International Coastal Management

Coastal Assessment Report

Coastal Protection Works at SP677 "Shipmates", Pittwater Road, Collaroy

Prepared for

Shipmates Body Corporate

By

International Coastal Management

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Table of Contents

1. INTRODUCTION

1.1. SITE LOCATION

The site is located at 1122 Pittwater Road, Collaroy, NSW and is referred to as “Shipmates”. The site is within the local government area of the Northern Beaches Council. The proposed works are contained fully within the RP boundary of the Shipmates, SP677 (Figure 1).

Figure 1. Location of site SP677 “Shipmates”

1.2. BACKGROUND

A rock seawall has been in place at Shipmates since 1967 and has seen multiple storm events. The seawall is a terminal structure, becoming exposed under storm conditions and then buried again as the Collaroy Beach recovers. The seawall became fully exposed during the 2016 storms and has since become mostly buried.

The existing seawall has a relatively flat slope of 1v:3h and sandstone boulders up to ½ ton in weight.

The Northern Beaches Council has endorsed a Coastal Zone Management Plan (CZMP) and provided a document of required specifications (CZMP Specifications) for coastal protection requirements for proposed developments in the region: *Collaroy – Narrabeen Coastal Protection Works Design Specifications*.

1.3. PURPOSE OF REPORT

This report provides supporting information for the Development Application as outlined in the Northern Beaches Guideline for Preparing Coastal Assessment Report.

This report outlines how the proposed design is in accordance with the *Collaroy – Narrabeen Beach Coastal Protection Works Design Specifications* and is designed for specific site conditions by a specialist coastal engineer.

The proposed design has consideration for the following legislation and policy relating to coastal protection works:

- Coastal Management Act 2016
- Environment Planning & Assessment Act 1979
- Warringah Local Environmental Plan 2011
- State Environmental Planning Policy 2018
- Warringah Development Control Plan
- Northern Beaches Coastal Erosion Policy
- Collaroy-Narrabeen Coastal Zone Management Plan Specifications

1.4. METHODOLOGY

Whilst the basis of design is to provide conformance to the CZMP Specifications, site specific elements such as toe foundation, structure footprint and tie-ins are site specific and require detailed design to ensure that the structure is fit for purpose and constructible.

Design steps:

- Define basis of design
- Define site conditions
- Design seawall based on empirical equations, best practice guidelines (including Rock Manual) and conformance requirements for the CZMP.
- Statutory requirements review.

2. BASIS OF DESIGN

2.1. DESIGN OBJECTIVE AND CONSTRAINTS

The objective of the seawall at Shipmates is to:

- Protect infrastructure and services from erosion (Shipmates, Pittwater Road)
- Protect adjacent infrastructure from flanking failure (Ramsay Street End, Flight Deck)
- Reduce scour and damage as a result of overtopping.
- Provide adequate drainage (associated with the seawall structure).
- Maintain public access along foreshore.
- Achieve current coastal design standards.
- Meet environmental and legislative requirements.
- Minimise whole of life costs (including capital, future adaptation and maintenance costs).

2.2. DESIGN LIFE & DESIGN EVENT

In accordance with the CZMP Specifications, and best practice for coastal infrastructure in Australia, a 60-year design life is nominated for the seawall. With suitable maintenance (restacking of rocks after damage), the design life may in fact be extended much longer than 60 years.

The selection of a 60 year design life provides a timeframe to assess potential climate change impacts on site conditions.

Design event: 1% AEP (100-year ARI)

Design life: 2079 (60 years)

3. SITE CONDITIONS

3.1. BATHYMETRY

The site is situated on the East Coast of Australia with exposure to the South Pacific Ocean directly to the east (Figure 2). Due to the shape of the coastline there is some protection to predominant south-easterly swell.

The beach width at the site is variable, with erosion events followed by periods of accretion. The beach width in May 2019 is approximately 50m (Figure 3).

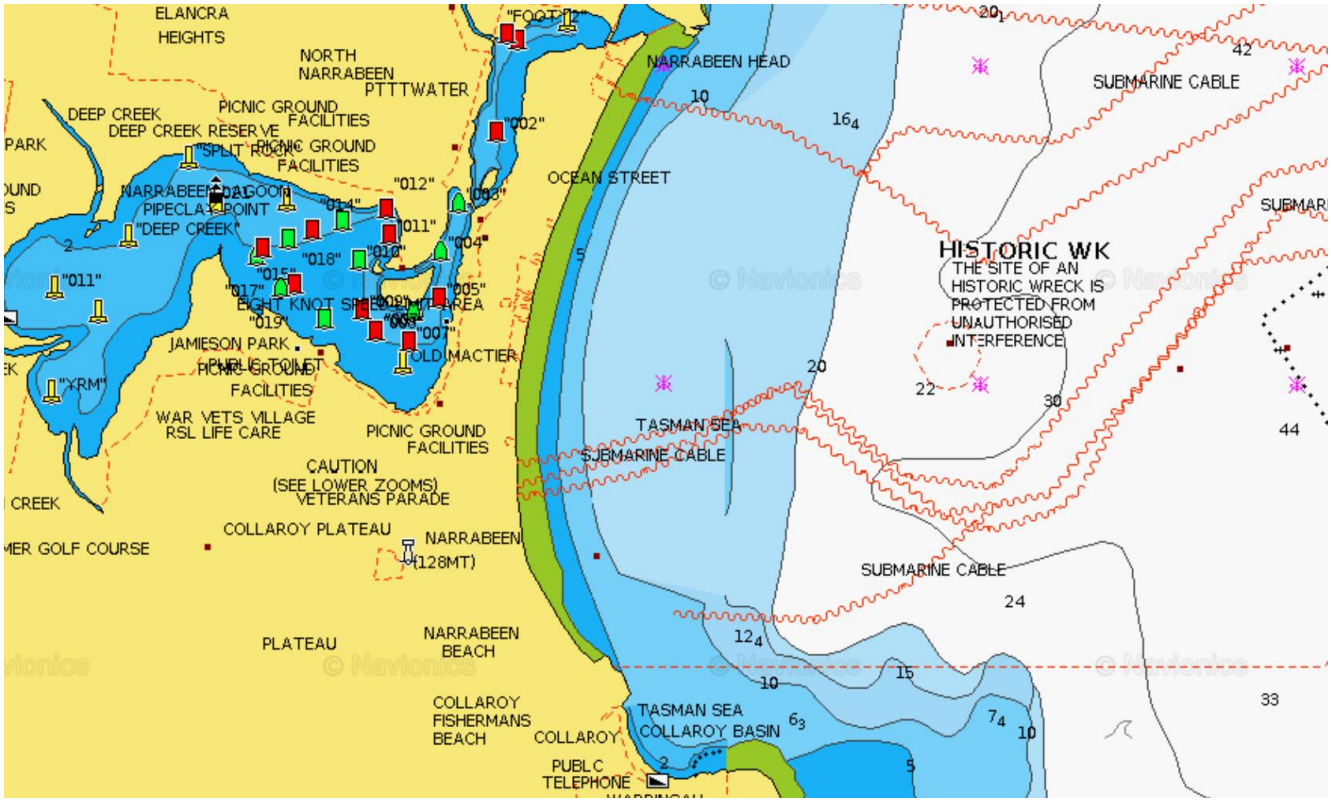

Figure 2: Collaroy / Narrabeen Beach Bathymetry (Navionics, 2019)

