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Tumby Bay Coastal Adaptation Strategy

Prepared for the

DISTRICT COUNCIL of TUMBY BAY

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Executive Summary

The District Council of Tumby Bay (DCTB) has commissioned Wavelength Consulting Pty Ltd (Wavelength) to develop a Coastal Adaptation Strategy (CAS). This strategy recommends specific priority adaptation pathways to manage coastal erosion and inundation risks taking into account economic, environmental and community considerations. The study area extends from the northern part of the Tumby Bay township (Elanora Avenue) to Back Beach, south of Tumby Bay.

The purpose of the CAS is as follows:

- To identify assets and values (public and private) and the risk posed to them by coastal hazards,
- To develop a plan that will allow DCTB to respond to identified risks through adaptation planning processes,
- To recommend specific actions and future monitoring to ensure the risk management and adaptation plan activities are working into the future as expected and guide their implementation over time.

This study considers a 76-year planning timeframe (to 2100) in line with adaptation planning best practice with consideration of coastal hazards under current and future (2050 and 2100) sea level rise scenarios.

For the purpose of the assessment, the study area was divided into eleven coastal segments in three main areas based on natural and built features. Recommended adaptation pathways were developed for the three main areas below:

- Townsite coast (segments 1 to 6)
- Southern shoreline (segments 7 to 11)
- Estuary connected areas (low-lying inland areas Segments 1 to 8)

These pathways show the sequencing of options through time against identified planning and action triggers. To implement these adaptation pathways the following immediate and short term actions are recommended, as detailed further in Section 7.

Immediate Planning

- Concept Protection Alignment Study - Townsite (Segments 1 to 6)
    - The aim of the concept study is to select the protection alignment for each segment to best meet the community's preferences, balancing trade-offs between foreshore assets, recreation space, water access and a usable beach. This should include an extensive community engagement campaign.
- McCallum St Raising Design – Estuary Connection (Segments 1 to 5)
    - Concept through detailed design of McCallum St road raising to counter coastal inundation.
- Monitoring and Review (0 to 5 years)
    - Coastal Adaptation Strategy review:
        - On-going review of CAS at approximately 5 year intervals.

Short Term Planning and Works

The following works should be prioritised in the coming 25 years:

- 0 to 5 years:
    - Segments 1 & 3: Subsequent to alignment study commence protection design and foreshore realignment (Inc. demolish seawall, removal or moving of assets)

- Segment 9: Monitoring of erosion set back using a physical maker and potential community support to monitor, record and report to Council.
- Segments 7 and 8: Geotechnical investigation of bedrock levels

- 5 to 10 years:
  - Raise McCallum St to limit estuary inundation into low lying areas inland from Townsite. Works include:
    - 0.3m road raising on eastern edge
    - 0.1m asphalt resheet McCallum St above culvert
  - Segments 4 & 5: New rock revetment and levee
  - Segment 6: Replace existing revetment with new rock revetment
- 10 to 15 years:
  - Segment 2: Replace existing GSC revetment with new rock revetment
- 15 to 25 years:
  - Segments 1 to 3 & 6: New levee at rear of seawall

Long Term Physical Works

The following works are likely to be required in the longer term (beyond 2050):

- Townsite (Segments 1 to 6):
  - Upgrade seawall and levee with an additional armour layer and higher crest.
- Southern Shoreline (Segments 8 and 9):
  - Continue to monitor shoreline position against foreshore path and Ski Beach Club House triggers.
- Estuary connected areas:
  - Segments 1 to 5 (north of McCallum St):
    - 0.5m to 1m road raising McCallum St
  - Segment 6:
    - 0.5m to 1m road raising Graham Smelt Causeway
  - Segment 7:
    - Construct levees along Berryman St (island south of marina)

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Abbreviations & Acronyms

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
CAS	Coastal Adaptation Strategy
CPB	Coast Protection Board
DCTB	District Council of Tumby Bay
DEM	Digital Elevation Model
DEW	Department for Environment and Water
HSD	Horizontal Setback Datum
MCA	Multi Criteria Assessment
S1	Potential storm erosion allowance
S2	Long-term shoreline movement allowance
S3	Sea level rise allowance
SBEACH	Storm-induced BEAch Change software
SLR	Sea Level Rise

1 Introduction

1.1 Background

The District Council of Tumby Bay (DCTB) is located approximately 50km north of Port Lincoln on the east coast of the Eyre Peninsula in South Australia, as shown in Figure 1.

