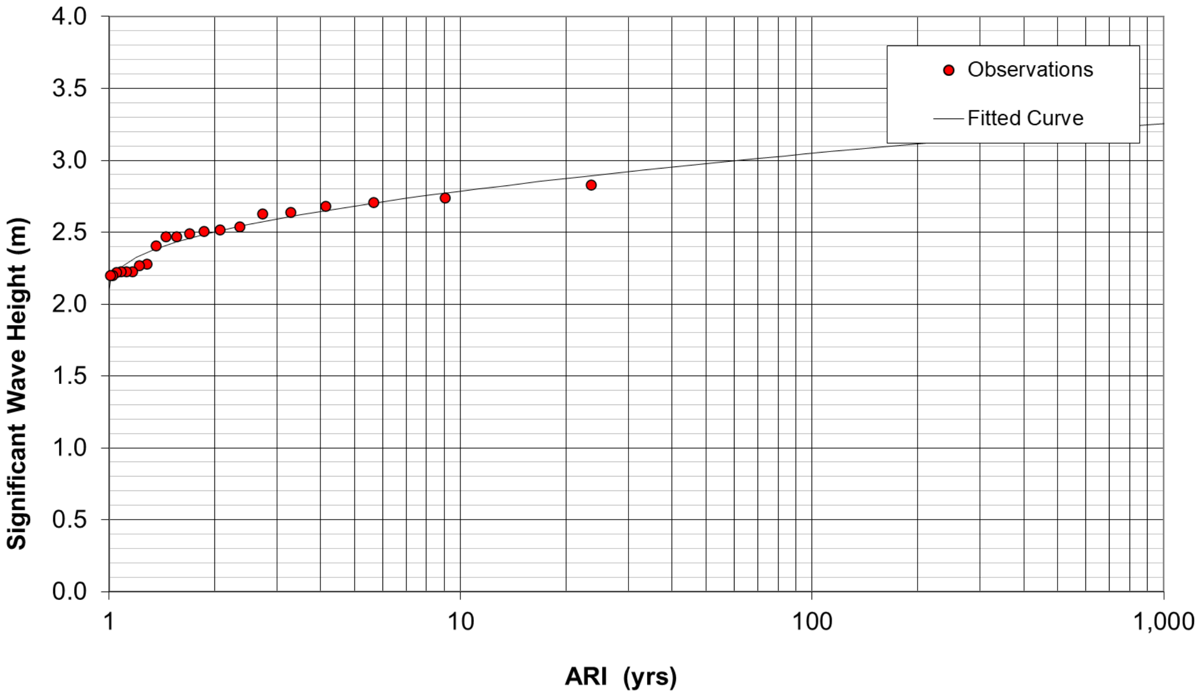

Figure 3.1 Extreme Analysis of Geraldton Outer Channel AWAC Measured Northerly Seas

As shown in Figure 3.2, the 1 year ARI northerly seas at the Geraldton Outer Channel AWAC is approximately 2.2 m.

Based on previous modelling completed by MRA (2017, 2021), an attenuation factor of 0.65 can be applied to the offshore northerly seas Geraldton Outer Channel AWAC to transfer the conditions to the facility entrance for the purposes of concept design. In this regard the 1 year ARI significant wave height for northerly seas is estimated to be 1.45 m.

A plot of the measured seas at Geraldton Outer Channel AWAC is provided in Figure 3.2. The plot shows that intensity and prevalence of the conditions tends to decrease with northerly directionality. The largest sea conditions tend to occur west of approximately 300°.

In this regard, a direction of 300° has been considered for the 1 year ARI northerly sea conditions at the facility.

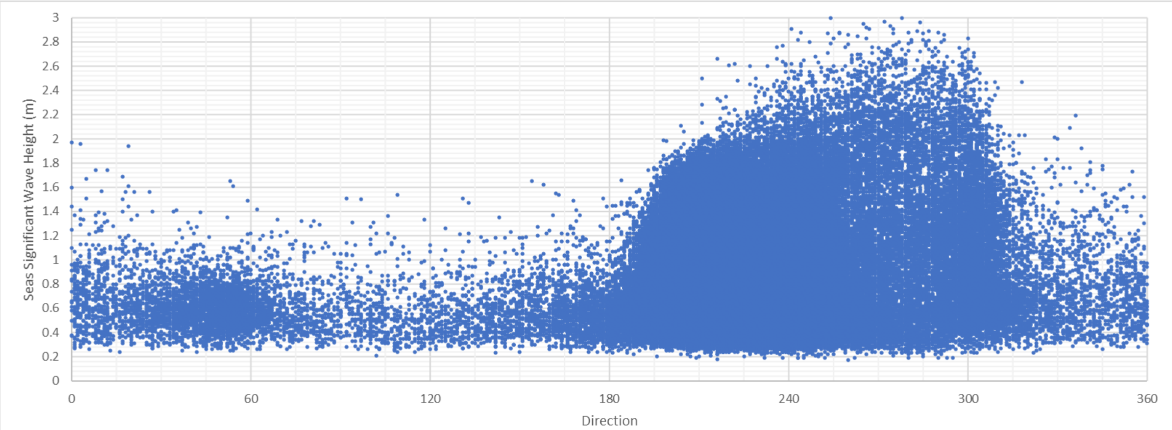

Figure 3.2 Geraldton Outer Channel AWAC Hs Sea vs Direction

3.5 Design Water Level Conditions

The design water levels at the site are driven by a combination of astronomical tides and storm surge. These are discussed in the following sections.

3.5.1 Astronomical Tides

Measurements have been taken by DoT using a tide gauge located at the Geraldton Port, which is approximately 12 km south of the site. Submergence curves have been prepared by the DoT and the key tidal levels are provided in Table 3.2.

Table 3.2 Tidal Planes for Geraldton

Tidal Plane	Prefix	Level (mAHD)	Level (mCD)
Highest Astronomical Tide	HAT	0.73	1.27
Mean Higher High Water	MHHW	0.47	1.01
Mean Sea Level	MSL	0.1	0.64
Mean Lower Low Water	MLLW	-0.27	0.27
Lowest Astronomical Tide	LAT	-0.47	0.07
Chart Datum	CD	-0.54	0

3.5.1 Extreme Water Level (Storm Surge)

During storms or cyclones, low barometric pressures and strong winds cause the water level to rise above the astronomical tide. An extreme analysis of both cyclonic and non-cyclonic events has been completed by MRA.

This extreme analysis used water levels recorded by the tide gauge at Geraldton Port between 1986 and 2015 (MRA 2018b) and detailed cyclone modelling using a synthesised cyclonic record for a 2,000 year period (MRA, 2016). The resulting extreme water levels are shown in Table 3.3.

Table 3.3 Extreme Water Levels at Geraldton Tide Gauge

ARI (years)	Static Water Level (mAHD)	Static Water Level (mCD)
1	0.91	1.45
25	1.25	1.79
50	1.35	1.89

3.5.2 Sea Level Rise

Climate change is believed to be causing an increase in mean sea level as a result of two main processes:

- the melting of land based ice, increasing the volume and height of the ocean waters; and
- a decrease in ocean density through thermal expansion, which increases the volume and thus the ocean height (CSIRO 2007).

Observations of sea levels have been carried out for centuries at some locations, allowing historical trends to be identified. The global mean sea level rose by between 0.12 to 0.22 m over the 20th century, which equates to an average of around 1.8 mm/yr (IPCC 2007).

Through review of this and other data and research, DoT released recommendations on the appropriate allowances for future climate change and sea level rise to be used for coastal planning and development in Western Australia (DoT 2010). These recommendations were adopted by SPP2.6 and are presented in Figure 3.3.