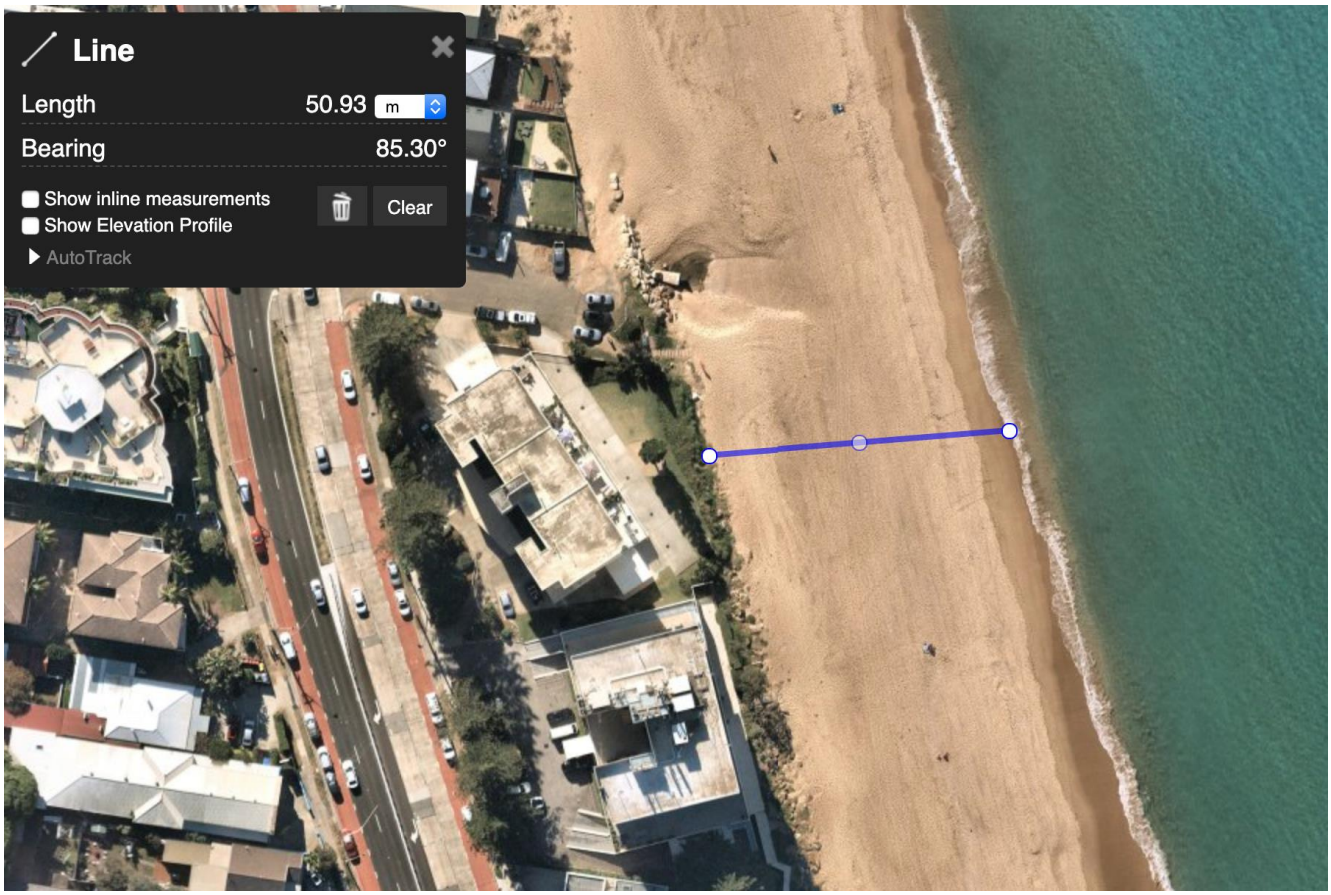

Figure 3. Approximately 50m wide beach 14 May 2019 (Source: Nearmap.com.au)

3.2. GEOTECHNICAL INVESTIGATION

A geotechnical investigation was undertaken by Crozier Geotechnical Consultants in April 2018. The investigation involved:

- A geotechnical inspection and mapping of the site and adjacent properties by a Principal Engineering Geologist.
- Drilling of two boreholes using hand tools along with Dynamic Penetrometer (DCP) testing to investigate the subsurface geology.
- Collection of a beach sand sample for determination of particle size distribution.

Based on the field borehole logs and DCP test results the subsurface conditions at the project site are typical of the region with Particle Size Distribution indicating a D_{50} of 0.4mm and the sediment classified as follows:

> ***SAND*** *– very loose from surface to approximately 0.75m depth then medium dense, becoming very dense below 1.35 to 2.40m depth (approximate R.L. 0.0 to 1.0). The sand is medium grained, subrounded quartz sand with extensive shell fragments and occasional carbonate cemented bands.*

It was also noted that other investigations undertaken in near proximity to the site were found to have:

… loose to medium dense sand from surface to approximately 4.0m depth (R.L. 1.8 to R.L. 1.0) where dense to very dense (potentially cemented) sand, was encountered extending to at least R.L. -1.0.

DCP results could be indicative to cemented sands possibly extending up to RL0.0 to +1.0m AHD.

3.3. WATER LEVELS

3.3.1. Tides

Tidal planes are expected to be similar to those derived by Manly Hydraulic Laboratory for Port Jackson (Table 1).

Table 1: Tidal Plane Northern Beaches, NSW (Source: MHL, 2012)

Tidal Plane	Level (m AHD)
High High Water Spring Solstice	0.926
Mean High Water Springs	0.578
Mean High Water Neaps	0.332
Australian Height Datum	0.000
Mean Low Water Neaps	-0.430
Mean Low Water Springs	-0.676
Indian Springs Low Water	-0.925

3.3.2. Storm Surge

Offshore storm surge is estimated to be +2.06m AHD (including 0.55m allowance for Sea Level Rise in 2079) (DECCW, 2010).

3.4. WAVE HEIGHT AND PERIOD

3.4.1. Offshore Conditions

Design conditions for a 100 year ARI are shown in Figure 4 and Table 2. Allowance has been made for a 10% increase of intensity associated with climate change.

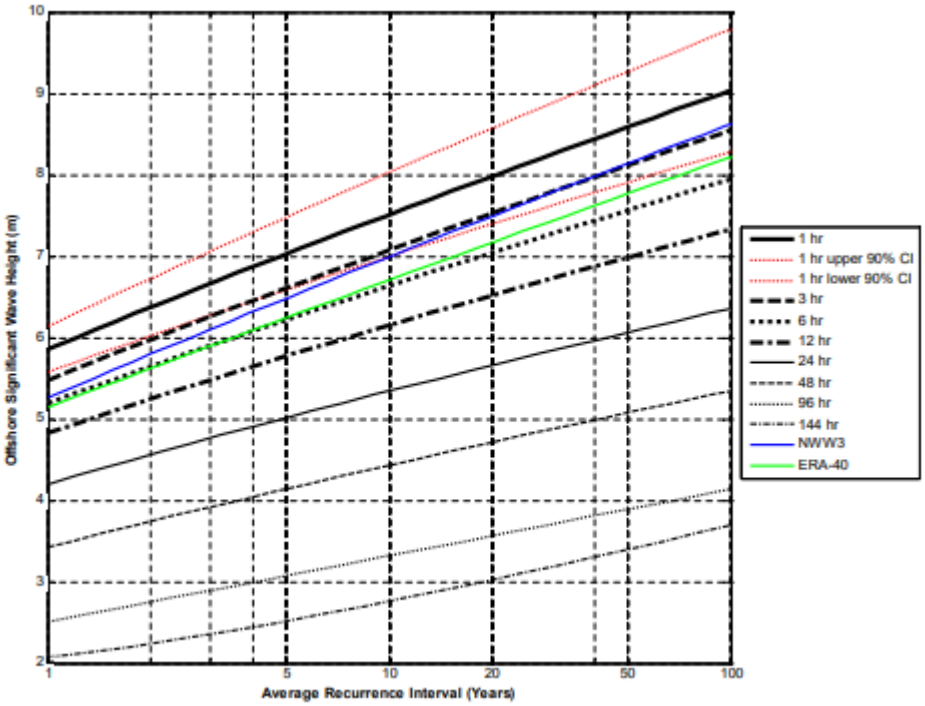

Figure 4: Offshore Significant Wave Height, Sydney (WRL, 2011)

Table 2: Offshore Wave Conditions

Parameter	100year ARI in 2019	100year ARI in 2079
Significant Wave Height, Hs (m)	9.0m	9.9m
Peak Wave Period, Tp (sec)	12s	12s

3.4.2. Nearshore Conditions

Wave height at the structure is effectively depth-limited. The conditions at the structure have been determined using the numerical model SBEACH (Storm-induced Beach Change Model) developed by the United States Army Corps of Engineers to simulate cross-shore beach, berm and dune erosion produced by storm waves and water levels. Modelling assumes erosion down to -1m AHD, as is typically adopted for NSW coastlines. Results of modelling are shown in Figure 5 & Table 3.

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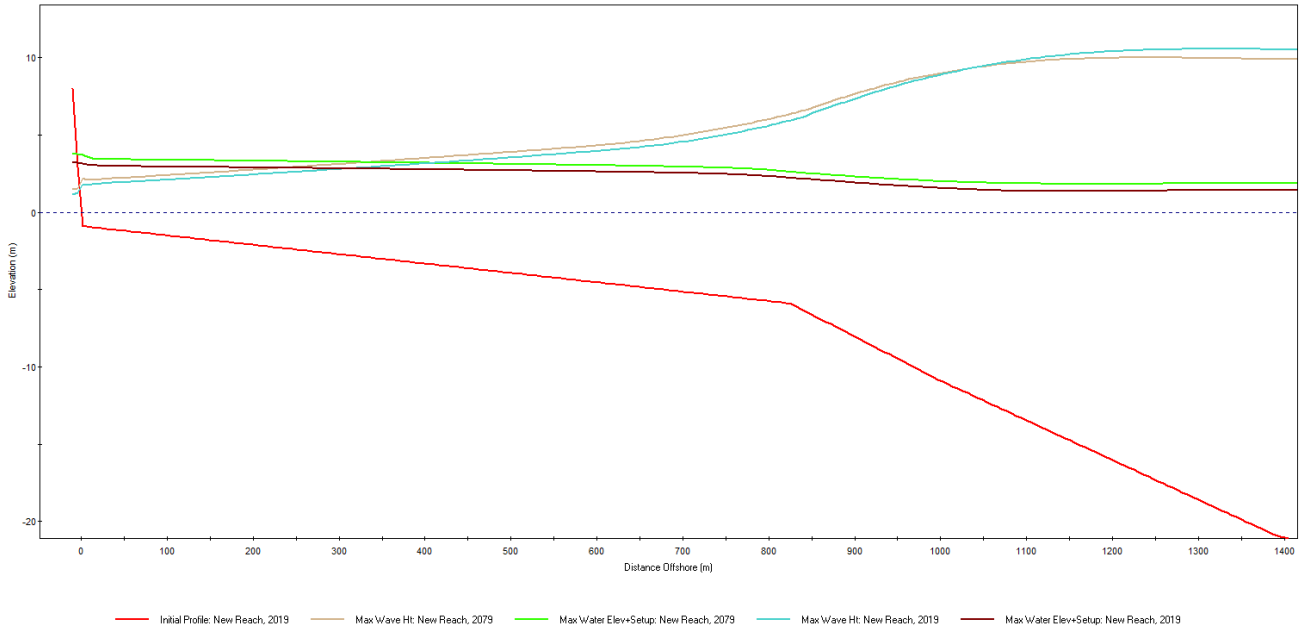

Figure 5: SBEACH model

Table 3: Nearshore Wave Conditions

Parameter	100 year ARI in 2019	100 year ARI in 2079
Water level (m AHD)	3.0m	3.5m
Significant Wave Height, Hs (m)	1.8m	2.0m
Peak Wave Period, Tp (sec)	12s	12s

4. SEAWALL DETAILED DESIGN

4.1. ARMOUR

Hydraulic stability has been assessed using Van Der Meer shallow water equations for the wave conditions incident on the structure (section 3.4.2). The required grading for stability is outlined in Table 4 for the recommended use of igneous rock and Table 5 for the optional use of sandstone boulders as an alternate. Calculations are provided in Appendix B. A standard 2-layer configuration has been adopted. This results in minimal damage during a design event (indicating displacement of <5% of boulders).