The district has a population of approximately 3,000 people and while predominantly rural, has several coastal holiday and permanent communities, including the township of Tumby Bay and Port Neill. Agriculture, including farming cereal crops, sheep and beef, and tourism are important industries for the region.

The Tumby Bay foreshore is highly developed and has a long history of coastal management. Historical photographs show disturbance of the natural coastal systems at Tumby Bay dates back to early settlement. For example, Figure 2 shows the natural foredune cleared for lawn and recreational space in 1938. Historical records have shown that the foreshore and beach adjacent to the town centre of Tumby Bay was further from the 1970s onwards. In the 1970s, further areas of the natural foreshore dune vegetation was cleared, flattened and replaced with lawn.

In response to ongoing erosion, a vertical concrete wall was constructed in the late 1990s. Over time, sections of this seawall have failed and have been removed, with the remaining sections in poor condition. During the early 2000's it's understood DCTB implemented a range of coastal management methods to deal with the impacts on the foreshore.

In 2014, following review of potential protection options (AECOM, 2014), DCTB proceeded with detailed design and cost estimation for a rock revetment seawall. However, the detailed cost estimate was significantly higher than indications in the concept report and in consideration of this, along with recognition of community concern regarding the use of rock protection for this purpose, the design was not finalised.

A number of significant erosion events have seen further failure of the seawall, footpath and access stairs which have subsequently been closed for periods over recent years. DCTB have continued to manage these risks with emergency works (e.g., exclusion fencing, sand bagging, repairs to access stairs and footpath).

Whilst more recent calmer conditions have allowed sand to build up along the foreshore, without a clear longer-term approach to manage the foreshore the risk to assets and public safety will only be exacerbated with sea level rise and climate change impacts. The coastal assets, public land and infrastructure along the Tumby Bay coast are exposed to increasing coastal risks, and at this time, limited strategic mitigation measures have been put in place.

DCTB has commissioned Wavelength Consulting Pty Ltd (Wavelength) to develop a Coastal Adaptation Strategy (CAS) for the Tumby Bay townsite, extending from the northern part of the Tumby Bay township (Elanora Avenue) to the northern part of Back Beach, refer Figure 3.

This CAS assesses the coastal erosion and inundation hazards and risks and recommends specific priority adaptation pathways to manage these risks now and into the future. An important part of the CAS involves community engagement to help guide the selection of adaptation pathways. The following report outlined the key methods, findings and recommendations of this CAS.

Figure 1: Tumby Bay locality plan

Figure 2: Tumby Bay foreshore , image dated 1939 (Source: DEW Coast branch)

Figure 3: Study area

1.2 Approach

The study utilises the *Local Government Association Coastal Adaptation Guidelines* in developing the overarching approach to the study. Several stages were undertaken in developing the CAS in accordance with the guidelines, as summarised below:

1. Data collation and review;
2. Coastal hazard mapping;
3. Coastal asset and infrastructure risk profiling;
4. Community and stakeholder engagement; and
5. Adaptation option assessment and action planning.

The primary objective of the study is to develop a workable CAS for use by DCTB and other stakeholders (including private landholders and the State Government) to address coastal management issues faced along the Tumby Bay coastline.

2 Site Setting

2.1 General

The Tumby Bay coastline is relatively protected, being located on the western side of Spencer Gulf, with large expanses of shallow water and seagrasses fronting the sandy beaches. For most parts of Tumby Bay Beach between Elanora Avenue and the marina, the beach is backed by foreshore reserve facilities including lawn areas, playgrounds, and car parks. To the north and south of this, the beaches are more natural, with dunes backing the sandy beaches.

2.2 Coastal Compartments

For ease of assessment, the study area has been split into two main coastal areas and eleven segments (as shown in Figure 4). These areas and segments are based on the underlying geomorphology and specific features such as coastal structures and dune systems:

- **Tumby Bay Townsite:**
  - **Segment 1:** Tumby Bay north
  - **Segment 2:** GSC seawall
  - **Segment 3:** Vertical seawall
  - **Segment 4:** Tumby Bay south of seawall
  - **Segment 5:** Tumby Bay north of rock revetment
  - **Segment 6:** Rock revetment
- **Southern shoreline:**
  - **Segment 7:** Rocky headland
  - **Segment 8:** Southern township south of rocky headland
  - **Segment 9:** Ski Beach north
  - **Segment 10:** Ski Beach south
  - **Segment 11:** Back Beach

These eleven segments will be referred to throughout this report.