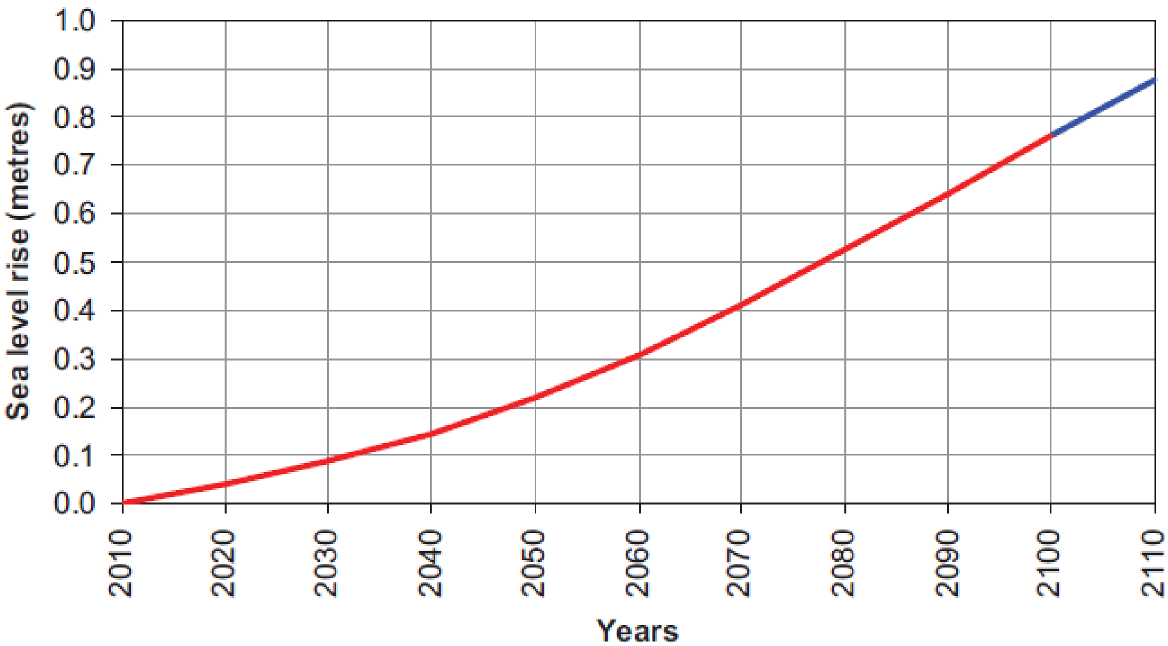

Figure 3.3 Recommended Allowance for Sea Level Rise (DoT 2010)

The recommended allowance for future sea level rise (SLR) over the design life of the facility has been determined and is presented in Table 3.4. The increase in sea level is referenced to 2021.

Table 3.4 Sea Level Rise Allowance

Design Life	SLR Allowance (m)
25	0.14

3.5.3 Wave Set-up

The shoreline fronting the Ad-Hoc Seawall is exposed to the open ocean, therefore the influence of water level setup induced by wave action is not included in the above analysis of static water levels at the tide gauge.

Dean and Walton (2008) provide a comprehensive review of numerous investigations into the extent of wave setup on a variety of different beach types throughout the world, including in the North Sea, Japan, USA and Australia. Dean and Walton (2008) determined that, as an average over all of the studies, the amount of wave setup was approximately 0.2 times the significant wave height in the surf one.

The wave setup on the shoreline fronting the John Batten Hall Ad-hoc Seawall has been estimated for the purposes of concept design based on Dean and Walton (2008).

3.5.4 Design Water Levels

The design water levels for each of the structures are outlined in the Table 3.5 below.

Table 3.5 Design Water Levels

Structure(s)	1 Year ARI Design Water Level	50 Year ARI Design Water Level
Breakwaters	1.05 mAHD (1.59 mCD)	1.5 mAHD (2.04 mCD)
Ad-hoc Seawall	1.3 mAHD (1.84 mCD)	1.8 mAHD (2.34 mCD)

4. Boat Launching Facility Entrance

MRA have completed a review of the entrance to confirm the suitability for concept design.

Key details of the entrance shown in the concept design are outlined below.

- Entrance width is 17 m (toe to toe) at the narrowest point.
  - This width increases to approximately 30 m at the mean sea level water line.

4.1 Entrance Width

AS3962-2020 provides the following guidance regarding the required width of entrances to marinas.

> *"…In order to minimize the penetration of waves into a vessel harbour, the width of the entrance channel may be narrowed over a short length at protecting breakwaters. The minimum width of the narrow section shall be the greater of 15 m and 3B, where B is the beam of the broadest mono-hull vessel in the marina…"*

The design vessel beam is 3.4 m. The minimum entrance width as per AS3962-2020 is 15 m. The concept design entrance is wider than this minimum value and hence is considered appropriate.

4.2 Wave Breaking Assessment

The PIANC Guidelines provide the following guidance regarding the required water depth entrances and along approaches to marinas in terms of wave breaking.

> *"… Preferably, the entrance should be in water depth at least twice the height of the design wave to be outside the limit for breaking…"*

The 1 year ARI design wave height at the facility entrance is 2 m. Seabed levels in the vicinity of the entrance and approach range between the approximately -3.5 mAHD and -5 mAHD.

MRA have calculated the depth limited breaking wave heights for these depths using the Goda (2010) method. The calculated breaking wave heights are 2.7 to 3.5 m, respectively. The 1 year ARI design significant wave height is below this value.

It is noted that significant wave height is defined as the average of the largest one third of wave heights over a given period. Hence, incidental waves larger than 2 m could occur during the 1 year ARI design event. For the open ocean, the largest incidental wave heights, or H_{max}, can be up 1.9 times larger than the significant wave height. However, the various reefs and shallow areas to the west and north west of the entrance will cause shoaling and breaking of larger incoming waves, and hence decrease the H_{max} that could occur. MRA estimates ratios of H_{max} to significant wave height of around 1.3 to 1.5 could occur at the facility entrance. Hence incidental waves of 2.6 m to 3 m in height may occur at the entrance during the 1 year ARI event, hence wave breaking may occur.

It is noted that the westerly swell conditions are oriented beam on to vessels that will navigate through the entrance and the north/south oriented section of the approach. With the dominant westerly swell conditions and the orientation of the shoreline etc. This is not readily avoidable. However, the outer breakwater extends northward of the inner breakwater by approximately 30 m, and hence will provide some protection against the westerly swell for vessels navigating in the vicinity of the entrance.

4.3 Indicative Facility Approach Channel

4.3.1 Required Navigation Depth

AS3962-2020 provides guidance on the design requirements for navigation depths for marinas and boat harbours. AS3962-2020 recommends the following allowances/

- An allowance for vessel movement caused by waves and boat wake. It is recommended that this allowance is a minimum of half the expected wave height.
- Half of the incident significant wave height.
- Vessel draughts.
- An appropriate siltation allowance.
- A minimum UKC of 0.3 m for a soft seabed or 0.5 m for a hard seabed.

These allowances are summarised in Table 4.1.

Table 4.1 AS3962 Navigation Depth Allowances

Factor	Level / Allowance
LAT	-0.47 mAHD (0.07 mCD)
AS 3962-2020 8 m Vessel Design Draught (m)	0.9 m
Siltation Allowance	0.5 m [1]
Half of the Significant Wave Height (i.e. **2** x 0.5)	1 m
UKC	0.5 m [2]
Required Seabed Level	**-3.37 mAHD (-2.83 mCD)**

Notes:

1) Estimated siltation allowance.
2) The larger UKC allowance appropriate for a hard seabed has been adopted. This is considered to be conservative.

As noted above, seabed levels in the vicinity of the entrance and approach range between approximately -3.5 mAHD and -5 mAHD. This is deeper than the required navigation depth.

An estimated siltation allowance of 0.5 m has been nominally included in Table 4.1. The prevailing northerly longshore sediment transport at the site is expected to lead to accumulation of sediment on the southern side of the outer breakwater. Management of accumulation of this material, ie sand bypassing etc, is expected to be required from time to time. If left unmanaged there lies the potential for this updrift accumulation to lead to siltation in the entrance.

An indicative navigation approach to the facility is provided in Figure 4.1. The shallow area to the west and north west of the outer breakwater are noted. These areas lie outside of the indicative approach and, depending on the tide level, may have sufficient water depths for the design vessel to navigate over them. However due to the shallow depths and the potential for shoaling of incoming waves over these reefs, the areas may present a navigation hazard.

In this regard, to avoid the navigation hazard piled navigation markers are recommended.