The sizing of the secondary armour layer has been determined in accordance with Rock Manual to achieve internal stability. A geotextile filter has been included to ensure internal stability of the sand fill behind the seawall.

Table 4: Armour Grade for Hydraulic Stability (Igneous Armour; density = 2.65t/m3)

	Primary	Secondary	
D_{n15}	1.01	0.43	m
D_{n50}	**1.13**	**0.52**	m
D_{n85}	1.20	0.59	m
M_{15}	2.84	0.21	Tonnes
M_{50}	3.80	0.38	Tonnes
M_{85}	4.82	0.56	Tonnes
Layer thickness (perpendicular to slope)	2.06	0.96	m
Layer thickness (horizontal)	3.71	1.72	m

Table 5: Armour Grade for Hydraulic Stability (Sandstone Armour; density = 2.30t/m3)

	Primary	Secondary	
D_{n15}	1.31	0.55	m
D_{n50}	**1.45**	**0.67**	m
D_{n85}	1.56	0.76	m
M_{15}	5.22	0.38	Tonnes
M_{50}	7.00	0.70	Tonnes
M_{85}	8.66	1.02	Tonnes
Layer thickness (perpendicular to slope)	2.62	1.22	m
Layer thickness (horizontal)	4.73	2.19	m

4.2. TOE LEVEL & DETAIL

In accordance with the CZMP, a minimum toe depth of -1.0m AHD has been adopted.

It is also noted in the CZMP that, "cemented sand layers are known to exist at locations along Collaroy-Narrabeen Beach at levels above -1m AHD and provide a suitable foundation for rock seawalls." This is consistent with the site geotechnical investigations (section 3.2) which identified "very dense" (possibly cemented) sands between RL 0.0m and +1.0m AHD. In cases where cemented sands are exposed, the design allows for the toe to be founded on this material where deemed suitable by engineer on site.

4.3. CREST LEVEL & DETAIL

The adopted crest level has been taken as being approximately level with the natural surface level at the front of the seawall (RL 5.5m AHD).

Predicted overtopping for the design event (Table 6) has been determined based on EurOtop. These values indicate that:

- Area landward of seawall is not safely accessible by pedestrians during design events. Access is to be restricted.
- Scour of grassed areas may be observed, particularly toward the end of the structure's design life and in instances where grass is not well maintained (typically occurs between 0.1L/m/s – 100 L/m/s depending on condition of the grass).
- No damage to concrete slab/driveway expected (typically occurs at 200L/s/m).

Table 6: Mean overtopping discharge at seaward edge of concrete path (L/s/m)

Crest Level	Mean Discharge 2019 (L/s/m)	Mean Discharge 2079 (L/s/m)
5.5m AHD	1.4	32

4.4. SLOPE

The slope of the front face of the seawall has been adopted as 1V:1.5H. This is to minimise the footprint of the seawall while retaining stability. This is the maximum steepness in accordance with the CZMP.

4.5. ALIGNMENT & EXTENT

The seawall alignment is controlled by the alignment of the toe (at -1m AHD) along the seaward property boundary (Figure 6). To the north, the alignment is controlled by a "smooth transition" (Figure 6) into the adjacent seawall is in accordance with the CZMP (Figure 7).

The seawall extent is from the southern RP boundary to the point where the seawall crest intersects with the northern RP boundary (Ch 29.3 in Figure 6). Tie in works to be undertaken concurrently with lower

section of wall by Council (blue section/ separate approval). This will allow the entire seawall to meet the seawall specification (Collaroy- Narrabeen Beach Coastal Protection Works Design Specifications 2016 and as detailed in the drawings). If not achievable, tie-in works will need to integrate with the base of the existing wall within property boundary (alignment may need to be modified on site). Integrity of this section of seawall would be significantly compromised and reconstruction would be required concurrent with future Council upgrades to achieve the required standard. (Figure 6).