Figure 4: Coastal segments definition

2.3 Conceptual Model

Figure 5 shows a conceptual model of coastal processes and management developed for the study area.

This conceptual model was developed through review of following:

- relevant historical reports and imagery,
- anecdotal evidence collated through community engagement (including photo records) and
- correspondence between DCTB and the Coast Protection Board (CPB).
- In addition to this, 10 cross-shore profiles captured by the Department for Environment and Water (DEW) for the past 40 years were reviewed, combined with additional comparison of the coastline from historic aerial imagery spanning a period 41 years from 1982 to 2023.

A site visit was also undertaken on 03 July 2023 by a qualified coastal engineer, results of which were incorporated into the conceptual model and the broader CAS . Further details on the key coastal management and coastal processes are summarised on following pages.

Figure 5: Overview of coastal processes and subsequent coastal management issues around the Tumby Bay township area

2.4 Coastal Processes and Management

The following provides a summary of coastal features, processes and coastal management around the Tumby Bay township area, previously presented in Figure 5:

2.4.1 Water levels

The Tumby Bay area experiences a mixed, mainly semidiurnal micro- to meso-tidal environment with tidal ranges in the order of 2 m on spring tides.

The coastline is also exposed to elevated water levels from storm surge and wave setup.

Sea level rise (SLR) will increase these mean and extreme water levels over time.

2.4.2 Waves

Located on the eastern side of Eyre Peninsula and on the lee side of a headland, the township of Tumby Bay is largely protected from south-westerly swell waves propagating through Spencer Gulf.

The dominant waves in Tumby Bay are wind waves. Wind waves, mainly generated in Spencer Gulf, can occasionally reach 3.5 – 4 m offshore from Tumby Bay foreshore (AECOM, 2014).

- Wind waves show a seasonal pattern:
  - During summer, waves approach the coast mainly from S to SE.
  - During winter, northern winds prevail, resulting in dominant waves from N to NE, but occasionally, waves also approach the coast from S to SE.

Back Beach, on the southern side of the headland, is slightly more exposed to swell waves from the south.

2.4.3 Sand movement: cross-shore and longshore sediment transport

Cross-shore sediment transport is driven by high tides combined with strong winds from the East, which can occur all year long. Within these events, the beach level can drop by 1 – 1.5 m, but usually, the pre-erosion beach levels return during calmer sea conditions within a few weeks (Ordinary Council Meeting Agenda Paper, 2021).

- Longshore sediment transport takes place in both directions:
  - during summer, most sediment is transported from south to north
  - during winter, most sediment is transported from north to south.
  - the net direction of sand movement over a year appears to be from south to north.

Northern part of Tumby Bay township:
Coastal management: Soft engineered solutions (re-vegetation), low-crested Geotextile Sand Container (GSC) groyne at the northern end of town (limited success in controlling littoral drift)

Net erosion: Sediment supply from the south is limited due to its sheltered location and seawall construction. Therefore, more sediment leaves this area than it comes in, which causes long-term erosion.

Middle part of Tumby Bay township:
The centre of the Tumby Bay township is highly developed and backed by a series of seawalls, including:

  - a recently constructed GSC seawall
  - a vertical concrete seawall, partly reinforced by GSC toe protection

The vertical seawall has failed several times in the past. Failing occurs due to overtopping and scour, causing erosion of the sand behind and under the wall.

Whilst the seawalls have maintained the general position of the shoreline, the beach in front of the seawalls has eroded over time.

Southern part of Tumby Bay township:
During summer, sediment is transported from south to north. A wave shadow is formed in the lee of the headland and marina entrance, sheltering this area from southerly wind waves and thus, sediment transport from south to north is limited in this area.

During winter, sediment is transported from north to south and might accumulate in this area. Consequently, this part of the coast is stable to slightly accreting.

The southern portion of the Tumby Bay shoreline is protected by a rock revetment structure. Marina construction as well as channel deepening might influence sediment transport processes.

Rocky shoreline on headland
Stable due to rocky nature of coastline.

Ski Beach south of the Tumby Bay headland
Stable to slightly eroding coastline, most erosion occurs in the South. This may indicate a predominant south to north sediment transport.