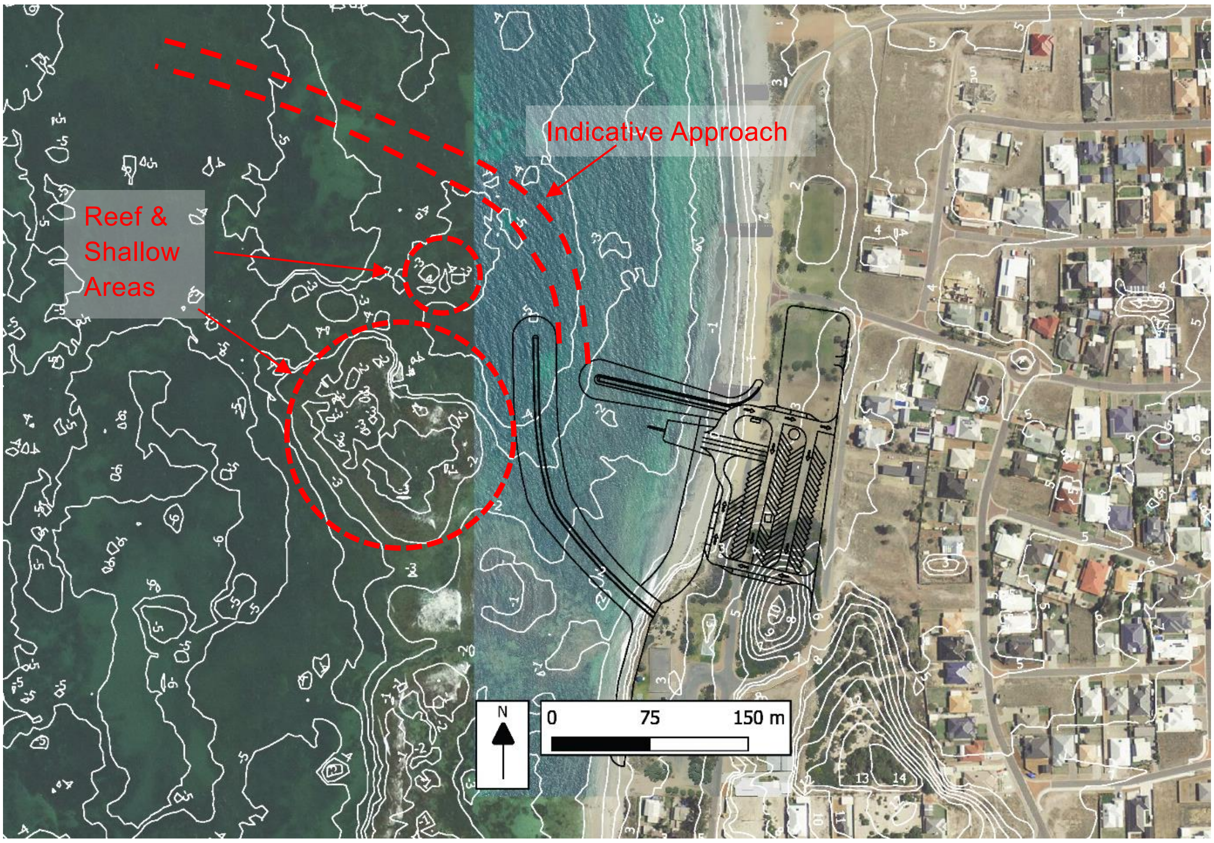

Figure 4.1 Indicative Facility Approach & Shallow Areas and Reef Adjacent to Entrance

4.4 Wave Penetration Assessment

MRA have completed a concept level wave penetration assessment to confirm the suitability of the entrance. The penetration assessment was based on wave diffraction diagrams provided in *Random Seas and Design of Maritime Structures* (Goda 2010).

The 1 year ARI design condition for swell and northerly seas were assessed as outlined in the figures below.

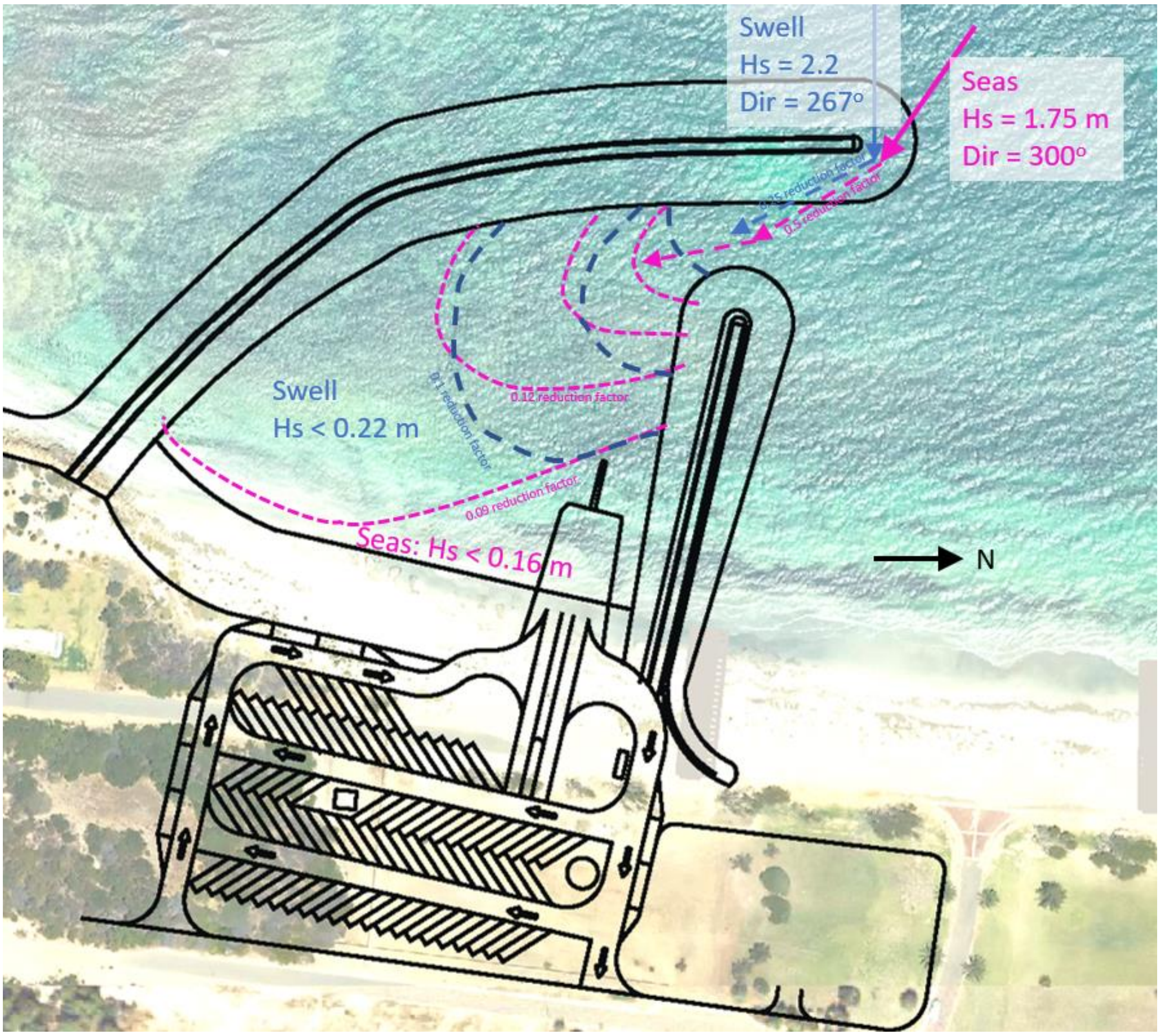

Figure 4.2 Swell Penetration Assessment

The wave penetration assessments presented above show that penetration of both incoming seas and swell into the protected waters are reduced as a result of wave diffraction around the head of the outer breakwater and through the narrow entrance.

The assessments suggest 1 year ARI swell and sea wave heights at the boat ramp in the order of 0.22 m and 0.16 m, respectively.