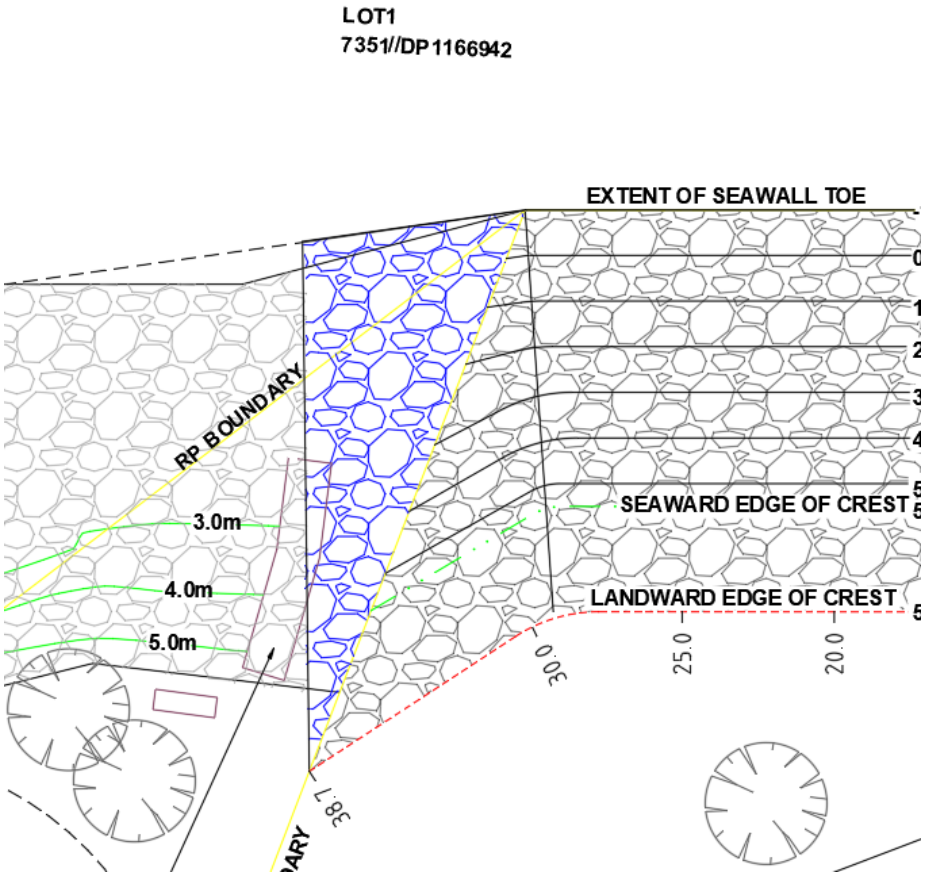

Figure 6: Tie-in works on northern boundary

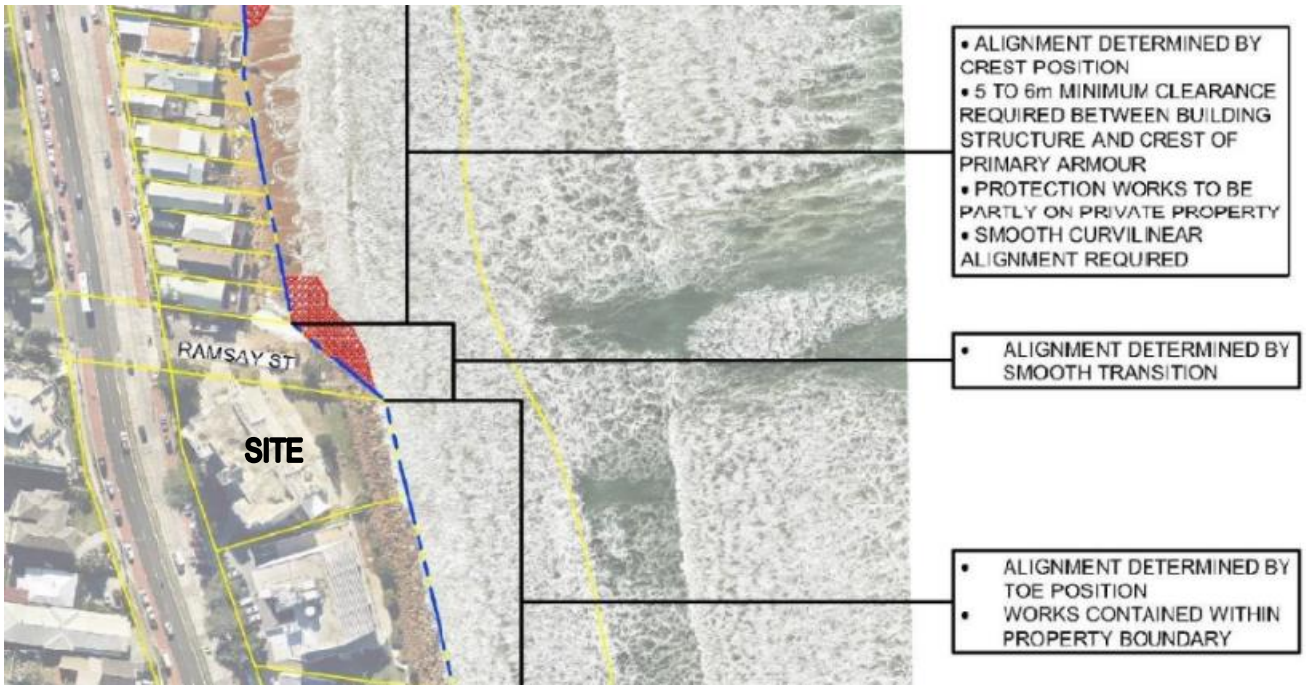

Figure 7: CZMP specification

4.6. DETAILED DESIGN DRAWINGS

Detailed design drawings have been prepared and are included in Appendix A.

5. COST ESTIMATE

An estimate of construction costs is shown in Table 7.

Costs are for a seawall founded to -1.0m AHD; however it is expected that toe level may be able to be raised due to the presence of cemented sand (section 3.2) and therefore quantities and costs will reduce. If cemented sand is found at RL0m AHD, costs could be reduced by approximately $80,000 inc GST.

Costs are for use of Igneous / Metamorphic rock design and quantities (minimum density SG = 2.65t/m3); however if the use of sandstone as primary armour is preferred, material quantities and rates will need to be adjusted accordingly (section 4.1).

Table 7: Estimate of Construction Costs

Cost Estimate						
Item	Description	Units	Qty	Rate (ex-GST)	Cost (ex-GST)	Cost (incl GST)
1	Establishment / Disestablishment	Item	1	$ 25,000.00	$ 25,000.00	$ 27,500.00
2	Traffic management	Item	1	$ 10,000.00	$ 10,000.00	$ 11,000.00
3	Excavation (including dewatering)	m^3	1217	$ 50.00	$ 60,850.00	$ 66,935.00
4	Supply Geotextile Filter	m^2	960	$ 7.00	$ 6,720.00	$ 7,392.00
5	Install Geotextile Filter	m^2	960	$ 15.00	$ 14,400.00	$ 15,840.00
6	Supply Primary Armour Rock	m^3	898	$ 190.00	$ 170,620.00	$ 187,682.00
7	Supply Secondary Armour Rock	m^3	331	$ 190.00	$ 62,890.00	$ 69,179.00
8	Install Armour	m^3	1229	$ 40.00	$ 49,160.00	$ 54,076.00
9	Rehandling of existing armourstone	m^3	494	$ 40.00	$ 19,760.00	$ 21,736.00
10	Reprofile (including flushing sand into seawall)	Item	1	$ 20,000.00	$ 20,000.00	$ 22,000.00
11	Dune Revegetation	Item	1	$ 15,000.00	$ 15,000.00	$ 16,500.00
12	Reinstate stairs	Item	1	$ 20,000.00	$ 20,000.00	$ 22,000.00
TOTAL					$ 474,400.00	$ 521,840.00

Notes

1. Estimate includes construction costs only. No allowance for approvals.
2. Supply rates (Item 6 & 7) after Quarry investigation. *Oberon Quarry* providing best quotation.
3. Savings resulting from the use of existing sandstone on site as secondary armour (Item 7) is dependent on volume of sandstone recovered, but is estimated to be up to ~$70,000 inc GST, allowing for rehandling).
4. If permits do not allow reconstruction outside private property using imported materials, seawall will be more vulnerable to damage during major events. Corresponding cost savings estimated at $25,000 incl GST.
5. Assuming no cost for dispossal of any excess rock.

6. STATUTORY REQUIREMENTS

6.1. STATE ENVIRONMENTAL PLANNING POLICY 2018

6.1.1. Clause 13

SEPP 2018 Clause 13 states:

Development on land within the coastal environment area

(1) Development consent must not be granted to development on land that is within the coastal environment area unless the consent authority has considered whether the proposed development is likely to cause an adverse impact on the following:

(a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,

(b) coastal environmental values and natural coastal processes,

(c) the water quality of the marine estate (within the meaning of the Marine Estate Management Act 2014), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,

(d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,

(e) existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,

(f) Aboriginal cultural heritage, practices and places,

(g) the use of the surf zone.

(2) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

(a) the development is designed, sited and will be managed to avoid an adverse impact referred to in subclause (1), or

(b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or

(c) if that impact cannot be minimised—the development will be managed to mitigate that impact.

Assessment in relation to SEPP 2018 Clause 13:

1)

a) The proposed works will not increase adverse impacts on the biophysical, hydrological or ecological environment compared to the existing rock seawall protecting the site. The proposed works are constructed using clean rock materials. As they do not extend above natural surface level and existing adjacent walls, they will not impact on drainage patterns. While they extend slightly below the groundwater table, they are permeable.

b) The nature, function and footprint of the works relative to the sandy beach is essentially the same as the existing seawall (or within nominated tolerances). As such, the proposed works will not increase impacts on coastal environmental values and natural processes compared to the existing seawall. The design and alignment is in accordance with the CZMP.
c) The proposed works are only expected to be partially within the marine estate during significant storm events. The works will be constructed of clean rock materials and will not increase impacts on the marine estate compared to the existing seawall. Sensitive coastal lakes are not in close proximity to the works and will not be impacted.
d) Assessed separately.
e) The proposed works will be within private property and the nature of the works is the same as the existing seawall. As such, the works will result in the public foreshore achieving the same public open space and safe access to and along the foreshore as the existing seawall.
f) Assessed separately.
g) Usage of the surf zone is not expected to change in response to the proposed upgrade of the existing seawall.

2) The development is designed, sited and will be managed in accordance with the recommendations in the CZMP being largely consistent with the existing seawall and within private property. This results in avoidance of adverse impacts as outlined above.

6.1.2. Clause 14

SEPP 2018 Clause 14 states:

(1) Development consent must not be granted to development on land that is within the coastal use area unless the consent authority:

(a) has considered whether the proposed development is likely to cause an adverse impact on the following:

(i) existing, safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,

(ii) overshadowing, wind funnelling and the loss of views from public places to foreshores,

(iii) the visual amenity and scenic qualities of the coast, including coastal headlands,

(iv) Aboriginal cultural heritage, practices and places,

(v) cultural and built environment heritage, and

(b) is satisfied that:

(i) the development is designed, sited and will be managed to avoid an adverse impact referred to in paragraph (a), or

(ii) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or

(iii) if that impact cannot be minimised—the development will be managed to mitigate that impact, and

(c) has taken into account the surrounding coastal and built environment, and the bulk, scale and size of the proposed development.

Assessment in relation to SEPP 2018 Clause 14(1) of SEPP 2018:

a)

(i) Existing access will not be adversely impacted as per 13(1)(e) above.

(ii) The works are upgrading of existing works in the same location and will not increase impacts on overshadowing, wind funnelling and the loss of views from public places to foreshores.

(iii) The works are upgrading of existing works in the same location and will not increase impacts on visual amenity and scenic qualities of the coast.

(iv) Assessed separately.

(v) Assessed separately.

b) The development is designed, sited and will be managed to avoid an adverse impact referred to in paragraph (a).

6.1.3. Clause 15

SEPP 2018 Clause 15 states:

Development consent must not be granted to development on land within the coastal zone unless the consent authority is satisfied that the proposed development is not likely to cause increased risk of coastal hazards on that land or other land.

Assessment in relation to SEPP 2018 Clause 15:

The proposed works at Shipmates are an upgrade to an existing seawall to a "consistent design standard that provides an appropriate level of protection" as per the objective of the certified CZMP (2016) and acts as a short section of what is effectively a much longer continuous erosion protection seawall. As such, the proposed development is not likely to cause an increased risk of coastal hazards on the private property or other land compared to the existing seawall.

6.1.4. Clause 16

SEPP 2018 Clause 16 states:

Development consent must not be granted to development on land within the coastal zone unless the consent authority has taken into consideration the relevant provisions of any certified coastal management program that applies to the land.

Assessment in relation to SEPP 2018 Clause 16:

The *Collaroy-Narrabeen Coastal Zone Management Plan (December 2016)* is a certified coastal management plan in accordance with the Coastal Management Act 2016. The proposed works are designed by a qualified coastal engineer in accordance with this certified CZMP.