3 Coastal hazard mapping

3.1 Planning horizons

The following planning horizons have been adopted for this study:

- Present day – presents the current state of play and identifies immediate risks and adaptation priorities.
- 2050 – provides a medium term (~30 years) outlook of risks, providing adequate time for adaptation options to be implemented to cater for the second half of the century, while allowing the time to monitor and verify projected erosion and coastal flooding scenarios.
- 2100 – demonstrates potential risks over the long term to the end of the century, which can be used to inform short to medium term decisions.

3.2 Sea level rise

The state planning policy recommends an allowance of 0.3 m for sea level rise (SLR) to the year 2050, and 1 m by 2100, when considering coastal flooding and long-term recession effects and planning for coastal development (CPB, 1992).

To summarise, the SLR scenarios adopted for this study are as follows:

- Present day
- 2050 – 0.3 m
- 2100 – 1.0 m

3.3 Coastal flood mapping

Bathtub modelling is a simplistic approach to identify areas at risk to coastal flooding. Bathtub models are elevation based, applying a deterministic line across a digital elevation model (DEM), allowing the areas of land lower than the given flood scenario to be identified.

There are a number of limitations to the bathtub model approach. Studies that have assessed bathtub models against more detailed hydrodynamic flood models have found that on an open coast, exposed to dynamic wind and wave processes, bathtub models could under-estimate the potential for flooding from extreme events (NCCARF, 2017). However, where there are extensive low-lying areas set back from the coast, bathtub modelling can overestimate the inundation extents due to the lack of direct flow paths from the coast and the large flood volumes required to fill these areas. Further to this, the quality of the DEM, which is a function of the spatial resolution and the vertical accuracy of the data source, has a great influence on the accuracy of the flood mapping.

For the purposes of providing a first pass of areas of risk to coastal flooding the bathtub model approach is considered appropriate.

3.3.1 Coastal flood parameters

The CPB has utilised the parameters presented in Table 1 for the 1% Annual Exceedance Probability (AEP) ocean water level event for Tumby Bay and the surrounds since 1993. Table 1 presents the coastal inundation parameters for the relevant horizons, which were applied for the coastal inundation mapping. It must be noted that run up was not included in the bathtub model for the year 2100 due to the presence of dense development (roads, houses etc.) in the 2100 flood extent. Accounting for run up in this scenario may overestimate the extent of flooding, as it would encompass a considerably larger area.

Table 1: Coastal Inundation Parameters for Tumby Bay (mAHD)

Parameter	Present day		2050		2100	
	Estuary	Coast	Estuary	Coast	Estuary	Coast
1% AEP Ocean water level	+1.95		+1.95		+1.95	
Wave set up	0.2		0.2		0.2	
Wave run up	-	0.5	-	0.5	-	
Sea level rise	-		0.3		1.0	
TOTAL	**+2.15**	**+2.65**	**+2.45**	**+2.95**	**+3.15**	

3.3.2 Results

These scenarios presented in Table 1 were mapped using the airborne light detection and ranging (LiDAR) derived DEM at a resolution of 1m with a horizontal accuracy of ± 0.5m and a vertical accuracy of ±0.15m captured in 2018 provided by DEW. The resultant inundation extents for the study area for the present day, 2050 and 2100 scenarios are displayed in Appendix A.

3.4 Erosion mapping

3.4.1 Approach

The CPB Policy for coastal erosion, flooding and sea level rise states that for consideration of erosion setbacks, estimates need to be made of the potential coastal retreat during the next 100 years. The policy recommends that local long-term erosion or accretion trends be considered, as well as potential storm erosion, and likely recession due to SLR (CPB, 1992). These three factors have been considered in establishing the erosion mapping for the relevant planning horizons (present day, 2050 and 2100) and are discussed in more detail below:

- **Storm erosion (S1):** SBEACH (Storm-induced BEAch CHange) software was used to predict and analyse short–term, storm-induced erosion at the site. Model inputs including design storm conditions and results are presented in the supporting technical note (Appendix A).

- **Long-term erosion or accretion (S2):** Analysis was undertaken of 10 cross-shore profiles captured by DEW. Data was available for up to 38 years for some profiles. Additionally, comparison of historical aerial imagery was completed covering 41 years from 1982 to 2023. Analysis is presented in the supporting technical note (Appendix A).