It is noted that boat launching is not expected to occur during the 1 year ARI conditions. Conditions such as this would trigger severe weather warnings etc. Typical conditions would be considerably calmer than the 1 year ARI conditions and hence the typical swell and sea wave heights at the boat ramp are expected to be below 0.2 m.

This is consistent with the guidance provided by AS3962-2020 on this issue. AS3962-2020 states that boat ramps should be "*…sheltered from short-period waves larger than 0.2 m*."

5. Breakwaters & Seawall Design

5.1 Rock Type

The City have determined that granite armour rock will be used for the breakwaters and seawall upgrades.

5.2 Armour Rock Size

Armour rocks need to be of sufficient size to withstand the forces applied by wave action. For each of the structures, the required armour size(s) under wave action was calculated using the Hudson and Van der Meer formulae (CIRIA 2007).

The required representative armour size (W_{50}) for each structure is outlined in Table 5.1.

Table 5.1 Armour Rock Sizes for Granite Rock

Structure	Armour Size (M50, T)
Outer Breakwater	2.5
Outer Breakwater (shoreward section)	1
Inner Breakwater	1
Internal Slopes – Inner & Outer Breakwaters	0.5 [1]
John Batten Seawall Upgrades	1

Notes:

1) Selection of 0.5 T sized armour rock for the internal slopes is based on stability underfoot and resistance to vandalism.

5.3 Core

Granite core has been selected for the concept design.

The core material will form the foundation of the breakwater structures and will be a well graded run of quarry material. The core material will have a median diameter of around 0.3 m for the inner breakwater and 0.5 m for the outer breakwater. The core material will need to incorporate a proportion of quarry fines down to around 0.1 m in diameter.

5.4 Pedestrian & Maintenance Access

The concept design of the rubble mound structures includes pedestrian and maintenance access along the crest of the structures. Disabled wheelchair access is recommended. This will require a smooth wheelchair accessible surface. There are a number of alternative materials that could be provided for this pedestrian access, including concrete or geocells, however given the expected settlement of the breakwaters following construction, asphalt is considered to be the most appropriate. Asphalt will be easier and comparably cheaper to repair following settlement and potential cracks/voids in order to retain disabled access along the structures.

A nominal path width of 3 m has been included in the concept design.

The crests of the breakwaters also need to be sufficiently wide to facilitate access for maintenance works of the structures. In MRA's experience, a 4 m wide crest is suitable and this been included. This is expected to be sufficient for large excavators to track along the crest of the structures and perform maintenance. It is noted that a wider crest may be beneficial from an ease of maintenance perspective, however widening the crest would result in an increase in the overall volume of the structure and would negatively impact environmental and sustainability outcomes associated with the project. It would also increase the construction cost.

5.5 Overtopping Assessment

The structure crest levels were determined based on a wave overtopping assessment completed using design and assessment approach for armoured slopes presented in EurOtop (2018).

The design crest levels and overtopping assessment are presented in Table 5.2.

Table 5.2 Breakwater & Seawall Design Crest Levels & Wave Overtopping Assessment

Structure	Crest Elevation (mAHD)	Setback (m)	ARI Event	Calculated Mean Overtopping Rate (l/m/s)	(EurOtop 2018) Acceptable Wave Overtopping		Outcome
					Mean Overtopping Discharge (l/s/m)	Hazard Type and Reason	
Outer Breakwater	4	**0.5**	**1**	**0.82**	**1**	**People at seawall / dike crest. Clear view of the sea (H_{mo} = 2m)**	**Acceptable**
		-	50	7.1	10	Damage to protected rubble mound embankment crest (Hm0 >5) [1]	Acceptable
Outer Breakwater (inner section)	3.8	0.5	1	0.5	1	People at seawall / dike crest. Clear view of the sea (H_{mo} = 2m)	Acceptable
		-	**50**	**10**	**10**	**Damage to protected rubble mound embankment crest (H_{m0} >5) [1]**	**Acceptable**
Inner Breakwater	3.8	0.5	1	0.54	1	People at seawall / dike crest. Clear view of the sea (H_{mo} = 2m)	Acceptable
		-	**50**	**10**	**10**	**Damage to protected rubble mound embankment crest (H_{m0} >5) [1]**	**Acceptable**
Seawall	**4.5**	**0.5**	**1**	**0.1**	**0.1**	**Non maintained landward slope (H_{mo} = 0.5 – 3m)**	**Acceptable**
		10	50	0	<1	Building structure elements (H_{mo} = 1-3 m)	Acceptable
		-	50	0.84	10	Damage to protected rubble mound embankment crest (Hm0 >5) [1]	Acceptable

Notes: 1. Based on a wave height of greater than 5 m. No guidance provided for lower wave heights. This allowance is considered to be conservative.

6. Boat Ramp

6.1.1 Relevant Design Standards & Guidelines

AS3962-2020 and DoT guidelines provide guidance for the development of boat ramp facilities. In order to ensure that the facility is suitable for use at all astronomical tides, certain recommendations are made regarding the location, alignment and dimensional criteria for the ramp. These include the following:

- The ramp should be located such that:
  - It is aligned directly into dominant waves from swell, sea and boat wash.
  - It is sheltered from waves larger than 0.2 m.
  - Land approaches permit queuing without blocking other traffic.
  - Water approaches have sufficient area to allow queuing and low speed manoeuvres without blocking fairways and channels.
- The head of the ramp should be 500 mm above highest astronomical tide (HAT).
- The ramp toe should be at least 1 m below chart datum but requires extension to at least 600 mm below lowest astronomical tide (LAT).
- The grade of the ramp should be between 1:7 and 1:9, preferably 1:8.
- A single lane ramp should be a minimum width of 4.0 m wide between kerbs, or at least 4.5 m for a single lane without kerbs. Multi lane ramps should have a minimum width per lane of 3.7 m.
- Efficiency of ramp usage can be increased by providing a boat holding jetty structure.
- The provision of rigging space, queuing lanes to the ramp approach, boat derigging and trailer bays on the exit route from the ramp approach should be provided. The arrival path to the ramp approach should be designed to provide adequate sight distance for optimum safety.
- Vehicle manoeuvring areas should be cognisant of the required vehicle turning path.

6.1.2 Key Features of the Concept Design

The concept design of the boat ramp has been developed based on considerations of the recommendations provided by AS3962-2020 and DoT. Key features of the concept design include the following.

- The head of the ramp has been set at an elevation of approximately +1.3 mAHD.
- The ramp toe has been set at a level of -2.0m AHD.
- The grade of the ramp has been set at 1:8.
- The width of each ramp lane is 4 m.

6.2 Holding Jetty

As outlined in MRA (2017), a floating type jetty is proposed for the holding jetty.

It is envisaged that the floating jetty will be a proprietary system and would be delivered by a design and construct contract. This is standard practise for floating jetties.

6.2.1 Design Criteria

The key requirements for the holding jetty, as provided in the relevant guidelines, are summarised by the following.

- Be of a sufficient length to accommodate at least two boats to line up at each ramp lane at all tides.
- Have a deck at least 1200 mm wide.

6.2.2 Piles

The piles would be part of a design and construct contract; however, the following would need to be considered in the design.

- The pile guide and pontoon connections to accommodate vertical movement of the floating jetty during the full tidal range.
- The piles should be designed to be adequately embedded and of sufficient size to withstand the environmental and berthing actions from the design vessel.
- The piles should not have excess deflection during operation.
- The piles should be protected from corrosion by installation of a HDPE sleeve or equivalent to ensure durability over its design life.
- The piles should also be high enough to prevent the pontoon floating off the top of the piles under the maximum surge level combined with the appropriate wave action. The following table provides MRA's calculation of the required pile cut off level.

Table 6.1 Estimates for Pile Cut Off Levels

50 yr ARI Water Level	+ 1.5 AHD (+2.04 m CD)
Allowance for Climate Change (25 yr horizon)	0.14 m
½ Wave Height[1]	0.25 m
Pontoon Freeboard	0.55 m
Safety Allowance	0.5 m
Resulting Estimated Pile Cut Off Level	**+2.94 mAHD (+3.48 mCD)**

Note 1: Wave heights due to boat wake of up 0.5 m are expected.