6.1.5. Clause 19

SEPP 2018 Clause 19 states:

> *(1) Coastal protection works by person other than public authority. Development for the purpose of coastal protection works may be carried out on land to which this Policy applies by a person other than a public authority only with development consent.*

Assessment in relation to SEPP 2018 Clause 19(1) of SEPP 2018:

The applicant for the proposed coastal protection works is not a public authority and the works are within private property. The proposed works are considered permissible to be undertaken with development consent.

6.2. WARRINGAH LOCAL ENVIRONMENTAL PLAN 2011

6.2.1. Clause 5.5

Warringah LEP 2011 Clause 5.5(2) states:

> *Development within the coastal zone*
>
> *(2) Development consent must not be granted to development on land that is wholly or partly within the coastal zone unless the consent authority has considered:*
>
> *(a) existing public access to and along the coastal foreshore for pedestrians (including persons with a disability) with a view to: (i) maintaining existing public access and, where possible, improving that access, and (ii) identifying opportunities for new public access, and*
>
> *(b) the suitability of the proposed development, its relationship with the surrounding area and its impact on the natural scenic quality, taking into account: (i) the type of the proposed development and any associated land uses or activities (including compatibility of any land-based and water-based coastal activities), and (ii) the location, and (iii) the bulk, scale, size and overall built form design of any building or work involved, and*
>
> *(c) the impact of the proposed development on the amenity of the coastal foreshore including: (i) any significant overshadowing of the coastal foreshore, and (ii) any loss of views from a public place to the coastal foreshore, and*
>
> *(d) how the visual amenity and scenic qualities of the coast, including coastal headlands, can be protected, and*
>
> *(e) how biodiversity and ecosystems, including: (i) native coastal vegetation and existing wildlife corridors, and (ii) rock platforms, and (iii) water quality of coastal waterbodies, and (iv) native fauna and native flora, and their habitats, can be conserved, and*
>
> *(f) the cumulative impacts of the proposed development and other development on the coastal catchment.*

Assessment in relation to Warringah LEP 2011 Clause 5.5 (2):

a) The proposed works will be within private property. As such, the works will result in the public foreshore achieving the same public open space and safe access to and along the foreshore as the

existing seawall. The proposed works are within private property and creating new public access to the foreshore is not appropriate.

b) The development is considered compatible to other development in the surrounding area, forms part of a continuous boulder seawall, will be buried where practicable and will not have an adverse impact on the scenic quality when viewed from a public place compared to the existing seawall.
c) The works will not result in overshadowing of the coastal foreshore or any loss of views from a public place to the coastal foreshore area.
d) The works will not negatively impact on the visual amenity and scenic qualities of the coast compared to the existing boulder seawall.
e) Assessed separately.
f) The proposed works will not negatively impact on the coastal catchment.

Warringah LEP 2011 Clause 5.5(3) states:

(3) Development consent must not be granted to development on land that is wholly or partly within the coastal zone unless the consent authority is satisfied that:

(a) the proposed development will not impede or diminish, where practicable, the physical, land-based right of access of the public to or along the coastal foreshore, and

(b) if effluent from the development is disposed of by a non-reticulated system, it will not have a negative effect on the water quality of the sea, or any beach, estuary, coastal lake, coastal creek or other similar body of water, or a rock platform, and

(c) the proposed development will not discharge untreated stormwater into the sea, or any beach, estuary, coastal lake, coastal creek or other similar body of water, or a rock platform, and

(d) the proposed development will not:

(i) be significantly affected by coastal hazards, or

(ii) have a significant impact on coastal hazards, or

(iii) increase the risk of coastal hazards in relation to any other land.

Assessment in relation to Warringah LEP 2011 Clause 5.5 (3):

a) The proposed works will be within private property and the nature of the works is the same as the existing seawall. As such, the works will result in the public foreshore achieving the same public open space and safe access to and along the foreshore as the existing seawall.
b) Not applicable. The works are a boulder seawall.
c) Not applicable. The works are a boulder seawall.
d) (i) The works are designed to a "consistent design standard that provides an appropriate level of protection" as per the objective of the certified CZMP (2016). As such, the proposed works will not be significantly affected by coastal hazards.
(ii) As an upgrade to the existing seawall, the works will not significantly impact on coastal hazards.
(iii) The works will increase protection of private property from coastal hazards compared to the existing seawall which is of a lower standard. The proposed works are the upgrade of a short section of an existing seawall and will not result in an increase of coastal hazards to any other land.

6.2.2. Clause 6.5

Warringah LEP 2011 Clause 6.5 states:

> *(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:*
>
> *(a) will not significantly adversely affect coastal hazards, and*
>
> *(b) will not result in significant detrimental increases in coastal risks to other development or properties, and*
>
> *(c) will not significantly alter coastal hazards to the detriment of the environment, and*
>
> *(d) incorporates appropriate measures to manage risk to life from coastal risks, and*
>
> *(e) avoids or minimises exposure to coastal hazards, and*
>
> *(f) makes provision for relocation, modification or removal of the development to adapt to coastal hazards and NSW sea level rise planning benchmarks.*
>
> *(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the foundations of the development have been designed to be constructed having regard to coastal risk.*

Assessment in relation to Warringah LEP 2011 Clause 6.5:

3.
   a) As an upgrade to the existing seawall, the works will not significantly impact on coastal hazards.
   b) The works will increase protection of private property from coastal hazards compared to the existing seawall which is of a lower standard. The proposed works are the upgrade of a short section of an existing seawall and will not result in an increase of coastal hazards to any other land.
   c) Refer response (b) above.
   d) Management of risks are included in the design drawings (Appendix A) and the Safety in Design Report (Appendix C). It includes regular and post-storm inspections and maintenance as required.
   e) As erosion protection structures, they are inherently exposed to coastal hazards but act to minimise the hazard exposure of the protected area.
   f) The proposed works have considered coastal hazards & NSW sea level rise planning benchmarks in the basis of design.

4. The works have been designed to be constructed having regard to coastal risk.

6.3. WARRINGAH DEVELOPMENT CONTROL PLAN

6.3.1. Part C5 (Erosion and Sedimentation)

Warringah DCP Part C5 states:

> 1. *All developments which involve the disturbance of land must install and maintain erosion and sediment controls until the site is fully stabilised.*
> 2. *Any erosion and sedimentation is to be managed at the source.*

3. *Erosion, sediment and pollution controls including water discharge from the site must comply with Council's Water Management Policy.*
4. *An Erosion and Sediment Control Plan must be prepared in accordance with Landcom's Managing Urban Stormwater: Soil and Construction Manual (2004) for all development which involves the disturbance of up to 2500m2 of land.*
5. *Soil and Water Management Plan must be prepared in accordance with Landcom's Managing Urban Stormwater: Soil and Construction Manual (2004) for all development which involves the disturbance of more than 2500m2 of land.*

Assessment in relation to Warringah DCP Part 5C:

Sediment controls to be implemented by contractor prior to start of works. Sedimentation sources including imported materials (clean rock with no organics) and excavated materials (beach sand, existing rock). All materials to be stockpiled primarily within private property. Any rock fragments to be removed and all sand sieved to 20mm prior to backfill as per Drawing: General Notes SSW-00.

6.3.2. Part E9 (Coastline Hazard)

Warringah DCP Part E9 states:

1. *The risk of damage from coastal processes is to be reduced through having appropriate setbacks and foundations, as detailed in Criteria for the Siting and Design of Foundations for Residential Development (see Policy volume).*
2. *For development in the area affected by the certified Coastal Zone Management Plan for Collaroy-Narrabeen Beach and Fishermans Beach (Coastal Zone Management Plan), the applicant must demonstrate compliance with the Northern Beaches Coastal Erosion Policy, the Coastal Zone Management Plan and the Collaroy-Narrabeen Protection Works Design Specifications (as amended from time to time).*

Assessment in relation to Warringah DCP Part E9:

The risk of damage from coastal processes has been reduced to an acceptable level in line with the Collaroy – Narrabeen CZMP. The works are compliant with the Collaroy – Narrabeen CZMP.

6.4. NORTHERN BEACHES COASTAL EROSION POLICY

In preparing this Development Application, due consideration has been given to relevant sections of the Northern Beaches Coastal Erosion Policy.

- The proposed protective works are considered in accordance with the CZMP for Collaroy-Narrabeen Beach.
- The public beachfront amenity in this precinct has been maintained and protected as a result of the proposed works.
- The subject property owner of Shipmates has accepted the responsibility for carrying out works on private property. Clarification is sought regarding the responsibility for the section of seawall on public lands (i.e. the blue area in Figure 6). It is strongly recommended that these works be undertaken concurrently with the seawall construction to provide the required level of protection, regardless of determination of responsibility.
- The proposed works are an upgrade to an existing seawall and are within private and do not have any adverse impact upon beachfront, beachfront assets or nearby beaches.
- Designing and Siting Protection Works. The works at Shipmates have been designed by International Coastal Management in accordance with the CZMP specifications.
- Alignment of Protection Works. In accordance with the certified CZMP, the applicant's property falls within area 2 (Collaroy to Narrabeen – Devitt St). The recommendations for area 2 is that all works are to be carried out within private property. Any protection works are to be constructed to a consistent satisfactory design standard and a continuous overall alignment as agreed to with Council. It is submitted that the proposed protective works meet the relevant criteria and in particular the preferred alignment.