- **Recession due to sea level rise (S3):** The most widely used method for estimates of recession as a result of SLR is the Bruun Rule (Bruun 1962, 1988). The Bruun Rule is considered a coarse, first-approximation approach, as it is a theoretical model and does not consider the effects of longshore transport, coastal inlets or structures, or aeolian transport (Passeri et al., 2015). Analysis of the beach profiles provided estimates of the active zone across the study area which had a slope of approximately 1V:9H to 1V:49H, resulting in a Bruun factor of 9 to 49 when the Bruun Rule is applied to the beach conditions. An **upper limit factor of 50** is proposed to account for factors not considered by the Bruun Rule, including changes in longshore transport, tidal currents, seagrass vegetation and wave action. This also applies where there was no measured value. Further details are presented in the supporting technical note (Appendix A).

Key assumptions related to the combined effects of S1, S2 and S3 factors to develop the erosion hazard maps are outlined below:

- **Segment 2 (GSC seawall)** – it is assumed that the GSC seawall does not fail in the 1% AEP event at present. The S2 value is applied from 2035 onwards (after the ~15 years design lifetime of the structure).

- **Segment 3 (Vertical seawall)** – it is assumed that the vertical concrete seawall fails in the 1% AEP event at present. 50% of the calculated storm erosion allowances value (S1) for the unprotected case is applied.

- **Segment 6 (Rock revetment)** – it is assumed that the rock revetment fails in the 1% AEP event at present. 50% of the calculated storm erosion allowances value (S1) for the unprotected case is applied.

Segment 7 (Rocky headland) – it is assumed that the rocky headland does not erode and is stable until 2100. This assumption would need to be confirmed through geotechnical assessment, as outlined further in Section 7.17.1.

It is acknowledged that a limitation to this study is the limited availability of field data to calibrate and verify the calculations set out in the technical note (Appendix A) and used in this study. Therefore, the calculated setback distances provide a first pass assessment of the areas at risk to inform the adaptation strategy and are to be used as approximations only. Recognising these limitations, a conservative approach has generally been adopted throughout the calculations.

Maps of coastal hazard lines were produced to provide general guidance for the adaptation plan and to identify areas prone to coastal hazards. It is acknowledged that best practices in coastal management industry are moving away from the use of coastal hazard lines, towards risk-based approaches. However, the conservative approach of mapping coastal hazard lines is considered sufficient for this study to provide a first pass assessment of areas at risk to coastal recession and erosion (Gordon, 2015).

3.4.2 Results

A summary of setback allowances from the preceding information is presented in Table 2. The following coastal hazard lines were mapped for present day (2023), 2050 and 2100 as shown in Appendix A:

- Present day erosion hazard line = S1;

- 2050 and 2100 hazard lines = S1+S2+S3;

The present day erosion hazard line was positioned based on the potential storm erosion (S1), relative to the Horizontal Setback Datum (HSD). Further details on the HSD are presented in Appendix A.

The future hazard lines for the 2050 and 2100 scenarios were estimated by taking the present day hazard line (S1 component) and adding the long-term shoreline movement (S2) and recession due to sea level rise (S3).

Table 2: Summary of setback allowances for present day, 2050 and 2100

Area	Segment	Location	Present erosion setback (m) S1	Future erosion setback (m) S1 + S2 + S3	
				2050	2100
Tumby Bay Townsite	**1**	Tumby Bay north	14	34	79
	2	GSC seawall	0	17	60
	3	Vertical seawall	4.5	24	66
	4	Tumby Bay south of seawall	9	28	71
	5	Tumby Bay north of rock revetment	18	33	68
	6	Rock revetment	9	24	59
Southern shoreline	**7**	Rocky headland	0	0	0
	8	Southern township south of rocky headland	9	27	68
	9	Ski Beach north	18	39	84
	10	Ski Beach south	18	33	68
	11	Back Beach	12	31	74

4 Asset and infrastructure risk profiling

Analysis has been carried out to identify all the assets that may be at risk from coastal flooding or erosion (whether in public or private ownership). The developed risk profiles have subsequently been used to identify priority areas at risk to inform the CAS.