7. Car Park

7.1 Car Park Design Requirements

AS3962-2020 provides guidance on the total number of trailer parking bays that should be provided for each lane of boat ramp. The number of trailer parking bays differs based on the location of the facility (rural versus urban) as well as whether boat holding structures or rigging and de-rigging areas are available. The reason for differentiation in the number of bays that are recommended dependant on both the location and level of supporting infrastructure is linked to the desirability of the facility. It is thought that the desirability of a facility increases with provision of associated infrastructure. Table 7.1 shows the recommended number of trailer parking bays outlined in AS3962-2020.

Table 7.1 AS39623-2020 Recommended Number of Trailer Parking Bays

Area Classification	Number of Car / trailer Spaces for Each Ramp Lane		
	Ramp only	With vessel holding structures	With separate rigging and derigging areas
Urban	20-30	30-40	40-50
Rural	10-20	20-30	30-40

The proposed Drummond Cove boat launching facility includes a separate overflow parking area which could also be used for rigging and derigging, the boat includes 2 lanes and a holding jetty. Based on the AS3962-2020 guidelines, around 80 trailer parking bays is recommended. This is consistent with the approach previously adopted by MRA (2017).

7.2 Car Park Concept Design

Details of the carpark included in the concept design are outlined below.

- 82 trailer parking bays.
- 7 rigging/derigging bays.
- One way traffic carpark with entry and exit via Estuary Way.
- Approximately 12,000 m^2 area.
- Asphalt pavement, line marking, kerbing etc. included.

7.2.1 Water Corp Asset

It is noted that the concept design carpark overlaps a Water Corp assert located adjacent to the remaining section of Whitehill Road South. It is expected that this asset will need to be reattained and hence the concept design has been developed around the asset.

7.3 Overflow Car Park Concept Design

An overflow carpark of approximately 4,000 m^2 has been included to the north of the main carpark. The entrance and exit to this area are via Estuary Way.

The nominated area is currently grassed foreshore reserve. It is envisaged that the grass could be retained and the area could be converted to overflow parking by adding grass reinforcement mesh and upgrading the current irrigation.

7.4 Toilet Block

An allowance for a toilet block has been included in the concept design.

7.5 Fish Cleaning Station

An allowance for a fish cleaning station has been included in the concept design.

7.6 Drainage

Costs associated with drainage have been included in the cost estimate outlined in Section 10. It is envisaged that drainage would include storm drains and a cut-off drain at the top of the boat ramp, to intercept any drainage flow prior to entering the waterway.

8. Whitehill Road Realignment

As outlined in the RFQ, the concept design includes an indicative concept for realignment of Whitehill Road North and re-establishment of road connectivity between Whitehill Road south and Drummond Cove Road.

The proposed realignment would run parallel to the previous alignment at the northern end of Drummond Cove. MRA understands that there are some community sensitivities associated with locating this road alongside properties located on the western side of Wave Crest Drive. In this regard, a notional alignment has been included in the concept design, with the exact alignment to be confirmed.

The concept design also includes an intersection between the realignment section of Whitehill Road North and Waterfront Circle, upgrades/widening of Waterfront Circle and Estuary Way, and establishment of connectivity between Estuary Way north and Estuary Way south.

9. Miscellaneous Items

9.1 Pontoon

A swimming pontoon has been included in the concept design. The functional requirements associated with a swimming pontoon are summarised below:

- Adequate depth for safety of patrons – i.e. diving off the pontoon.
- Located outside of the boating area.
- Adequate size for intended use.

In light of the above considerations the swimming pontoon has been included on the northern side of the inner breakwater in area where seabed levels are around -2.5 mAHD.

Similar pontoons located on beaches in the Perth metropolitan area are generally 6-6.5 m x 3.5-4.5 m in size. In this regard, a pontoon measuring 6.5 m x 4.5 m is considered to be suitable in size.

9.2 Swimming Beach

A swimming beach has been included in the concept design. The key function of the beach is to achieve the following.

- Provide a space for public recreation.
- Provide a space for public interaction with the water.

The beach is expected to be relatively stable as the wave conditions inside the facility will be very calm. Sediment movement and potential for infilling at the boat ramp can be considered further during detailed design.

9.3 Potential Boardwalk

Early concept options for the proposed facility included a boardwalk along the inner side of the outer breakwater. Inclusion of such a feature within the facility would be possible, however the cost is relatively high and hence it has not been included at this stage.

Indicative costs for the boardwalk are estimated at approximately \$8,000 to \$10,000 / m^2.

Key considerations for a potential boardwalk are noted below.

- To allow two wheelchairs to pass each other a minimum clear width of 1800 mm is required.
- The structure would need to be above the extreme water level and wave conditions, or be designed to withstand wave uplift forces etc.
- Safety barriers (eg handrails) may be required, depending on the fall height.

9.4 Additional Space

Considerable additional space remains available on the southern side of the carpark. The City may wish to include additional features for this area.

10. Opinion of Probable Construction Cost

A concept construction cost estimate for the Drummond Cove Boat Launching Facility has been prepared and is presented below.

This cost estimate is based on the concept design and hence should be considered as concept level only.

The following considerations are noted.

- The cost estimate is for construction only and does not include costs associated with approvals (ie environmental, heritage, planning or otherwise).
- This estimate does not include a contingency allowance.
- Future escalation has not been included.
- Effects of delays and costs due to COVID19 have not been included.

The City should consider inclusion of appropriate allowances for each of the above items.

Table 10.1 Drummond Cove Boat Launching Facility – Concept Construction Cost Estimate

Item	Activity	Quantity	Units	Unit Rate	Subtotal	Total for Item
1	**Preliminaries**					**$ 600,000**
1.1	Contractor preliminaries, including mobilisation, demobilisation, insurances, etc.	1	item	$ 600,000	$ 600,000	
2	**Breakwaters**					**$ 3,731,950**
2A	**Outer Breakwater**					
2.1	Supply & place core	23,883	m3	$ 65	$ 1,552,418	
2.2	Supply & place 2.5T granite armour	10,006	T	$ 90	$ 900,534	
2.3	Supply & place 1T granite armour	1,091	T	$ 90	$ 98,224	
2.4	Supply & place 0.5T granite armour	4,222	T	$ 80	$ 337,731	
2B	**Inner Breakwater**					
2.5	Supply & place core	8,131	m3	$ 65	$ 528,528	
2.7	Supply & place 1T granite armour	2,613	T	$ 90	$ 235,142	
2.7	Supply & place 0.5T granite armour	992	T	$ 80	$ 79,373	
3	**Ad-Hoc Seawall Upgrade**					**$ 621,440**
3.1	Demolish existing seawall, off site disposal of unsuitable material	1	Item	$ 75,000	$ 75,000	
3.2	Earthworks to permit construction of seawall upgrade	800	m3	$ 10	$ 8,000	
3.3	Supply & place geotextile	2,496	m2	$ 20	$ 49,920	
3.4	Supply & place core	1,008	m3	$ 65	$ 65,520	
3.5	Supply & place 1T granite armour	4,700	T	$ 90	$ 423,000	
4	**Two Lane Boat Ramp & Finger Jetty**					**$ 520,000**
4.1	Supply & install 2 lane boat ramp (includes earthworks, scour protection and concrete)	1	Item	$ 400,000	$ 400,000	
4.2	Supply & install floating finger jetty (includes piling)	1	Item	$ 120,000	$ 120,000	
5	**Car Parking**					**$ 622,000**
5.1	Car & trailer parking area (includes earthworks, asphalt, line marking, kerbing, drainage lighting etc.)	11,000	m2	$ 50	$ 550,000	
5.2	Allow for treatment of grassed area for overflow carpark	3,800	m2	$ 15	$ 57,000	
5.3	Allow to upgrade existing irrigation for overflow carpark	1	Item	$ 15,000	$ 15,000	
6	**Whitehill Road Realignment**					**$ 141,500**
6.1	Construct Whitehill Road on new alignment	1,000	m2	$ 60	$ 60,000	
6.2	Allow to upgrade & widen sections of existing road as required	1,600	m2	$ 40	$ 64,000	
6.3	Allow to connect Estuary Way North & Estuary Way South	350	m2	$ 50	$ 17,500	
7	**Miscellaneous Items**					**$ 177,000**
7.1	Waste facilities (includes bins)	1	Item	$ 5,000	$ 5,000	
7.2	Toilet block	1	Item	$ 60,000	$ 60,000	
7.3	Fish cleaning station	1	Item	$ 7,000	$ 7,000	
7.4	Swimming pontoon	1	Item	$ 5,000	$ 5,000	
7.5	Navigation aids (2 x breakwater beacons, 3 x navigation markers)	1	Item	$ 100,000	$ 100,000	
	Subtotal 2				**$ 6,413,890**	**$ 6,413,890**
	Goods & Services Tax				**$ 641,389**	**$ 641,389**
	Total Estimated Cost				**$ 7,055,279**	**$ 7,055,279**

10.1 Contingency Allowance

As a guide to the City, MRA have completed an assessment of the appropriate contingency for the construction cost estimated based on the South Australian Department of Planning, Transport Infrastructure Cost Estimating Manual guidelines. The assessment is presented in Table 10.2.