- Approval Process for Protection Works. The proposed new protection works have addressed the requirements of all relevant legislation, guidelines and policies. In accordance with the policy, a technical report addressing the relevant Collaroy-Narrabeen Protection Works guidelines have been duly considered and where relevant have been addressed in this report.
- Funding. In accordance with Clause 8(a) of the policy, the protection works have been designed, constructed within the confines of the subject property and the owners of the land have met all relevant expenses pertaining to the preparation of the Development Application and technical data and also the future costs associated with the construction of the protective works in conjunction with the existing built structures.
- Maintenance of Protective Works. The applicants acknowledge the responsibility of ensuring that the proposed protection works are maintained in a manner that safeguards the ongoing level of design performance.

6.5. COASTAL MANAGEMENT ACT 2016

6.5.1. Section 27

Coastal Management Act Section 27 states:

> *(1) Development consent must not be granted under the Environmental Planning and Assessment Act 1979 to development for the purpose of coastal protection works, unless the consent authority is satisfied that:*
>
> > *(a) the works will not, over the life of the works: (i) unreasonably limit or be likely to unreasonably limit public access to or the use of a beach or headland, or (ii) pose or be likely to pose a threat to public safety, and*
> >
> > *(b) satisfactory arrangements have been made (by conditions imposed on the consent) for the following for the life of the works: (i) the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by the presence of the works, (ii) the maintenance of the works.*

Assessment in relation to Coastal Protection Act 2016 Section 27 (1):

a) (i) The proposed works will be within private property and the nature of the works is the same as the existing seawall. As such, the works will result in the public foreshore achieving the same public open space and safe access to and along the foreshore as the existing seawall.
(ii) The works are for the upgrade of the existing seawall to a higher standard and, being more stable under design conditions will result in an improvement to public safety after storm events. Maintenance is to be undertaken as required by the property owner.

b) At the end of the design life of the works, a design review is to be undertaken to facilitate any design adaptation required in response to actual and forecast climate change. The proposed works are upgrade of an existing structure that forms part of a much longer erosion protection strategy that is in accordance with the adopted CZMP. As such, increased impacts associated with these works are not likely and further conditions on the consent are not anticipated to be required. Maintenance of the works as required is already included as part of the design requirements, but could also be included in the consent conditions if desired.

7. REFERENCES

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Appendix A. **ICM DRAWINGS**

Appendix B. **STABILITY CALCULATIONS**

International Coastal Management

Boulder Wall Design Worksheet

PROJECT	Shipmates - Igneous Armour Design	Date	25-07-19

Adopted Design Conditions at Structure

Design Year & Event	2079	100	year ARI
Wave height at structure	H_S	2.00	m
	$H_{2\%}$	2.80	m
Critical wave period	T_{cr}	*8.3*	*sec*
Critical Iribarren number	$\varepsilon_{cr:}$	*4.87*	-
Adopted wave period	$T_{m-1,0}$	12.0	sec
Adopted Iribarren number	$\varepsilon_{s-1,0:}$	7.07	-
Breaker Type		Surging	-
Density of Seawater	ρ_{WATER}	1.024	t/m^3

Structure Characteristics

		Primary	Secondary	-
Density of Rock	ρ_{ROCK}	2.650	2.650	t/m^3
Relative Buoyant Density of Roc	Δ	1.59	1.59	-
Grade Description		Uniform	Narrow	-
Grade Ratio	D_{85}/D_{15} <	1.7	2.7	-
No. of Layers	n	2	2	-
Layer thickness co-efficient	k_t	0.91	0.91	-
Seawall Slope (1V: ?? H)	cot α	1.5	1.5	-
Layer (void) porosity	n_v	25%	25%	

Van Der Meer Shallow Water Equations

Equation 1: Van Der Meer shallow water formula for plunging waves ($\xi_{s-1,0} < \xi_{cr}$) (CIRIA, 2007)

$$\frac{H_s}{\Delta D_{n50}} = c_{pl} P^{0.18} \left(\frac{S_d}{\sqrt{N}}\right)^{0.2} \left(\frac{H_s}{H_{2\%}}\right) \left(\xi_{s-1,0}\right)^{-0.5}$$

Equation 2: Van Der Meer shallow water formula for surging waves ($\xi_{s-1,0} > \xi_{cr}$) (CIRIA, 2007)

$$\frac{H_s}{\Delta D_{n50}} = c_s P^{-0.13} \left(\frac{S_d}{\sqrt{N}}\right)^{0.2} \left(\frac{H_s}{H_{2\%}}\right) \sqrt{\cot\alpha} \left(\xi_{s-1,0}\right)^{P}$$

Input Parameters & Output

Storm Duration (No. of Waves)	N	692	-
Storm Duration		2.31	hrs
Acceptable Damage Level	S_d	2.0	-
Notional permeability	P	0.10	-
Breaker coefficients	C_{PL}	8.4	-
MEAN BEST FIT	C_S	1.3	-
Min Nominal Diameter (plunging)	D_{n50}	1.41	m
Min Nominal Diameter (surging)	D_{n50}	1.13	m
Primary Armour Nominal Diameter (Min)	**D_{n50}**	**1.13**	**m**
Primary Armour Weight (Min)	**M_{50}**	**3.83**	**tonne**

Adopted Nominal Diameter & Grade

	Primary	Secondary	
D_{n15}	1.02	0.43	m
Adopted D_{n50}	**1.13**	**0.52**	m
D_{n85}	1.22	0.60	m

Layer thickness (perpendicular to slope)	2.06	0.96	m
Layer thickness (horizontal)	3.71	1.72	m

Adopted Boulder Weight & Grade

	Primary	Secondary	
M_{15}	2.84	0.21	Tonnes
Adopted M_{50}	**3.83**	**0.38**	Tonnes
M_{85}	4.82	0.56	Tonnes

Expected Performance for 5% Exceedance Fit	5.81	High damage

Check

Primary Armour Size > Van Der Meer	TRUE	Primary Boulder Size Stable
D_{85}(Primary) / D_{15}(Secondary) < 4	2.9	Secondary Armour Retained

Primary - Actual Grade Ratio (M_{85}/M_{15})	1.7	Uniform Grade
Secondary - Actual Grade Ratio (M_{85}/M_{15})	2.7	Narrow Grade

International Coastal Management

Boulder Wall Design Worksheet

PROJECT	Shipmates - Sandstone Armour Design	Date	25-07-19

Adopted Design Conditions at Structure

Design Year & Event	2079	100	year ARI
Wave height at structure	H_S	2.00	m
	$H_{2\%}$	2.80	m
Critical wave period	T_{cr}	*8.3*	*sec*
Critical Iribarren number	$\varepsilon_{cr:}$	*4.87*	-
Adopted wave period	$T_{m-1,0}$	12.0	sec
Adopted Iribarren number	$\varepsilon_{s-1,0:}$	7.07	-
Breaker Type		Surging	-
Density of Seawater	ρ_{WATER}	1.024	t/m^3

Structure Characteristics

		Primary	Secondary	-
Density of Rock	ρ_{ROCK}	2.300	2.300	t/m^3
Relative Buoyant Density of Roc	Δ	1.25	1.25	-
Grade Description		Uniform	Narrow	-
Grade Ratio	D_{85}/D_{15} <	1.7	2.7	-
No. of Layers	n	2	2	-
Layer thickness co-efficient	k_t	0.91	0.91	-
Seawall Slope (1V: ?? H)	cot α	1.5	1.5	-
Layer (void) porosity	n_v	25%	25%	

Van Der Meer Shallow Water Equations

Equation 1: Van Der Meer shallow water formula for plunging waves ($\xi_{s-1,0} < \xi_{cr}$) (CIRIA, 2007)

$$\frac{H_s}{\Delta D_{n50}} = c_{pl} P^{0.18} \left(\frac{S_d}{\sqrt{N}}\right)^{0.2} \left(\frac{H_s}{H_{2\%}}\right) \left(\xi_{s-1,0}\right)^{-0.5}$$

Equation 2: Van Der Meer shallow water formula for surging waves ($\xi_{s-1,0} > \xi_{cr}$) (CIRIA, 2007)

$$\frac{H_s}{\Delta D_{n50}} = c_s P^{-0.13} \left(\frac{S_d}{\sqrt{N}}\right)^{0.2} \left(\frac{H_s}{H_{2\%}}\right) \sqrt{\cot\alpha} \left(\xi_{s-1,0}\right)^{P}$$

Input Parameters & Output

Storm Duration (No. of Waves)	N	692	-
Storm Duration		2.31	hrs
Acceptable Damage Level	S_d	2.0	-
Notional permeability	P	0.10	-
Breaker coefficients	C_{PL}	8.4	-
MEAN BEST FIT	C_S	1.3	-
Min Nominal Diameter (plunging)	D_{n50}	1.80	m
Min Nominal Diameter (surging)	D_{n50}	1.44	m
Primary Armour Nominal Diameter (Min)	**D_{n50}**	**1.44**	**m**
Primary Armour Weight (Min)	**M_{50}**	**6.87**	**tonne**

Adopted Nominal Diameter & Grade

	Primary	Secondary	
D_{n15}	1.31	0.55	m
Adopted D_{n50}	**1.45**	**0.67**	m
D_{n85}	1.56	0.76	m

Layer thickness (perpendicular to slope)	2.64	1.22	m
Layer thickness (horizontal)	4.75	2.21	m

Adopted Boulder Weight & Grade

	Primary	Secondary	
M_{15}	5.22	0.38	Tonnes
Adopted M_{50}	**7.000**	**0.70**	Tonnes
M_{85}	8.66	1.02	Tonnes

Expected Performance for 5% Exceedance Fit	5.65	High damage

Check

Primary Armour Size > Van Der Meer	TRUE	Primary Boulder Size Stable
D_{85}(Primary) / D_{15}(Secondary) < 4	2.8	Secondary Armour Retained

Primary - Actual Grade Ratio (M_{85}/M_{15})	1.7	Uniform Grade
Secondary - Actual Grade Ratio (M_{85}/M_{15})	2.7	Narrow Grade

Appendix C. **SAFETY IN DESIGN REPORT**

International Coastal Management

Safety in Design Report

Shipmates Seawall

Prepared for

Shipmates Body Corporate

By

International Coastal Management

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Document Control Sheet

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Company:	International Coastal Management

Version History

Version No.	Date	Changed by	Nature of Amendment
Ver 0			Initial issue

1. SAFETY IN DESIGN

1.1 THE LEGISLATION

The following legislation is relevant to this assessment.