4.1 Approach

The coastal assets and values within the hazard areas were separated into three main categories below:

- Property (both DCTB and private property)
- Community
- Environment

A qualitative, risk-based approach was developed to assess the magnitude of the risks associated with both erosion and flooding on these assets, as described below:

- **Consequence scale:** The assessment of consequences for both erosion and flooding was based on a "Do Nothing" scenario and adopting the local government framework for coastal risk assessments in Australia developed for damage to infrastructure and services and the environment (Wainwright, D. et.al, 2016), presented in Table 3. For the Community and Environment assets and values, the consequence descriptors from the DCTB's Risk Management Framework were also used to guide the consequence ratings.

- **Likelihood:** The hazard likelihood descriptors have been based on the likelihood descriptors in the DCTB's Risk Management Framework, presented in Table 4. These showed good agreement with the cumulative probability of event occurring over the planning horizon, as developed by the Australian Geomechanics Society (AGS) in 2007 also presented in Table 4.
- **Risk matrix:** The risk matrix was taken from the DCTB's Risk Management Framework and modified in consultation with DCTB, as presented in Table 5.

Based on the DCTB Risk Management Framework, action is required to manage risks for assets assessed at High or Extreme risk. That is, High and Extreme risks represent an unacceptable level of risk for DCTB and require some form of adaptation to be implemented to manage risk.

Table 3: Consequence descriptors (Wainwright, D. et.al, 2016)

Descriptor	Property approximate quantum of damage (cost)	Community	Environment
Catastrophic	>100%	No local resources – external help required Loss of multiple lives or permanent impairment Pandemic or epidemic More than 50% of community affected Displaced people Major businesses severely affected	Species loss Permanent damage to native habitat/grasses/wetlands EPA involvement Significant legal impact Extensive remediation
Major	40 to 100%	Residual effect – outside help needed 25-50% of community affected Individual loss of life or single person with permanent or partial disability Medium/large business affected	Major regional impact & external management needed Non-permanent long-term effects Species impact – re-established over time with assistance
Medium	10% to 40%	Serious injuries or health impairments requiring hospitalisation and/or rehabilitation Locally managed 10 - 25% of community affected Medium sized business affected	Regional impact with focus on local area External advice needed No lasting effects Species can repopulate
Minor	1% to 10%	Minor injuries only – first aid or medical attention required Up to 10% of community affected Small local businesses affected	Minor local impact No external assistance required Managed locally within 2 hours No permanent effect
Insignificant	<1%	Little or no disruption Minor first aid on site No businesses affected	No measureable impact No lasting damage Contained immediately No EPA involvement

Table 4: Modified likelihood descriptors

Descriptor	Risk Likelihood Descriptor	Designated cumulative probability of event occurring over design life of 60 years (AGS, 2007)
Almost Certain	The event will occur within the planning period *Occurs more than once per month*	95.4%
Likely	The event is likely to occur within the planning period *Occurs once every 1 month – 1 year*	26%
Possible	The event may occur within the planning period *Occurs once every 1 year – 10 years*	3%
Unlikely	The event is not likely to occur within the planning period *Occurs once every 10 – 100 years*	0.3%
Rare	The event will only occur in exceptional circumstances *Occurs less than once every 100 years*	<0.03%

Table 5: Likelihood/Consequence Matrix

Likelihood	Consequence				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost Certain	Moderate	High	Extreme	Extreme	Extreme
Likely	Low	Moderate	High	Extreme	Extreme
Possible	Low	Moderate	Moderate	High	Extreme
Unlikely	Low	Low	Moderate	Moderate	High
Rare	Low	Low	Low	Low	Moderate

4.1.1 Coastal Inundation

For developing inundation risk profiles for each of the planning scenarios, inundation maps (as presented in Appendix A) are used to identify the greatest depth of flood for each of the assets at risk. It was assumed that buildings were constructed on a 0.25 m high foundation, based on the recommendations in the CPB policy (1992). For buildings, the damage curve presented in Figure 6 was used to determine the extent (%) of damage, which was then compared to the consequence descriptor in Table 3 to determine the risk.