Table 10.2 Contingency Assessment

Element	Factors			Highly Confident & Reliable	Reasonably Confident & Reliable	Not Confident & Not Reliable	Selected Percentage
Project Scope	Is the project scope well defined?	Yes ↓	No ↑	3%	4%	5%	4%
	Could the works be varied?	Yes ↑	No ↓	3%	4%	5%	5%
	Are many project options possible?	Yes ↑	No ↓	3%	4%	5%	4%
Risks	Are there significant risks?	Yes ↑	No ↓	5%	6%	7%	6%
	Has a detailed risk analysis been done?	Yes ↓	No ↑	5%	6%	7%	7%
Constructability	Has a constructability review been undertaken?	Yes ↓	No ↑	3%	4%	5%	3%
	Are there constructability issues with the project?	Yes ↑	No ↓	3%	4%	5%	3%
Key Dates	Are project commencement and completion dates known?	Yes ↓	No ↑	1%	2%	3%	3%
	Is the project planned to occur in the distant future?	Yes ↑	No ↓	1%	2%	3%	2%
Information	Have geotechnical, heritage, environmental and technical investigations been undertaken?	Yes ↓	No ↑	9%	12%	15%	15%
Length of Project	What is the extent of the project? <2km - short, <5km long	Short ↓	Long ↑	4%	7%	10%	4%
Total contingency percentage to be adopted for an estimate with a 90% confidence of not being exceeded							**56%**
Total contingency percentage to be adopted for an estimate with a 50% confidence of not being exceeded (*assessed as 40% of the 90% confidence level*)							**22%**

The assessment suggests that a contingency allowance of +22% would be appropriate for a P50 cost estimate, with a +56% allowance for a P90 estimate.

Including the +22% contingency allowance, the construction costs are estimated at approximately **$7.8 M excluding GST** as a P50. The P90 cost estimate would be approximately **$10.0 M excluding GST.**

It is noted that the construction cost estimate is considerably higher than the previous estimate outlined in MRA (2017). The following is noted regarding this.

- In general, 2021 construction costs are considerably higher than 2017 construction costs. Construction costs are currently inflated due to various construction works associated with COVID stimulus projects consuming significant contractor resources. MRA have recently observed considerable price increases for marina works. To compound this, marine works are particularly vulnerable to price increases as they are typically considered more "risky" by contractors are therefore less preferable than simple bulk earthworks, or subdivision works etc.
- The 2021 costs for supply and place of granite rock are significantly higher than the rates used for supply and placement of limestone rock by MRA in 2017.
- The concept design includes pedestrian access over the crest of the breakwaters. This was not included in the 2017 design. This results in wider and taller structures, and hence larger quantities of rock required.
- The 2017 cost estimate did not include the Ad-Hoc Seawall Upgrades or realignment of Whitehill Road.
- The 2017 cost estimate was developed based on a staged approach to construction including an initial half sized gravel car park, with upgrades to occur during future stages. The 2021 cost estimate is based on construction of the full design.

Options for staging of construction and cost optimisation etc. are available to the City and can be considered in detail during future design works.

10.2 Limestone Core Option

Inclusion of limestone core, instead of granite core, for the rubble mound structures is an option that can also be considered during future design works. MRA estimate that this may result in a cost saving of up to $0.5 M for the supply and placement of core for the works.

However, use of limestone core may result in increased rates for supply of granite armour rock. With granite core included in the design, the range of granite material that could be used is reasonably wide. This allows for more efficient quarrying works as material that does not meet the requirements for armour would be suitable for use as core material. Hence, use of limestone core instead of granite core may increase the granite armour rock supply costs.

This can be considered in detail during future design works.

11. Future Design Costs

MRA have estimated high level costs for various tasks required for detailed design of the boat launching facility. These high level costs are outlined below.

- Detailed metocean analysis, including cyclone analysis etc. - $50K exc. GST.
- Long period wave assessment etc - $20K exc. GST.
- High level geotechnical investigations - $30K exc. GST.
- Detailed design of breakwaters - $70K exc. GST.
- Detailed design of boat ramp - $20K exc. GST.
- Detailed design of additional marina elements (ie swimming beach etc.) - $20K exc. GST

MRA recommend including a contingency allowance of +25% for the high level estimated design costs outlined above.

The total of the above allowances (including contingency) is **approximately $260K excluding GST**.

It is noted that the above does not include additional engineering works associated with environmental approval of the facility including water quality assessments, coastal processes and wrack studies, or design of coastal structures required for the management of coastal processes – ie additional groynes etc.

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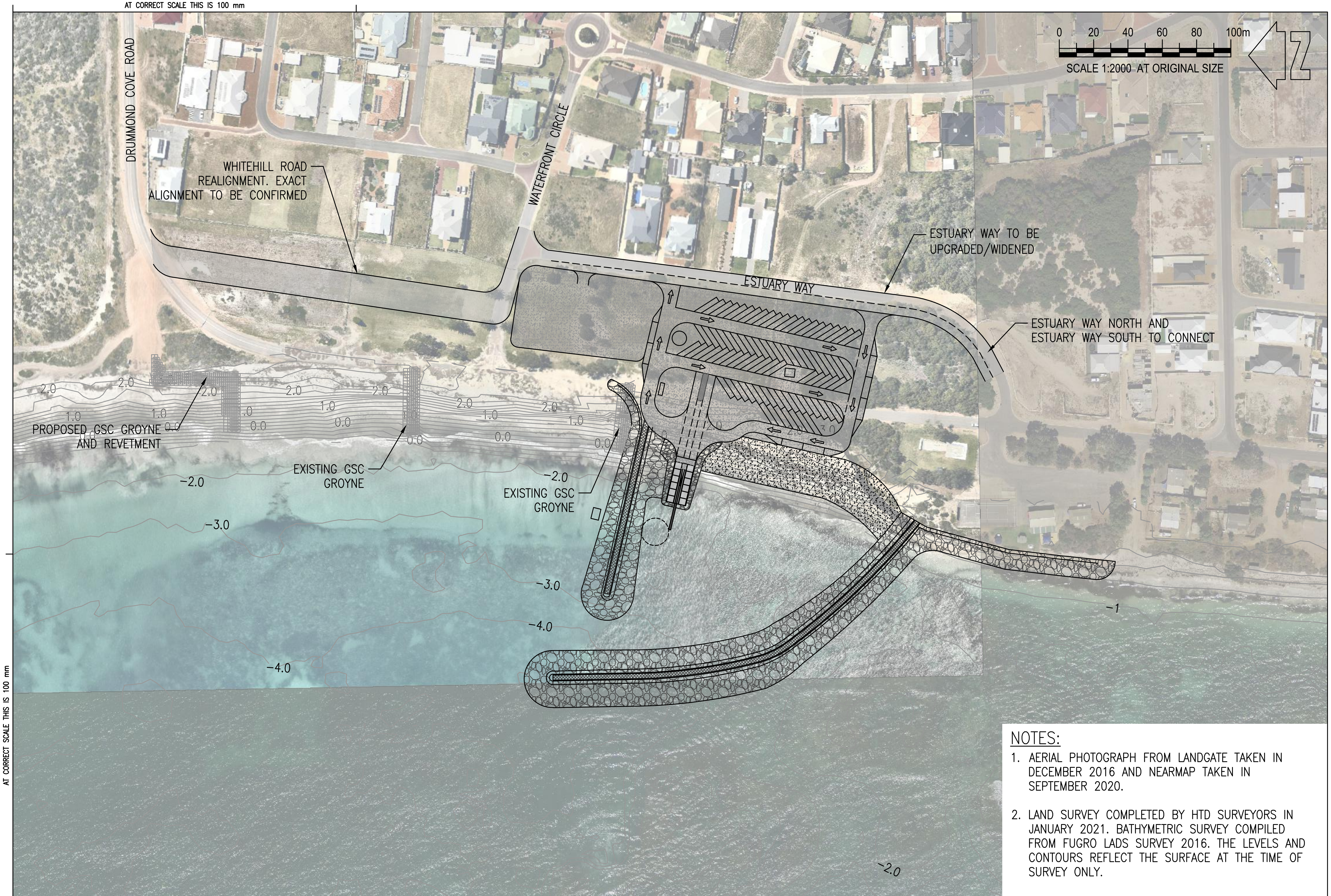
13. Appendices