- Work Health and Safety Act 2011
- Work Health and Safety Regulations 2011

ICM acknowledges it has a duty to comply with section 22 of the Work Health and Safety Act 2011 and ensure, so far as is reasonably practicable, that the design does not result in an increase of risks to health and safety.

This report is to be provided to the client (section 295 of the Work Health and Safety Regulations). The client is responsible for providing this report to the Principal Contractor (section 296).

1.2 PRINICPLES, FRAMEWORK & PROCESS

The process of Safety in Design (SiD) adopted by ICM is consistent with ISO 31000:2018 (Figure 1), adapted as required to suit a specific project and focussed only on risks associated with health and safety.

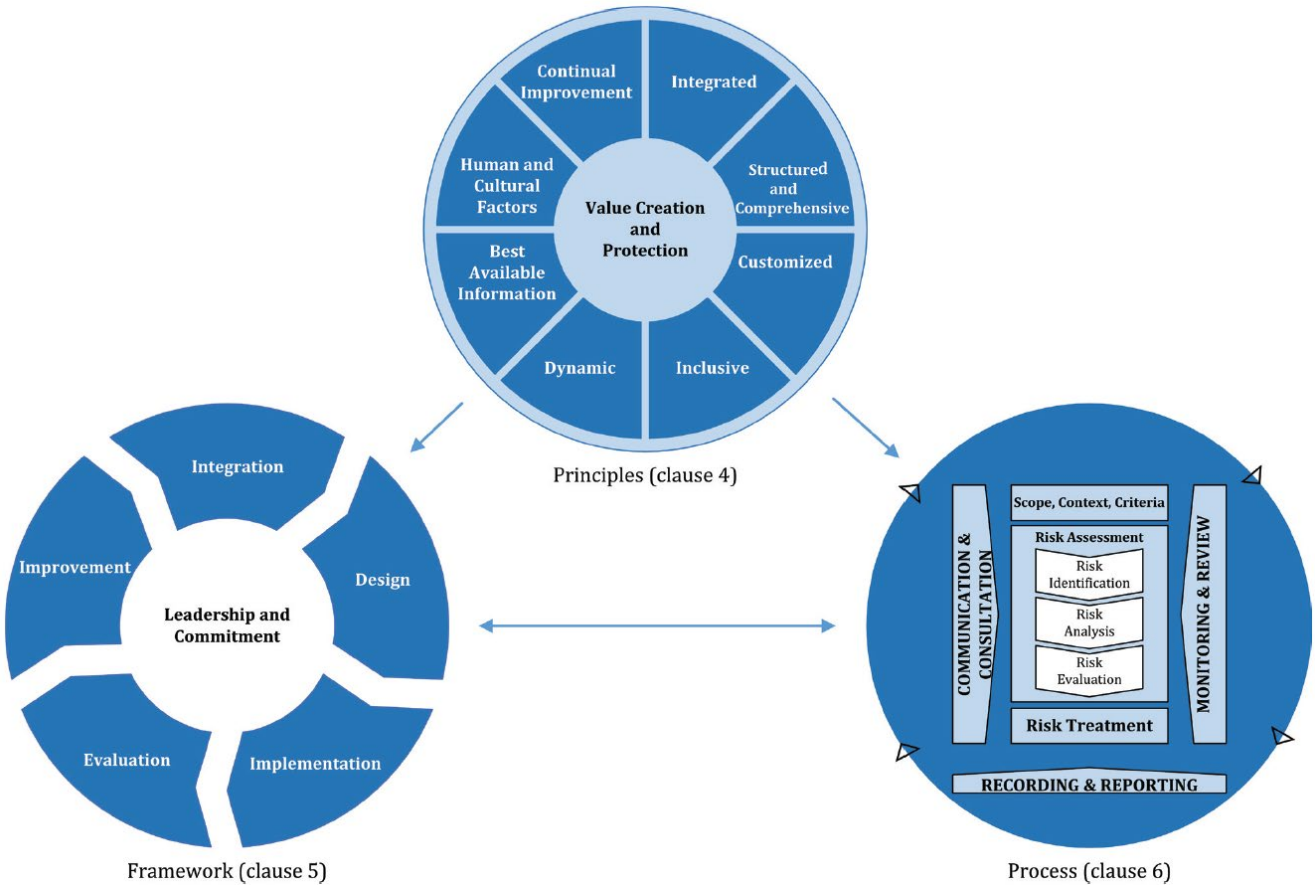

Figure 1: The Principles, Framework & Process (extract ISO 31000:2018)

1.2.1 Principles

Integrated	This assessment is undertaken during the design phase of the project, but addresses risks expected to be encountered throughout the life of the project.
Structured & Comprehensive	This report has been presented in a structured and comprehensive way and should be reviewed and implemented in a similar manner.
Customised	The assessment is specific to a single unique project. It should not be utilised on other similar projects without review and adaptation as required.
Inclusive	This report is to be provided to relevant stakeholders during the design process to ensure awareness and facilitate discussion. Feedback is welcome.
Dynamic	This report is a living document. It is the responsibility of the Client, Contractor and future stakeholders to update the risk register as required during future stages of work and in response to other changes that might affect the safety risk assessment.
Best available information	This report is based on historical and current information as well as future expectations. It considers limitations and uncertainties associated with such information and expectations.
Human & Cultural Factors	Human behaviour and Australian culture have been considered when undertaking this risk assessment.
Continual Improvement	ICM is committed to continual improvement.

1.2.2 Framework

This report should form part of the client's risk management framework.

1.2.3 Process

Scope	This report relates to health and safety risks associated with this project throughout its life cycle.
Context	A description of the project is provided in section 1.3

Criteria

Risks are to be assessed in terms of their likelihood and consequences based on the following classifications.

Risk Classification Table

	Consequences				
Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	M	M	H	E	E
Likely	L	M	M	H	E
Possible	L	M	M	H	H
Unlikely	L	L	M	M	M
Rare	L	L	L	M	M

Qualitative Measures of Risk

Classification	**Interpretation**
Extreme	Unacceptable. *Add additional controls or do not proceed.*
High	May be acceptable if additional controls not practicable. *Senior management attention required prior to acceptance.*
Medium	Acceptable.
Low	Acceptable.

Qualitative Measures of Consequence or Impact

Classification	**Interpretation**
Catastrophic	Death
Major	Extensive injuries
Moderate	Medical treatment required
Minor	First aid treatment, on-site with immediate release
Insignificant	No treatment required

Qualitative Measures of Likelihood

Classification	**Interpretation**
Almost certain	Is expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possible	Might occur at some time
Unlikely	Could occur at some time
Rare	May occur only in exceptional circumstances

Risk Identification	Risks are to include risks associated with all stages of the project lifecycle including construction, operation, during and after storm events, the impacts of climate change and future works or maintenance.
Risk Analysis	Risk analysis is to identify the risk source, likelihood and expected consequences.
Risk Evaluation	Quantify the level of risk based on the risk criteria, considering existing controls (assuming typical safety procedures for a competent but inexperienced contractor). This evaluation is to be documented in the Risk Register in section 1.4 .
Risk Treatment & Controls	Safety risks are to be eliminated or minimised where reasonably practicable. Risk control measures are to be implemented in accordance with the following risk hierarchy: 1. Eliminate risk 2. Substitute hazard (wholly or partly) with lower risk alternative 3. Isolate hazard from exposed persons 4. Engineering Controls 5. Administrative Controls (e.g. signage) 6. Suitable PPE provided and used Selected controls and responsible person for each control (control owner) are to be documented in the Risk Register in section 1.4 . Where safety is managed through engineering controls as part of the design process, details regarding selection and expected performance are to be documented in the Design Report.
Communication	This report is to be provided to the client and any appropriate external and internal stakeholders as part of the consultation process prior to finalising the design to promote awareness and facilitate discussion. Any feedback is to be incorporated into the document as appropriate. The report is to be provided to the Contractor to allow for the preparation of a Site-Specific Safety Management Plan.
Monitoring & Review	It is the client's responsibility to ensure that safety performance of the project is monitored and the safety assessment reviewed through key project stages to ensure nominated controls successfully achieve safety objectives.
Recording & Reporting	This report has been prepared to document the process and meet the various needs of the stakeholders throughout the project.