Appendix A Drummond Cove Boat Launching Facility Concept Design Drawings

Appendix A Drummond Cove Boat Launching Facility Concept Design Drawings

AT CORRECT SCALE THIS IS 100 mm



NOTES:

1. AERIAL PHOTOGRAPH FROM LANDGATE TAKEN IN DECEMBER 2016 AND NEARMAP TAKEN IN SEPTEMBER 2020.
2. LAND SURVEY COMPLETED BY HTD SURVEYORS IN JANUARY 2021. BATHYMETRIC SURVEY COMPILED FROM FUGRO LADS SURVEY 2016. THE LEVELS AND CONTOURS REFLECT THE SURFACE AT THE TIME OF SURVEY ONLY.

AT CORRECT SCALE THIS IS 100 mm

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CONCEPT LAYOUT - WHITEHILL ROAD REALIGNMENT

DRUMMOND COVE – BOAT LAUNCHING FACILITY

SCALE AT A3 1:2,000

FEBRUARY 2021

SK1861-01-01A

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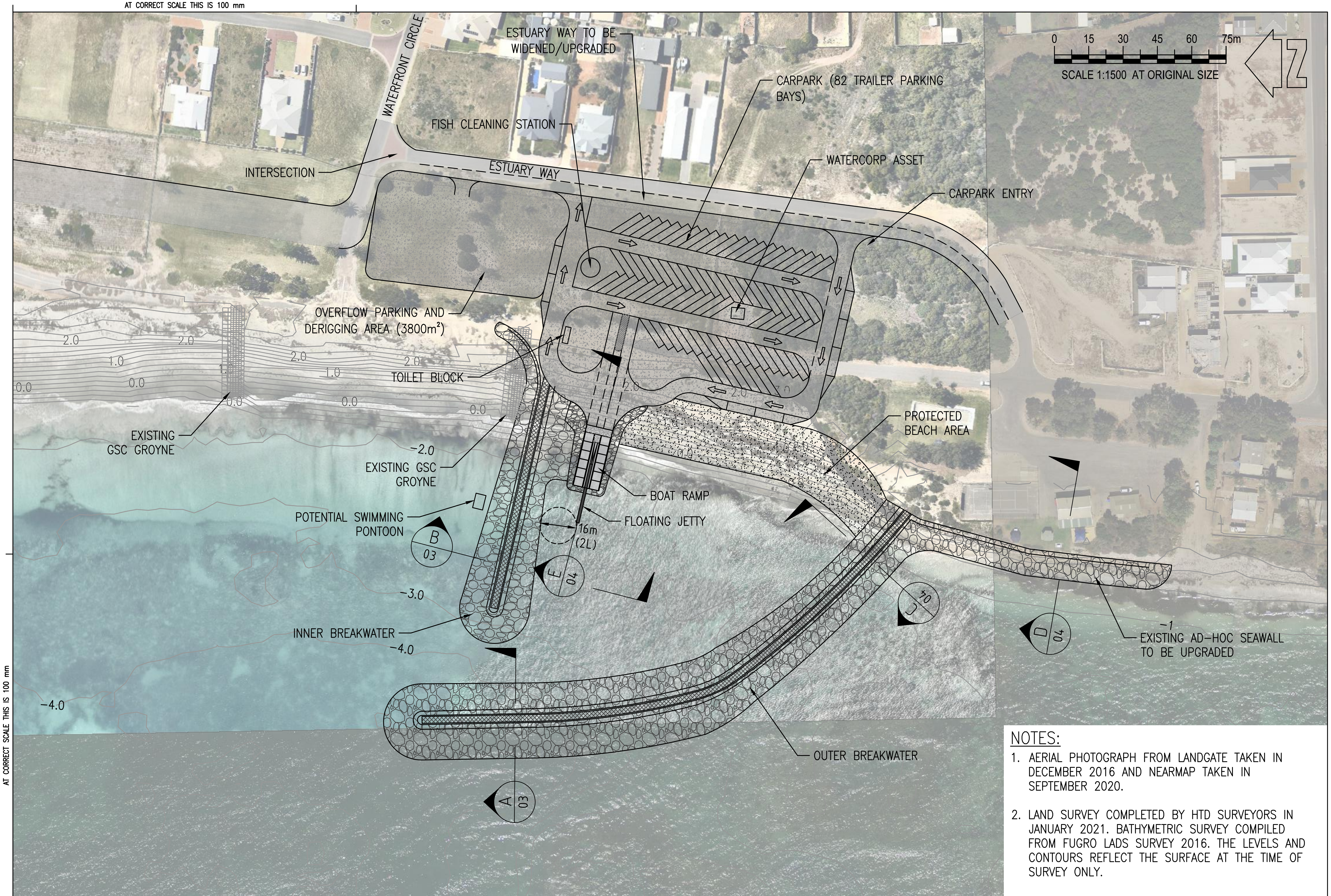

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CONCEPT LAYOUT

DRUMMOND COVE – BOAT LAUNCHING FACILITY

SCALE AT A3 1:1,500

FEBRUARY 2021

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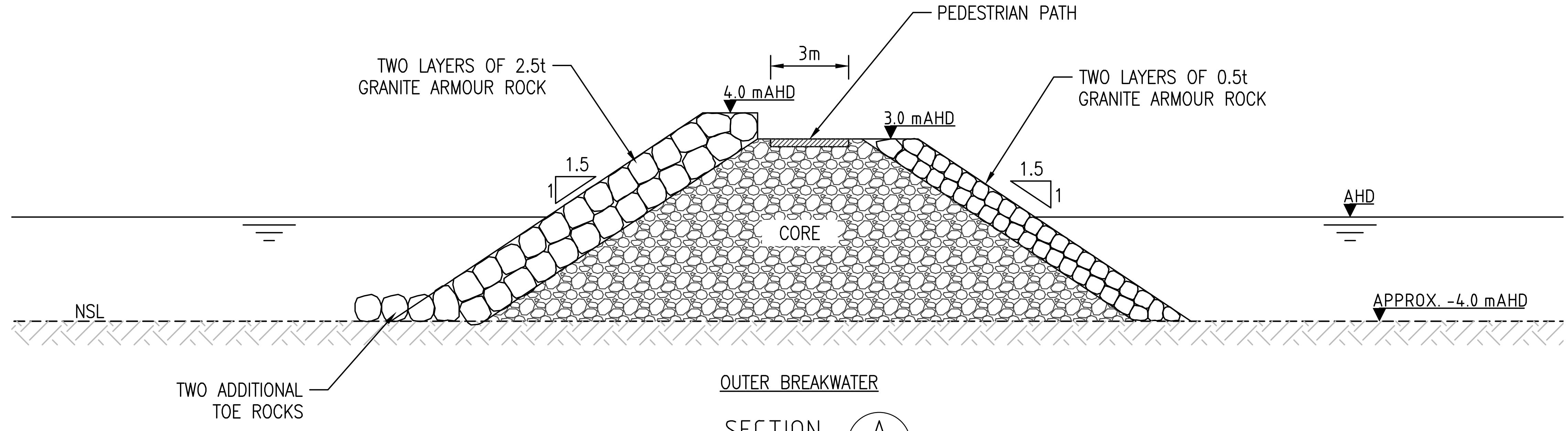

OUTER BREAKWATER

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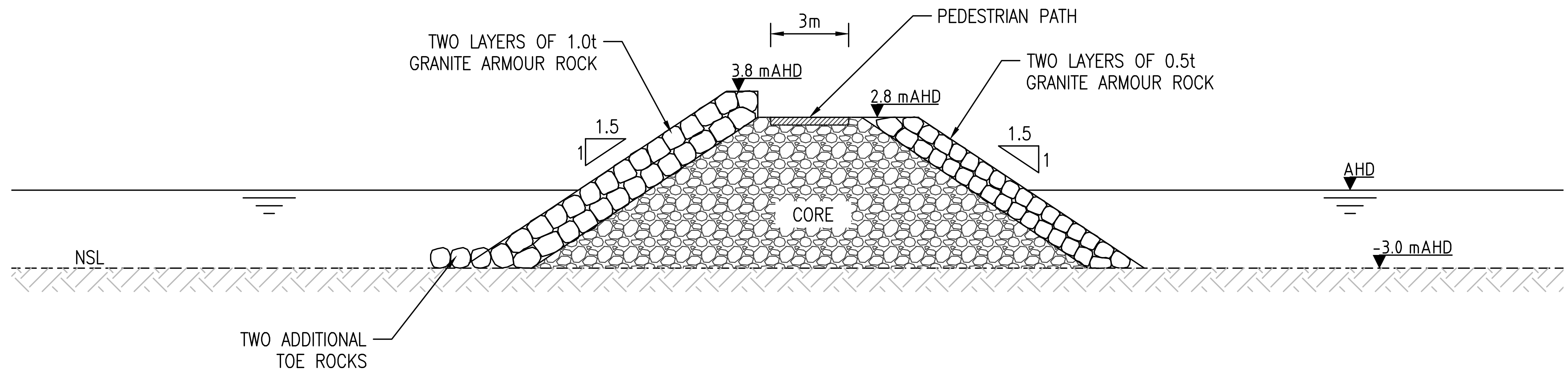

INNER BREAKWATER

SECTION B 02
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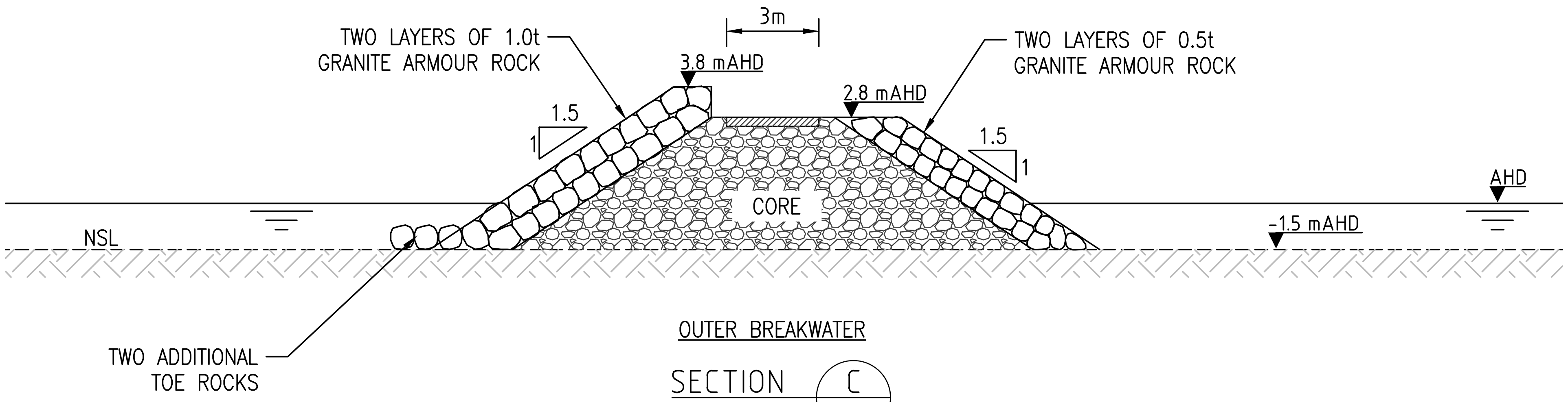

OUTER BREAKWATER

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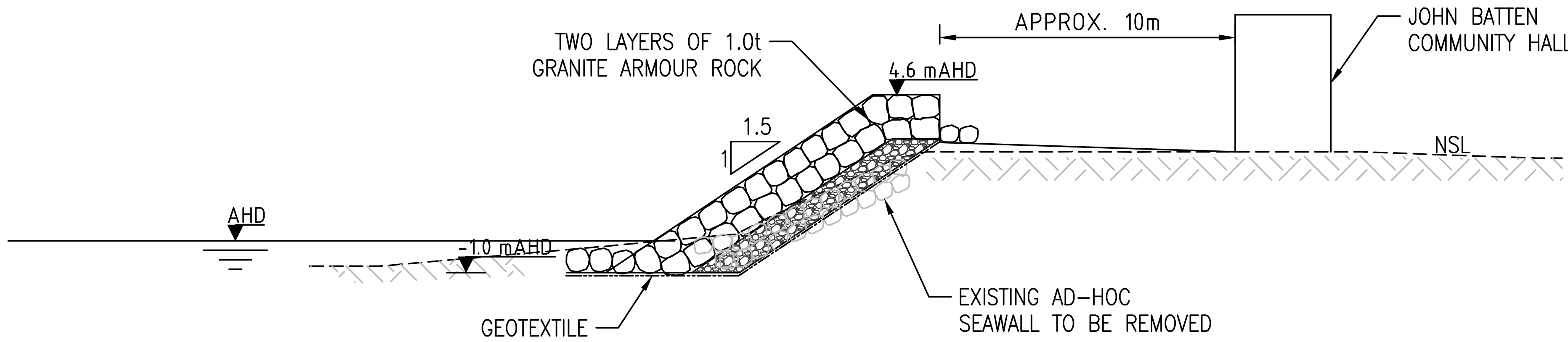

SEAWALL UPGRADE

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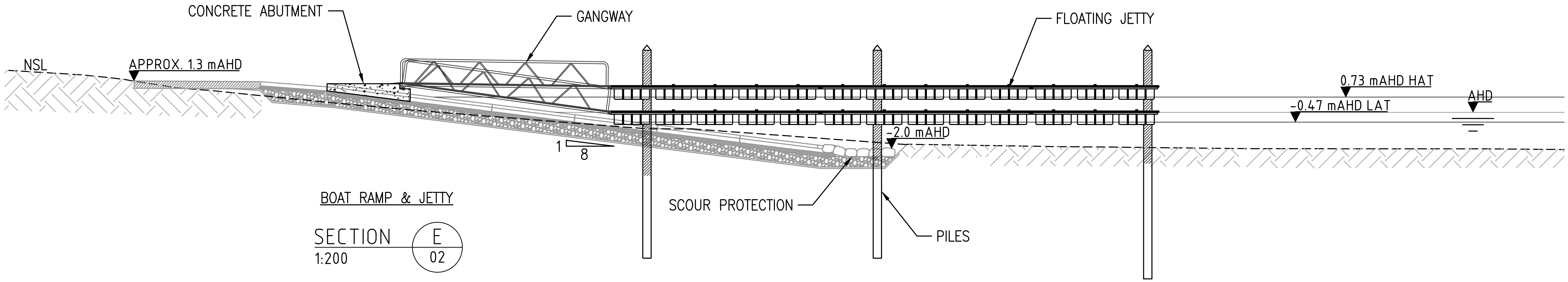

BOAT RAMP & JETTY

SECTION E 02
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