1.3 **PROJECT DESCRIPTION**

The objective of this project is to upgrade the existing boulder seawall protecting Shipmates at 1122 Pittwater Road, Collaroy Beach to the required standard. The works are to tie-in with adjacent existing seawalls.

The structure is within private property but directly adjacent to the adjacent public sandy beach (Collaroy Beach). Site access and construction is proposed to be undertaken from the adjacent public beach using excavators.

The duration of the works is expected to take up to 8 weeks.

The works may be impacted by tide and weather events. The adjacent beach width may is response to storm conditions prior to or during the works.

1.4 **RISK REGISTER**

A detailed safety risk register has been developed (Table 1).

Table 1: Safety Risk Register

RISK IDENTIFICATION	RISK ASSESSMENT		RISK EVALUATION			RISK TREATMENT		RESIDUAL RISK EVALUATION			
Risk Name	**Causes**	**Consequences**	Consequence	Likelihood	Risk	**Controls to be implemented to reduce risk**	**Control Owner**	Consequence	Likelihood	Residual Risk	Accepted / Not
CONSTRUCTION PHASE											
Excavation cut resulting in height >2.0m	▪ Fall from Height	▪ Injury or death	*Catastrophic*	*Possible*	*H*	▪ Batters to be maintained at minimum 1:1.5 where possible. ▪ Workers to maintain safe distance from top of batter. Consider safety bunting to restrict access. ▪ Fencing to be installed to restrict public access.	Contractor	*Catastrophic*	*Unlikely*	*M*	
Unstable rock slope at tie-in	▪ Rock fall	▪ Injury or death	*Catastrophic*	*Possible*	*H*	▪ No personnel to be in near proximity of exposed tie-in face (if steeper than 1:1) ▪ If tie in face is not able to maintain temporary steeper cut, works must battered back at 1:1 into adjacent property. This must be communicated with adjacent seawall owners prior to commencing. ▪ Placing geotextile at tie-in to be undertaken with excavator only.	Contractor	*Catastrophic*	*Unlikely*	*M*	
Working near water	▪ Working near ocean. ▪ Excavation below water table.	▪ Injury or drowning	*Catastrophic*	*Unlikely*	*M*	▪ If beach is in eroded state, ensure it is safe to access the site and retreat of machinery possible within tide window. ▪ In event of significant water depths during toe excavation (e.g. elevated water table or requirement for deeper toe due to lack of cemented sand layer), dewatering and suitable PPE to be adopted as required. ▪ Minimise timeframe between excavation below water table and placement of geotextile and toe boulders. ▪ Work area not to extend to waterline. In the event of an eroded beach during construction, temporary bund to be constructed around work area with beach sand if required or works to be timed around daily low tides. ▪ Fencing on water side to be located to allow sufficient space on beach for safe public access along foreshore.	Contractor	*Catastrophic*	*Rare*	*M*	

RISK IDENTIFICATION	RISK ASSESSMENT		RISK EVALUATION			RISK TREATMENT		RESIDUAL RISK EVALUATION			
Risk Name	**Causes**	**Consequences**	Consequence	Likelihood	Risk	**Controls to be implemented to reduce risk**	**Control Owner**	Consequence	Likelihood	Residual Risk	Accepted / Not
Slips of batter slope	▪ Shear failure of soil (sand)	▪ Burial under collapsed earth.	*Catastrophic*	*Possible*	*H*	▪ Excavation slope designed to suitable batter. Factor of safety 1.0 suitable for short term excavation.	Designer	*Catastrophic*	*Unlikely*	*M*	
						▪ Excavation to be inspected and monitored for formation of slips or reduction in soil strength throughout construction. ▪ Fencing to be installed to keep public away from excavation.	Contractor				
Unstable rock	▪ Unstable rock in stockpiles ▪ Unstable rock in structure	▪ Fall onto rock, worker crushed by rock or death	*Catastrophic*	*Possible*	*H*	▪ Rock seawall designed by engineer to safe slope to relevant standards and best practice.	Designer	*Catastrophic*	*Unlikely*	*M*	
						▪ Rocks in structure to be placed individually and ensure rocks are stable with 3 points of contact. ▪ Workers to traverse completed sections of rock structure only as required and to do so with caution. ▪ Rock stockpiles not to be steeper than 1:1 slope. ▪ Workers not to traverse rock stockpiles. ▪ Fencing to be installed to keep public away from rock stockpiles and sections of structure not fully completed.	Contractor				
Unfilled voids in rock under backfilled sand	▪ Worker to fall into void when walking on sand.	▪ Injury to worker	*Moderate*	*Likely*	*M*	▪ Any backfilled sand over structure is to be hydraulically flushed in and not left as a loose surface layer. ▪ Areas with loose sand over rock and in the process of being flushed in are to be fenced with safety bunting or mesh fence. ▪ Fencing to keep public away from construction to be maintained until flushing in is complete.	Contractor	*Moderate*	*Rare*	*L*	
Trip hazard	▪ Boulders exposed along crest	▪ Injury to worker ▪ Injury to public	*Moderate*	*Likely*	*M*	▪ Ensure crest boulders are not left partially exposed.	Contractor	*Moderate*	*Rare*	*L*	
Mobile plant on site	▪ Working with and around mobile plant (i.e. excavator)	▪ Injury or death	*Catastrophic*	*Possible*	*H*	▪ Operator to be suitably qualified for undertaking construction activities with all mobile plant on site. ▪ Safe Work Method Statement to be prepared for all construction activities required by the mobile plant. ▪ Workers to wear suitable PPE. ▪ Fencing of site to restrict public access.	Contractor	*Catastrophic*	*Unlikely*	*M*	

RISK IDENTIFICATION	RISK ASSESSMENT		RISK EVALUATION			RISK TREATMENT		RESIDUAL RISK EVALUATION			
Risk Name	**Causes**	**Consequences**	Consequence	Likelihood	Risk	**Controls to be implemented to reduce risk**	**Control Owner**	Consequence	Likelihood	Residual Risk	Accepted / Not
General Construction Risks	▪ Animals ▪ Extreme heat ▪ UV exposure ▪ Fall from Height ▪ Inadequate lighting ▪ Excessive noise ▪ Vibration ▪ Manual tasks ▪ Slips, trips & falls ▪ Violence & aggression ▪ Worker Fatigue	▪ Injury or death	*Catastrophic*	*Possible*	*H*	▪ Contractor site-specific WH&S plan to address identified risks.	Contractor	*Catastrophic*	*Unlikely*	*M*	
OPERATIONAL PHASE (INLCUDING POST-STORM & CLIMATE CHANGE)											
Voids in rock	▪ Exposure of wall and loss of sand from voids during storm event results in loose surface layer of sand.	▪ Injury or death.	*Moderate*	*Likely*	*M*	▪ Seawall to be inspected routinely and after major events. ▪ In event seawall is exposed and voids could be present, wall to be buried and sand flushed into structure or fencing to be installed landward of crest.	Owner	*Moderate*	*Rare*	*L*	
						▪ Smaller rock to be placed in interstitial voids in Primary Armour along crest to minimise size of voids. ▪ Geotextile to be placed under turf on crest to prevent sink holes on crest.	Designer				
Trip hazard.	▪ Overtopping exposes crest boulders	▪ Trip or Fall	*Moderate*	*Likely*	*M*	▪ Maintain vegetated areas in good condition or install fence landward of seawall. ▪ Seawall to be inspected routinely and after major events. ▪ Maintenance to be undertaken as required.	Owner	*Moderate*	*Rare*	*L*	
Dislodgement of rock from seawall during storm event.	▪ Rock dislodged under wave attack ▪ Scattered rock on beach ▪ Remaining rock face unstable	▪ Trip or fall ▪ Injury or death	*Catastrophic*	*Possible*	*H*	▪ Seawall designed by engineer using relevant guidelines and best practice.	Designer	*Catastrophic*	*Rare*	*M*	
						▪ Seawall to be inspected routinely and after major events. ▪ Seawall maintenance (including re-stacking and top-up of rock) to be undertaken as required.	Owner				

RISK IDENTIFICATION	RISK ASSESSMENT		RISK EVALUATION			RISK TREATMENT		RESIDUAL RISK EVALUATION			
Risk Name	**Causes**	**Consequences**	Consequence	Likelihood	Risk	**Controls to be implemented to reduce risk**	**Control Owner**	Consequence	Likelihood	Residual Risk	Accepted / Not
Overtopping during storm event.	▪ High volume / force of water over the top of seawall. ▪ Debris ▪ Sand build-up	▪ Injury/death to unaware pedestrians landward of seawall.	*Catastrophic*	*Possible*	*H*	▪ Area behind seawall not suitable for pedestrian access during larger storm events with the seawall exposed.	Owner	*Catastrophic*	*Unlikely*	*M*	
MAINTENANCE & REMOVAL											
Risk as included in construction phase						▪ Control measures outlined in construction phase. ▪ Works during storm events to be undertaken at low tides after site specific risk assessment. ▪ Works to be undertaken from the top of wall if required					
UPGRADE											
Risk as included in construction phase						▪ Updated Safety in Design Assessment to be undertaken prior to works. ▪ Detailed design by a suitably qualified engineer to relevant standards and best practice.					