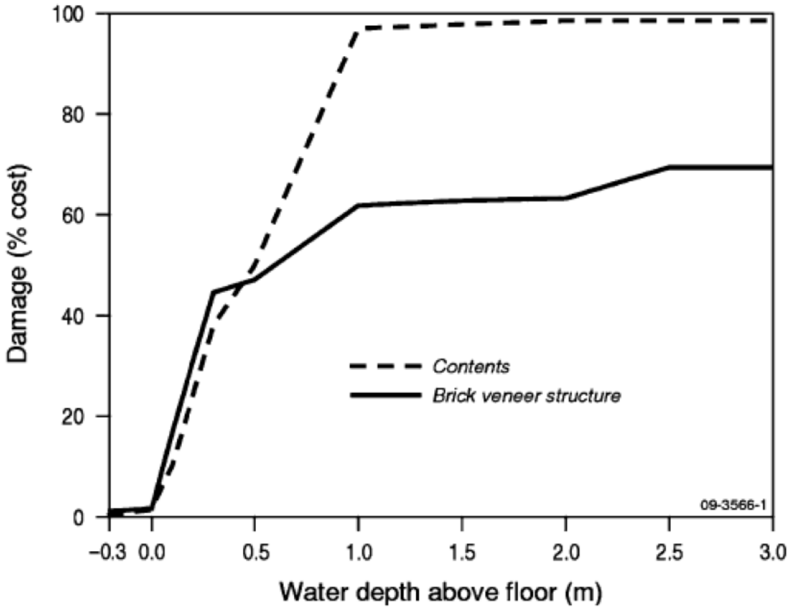

Figure 6: Flood Damage Curve (Balston et al, 2012)

For flooding of roads, beaches, foreshore reserve areas, boat ramps, footpaths, carparks, seawalls, and the jetty, a minor consequence was applied due to the short-term service disruption to this infrastructure.

In determining the likelihood descriptors assigned for the inundation risk profiles, they were determined based on the probability of the 1% AEP event occurring for the relevant planning horizon, and assigning the relevant descriptor outlined in Table 4 for the three planning horizons:

- **Present day scenario**: there is a 1% probability of 1% AEP event occurring within the year therefore an **Unlikely** likelihood descriptor was assigned;
- **2050 scenario**: there is a 24% probability of a 1% AEP event occurring in the next 27 years, therefore a **Likely** likelihood descriptor was assigned;
- **2100 scenario**: there is a 54% probability of a 1% AEP event occurring in the next 77 years, therefore an **Almost Certain** likelihood descriptor was assigned

The preliminary risk assessment has focussed on coastal inundation only and does not consider flood risk from catchment or stormwater flooding.

4.1.2 Erosion

The current state adaptation planning guidelines do not prescribe a method for evaluating the level of risk due to erosion, where loss of land may occur separately from loss of buildings, with varying financial implications. However, in most erosion cases total loss of land and assets will be the eventual outcome. The approach adopted was to use the extent (%) of damage prescribed in Table 3 from the consequence descriptor to determine the risk.

The following likelihood descriptors (Table 4) have been assigned for the erosion risk profiles:

- **Present day erosion risk (S1) -** under the present-day scenario there is a 1% probability of the 1% AEP event occurring within the year, therefore an **Unlikely** likelihood descriptor was assigned.

- **2050 and 2100 erosion risk (S1+S2+S3)** - For assessing coastal erosion to 2050 and 2100, the coastal hazard line descriptor **Possible** was adopted from the likelihood descriptors presented in Table 4.

4.2 Asset risk profiling results

A High or Extreme risk is considered unacceptable, requiring adaptation responses to be implemented prior to this risk level occurring. Given the large number of assets at risk from coastal hazards, summary risk tables have been prepared for assets with a High or Extreme risk to 2100, as presented in Appendix B. This gives an indication of the assets requiring adaptation responses. State owned assets such as telecommunication and power lines are not included in the assessment.

Further details are provided in the following sections.

4.2.1 Short term scenario

The assets, which are currently at risk of inundation/erosion and require adaptation options to be implemented in the short term (2 to 10 years) to prevent the risk becoming unacceptable (High to Extreme) are presented in Table 6 (inundation risk) and Table 7 (erosion risk). The location of the assets at risk is shown in Appendix C.

Table 6: Present day inundation risk

Type	Segment	Number of assets	Details	Present day risk
Private Properties	3	2	2x Tumby Terrace	High
Roads & Parking	4	1	Dutton Terrace	High
	6	1	Graham Smelt Causeway	High

Table 7: Present day erosion risk

Type	Segment	Number of assets	Details	Present day risk
Public	1	9	Beach, Foreshore Reserve Areas, Footpaths, Public Toilet, 5x Beach Access	High
	2	1	Beach	High
	3	6	Beach, Jetty, Protection Structures, 3x Beach Access	High
	4	4	Beach, Foreshore Reserve Areas, 2x Beach Access	High
	5	2	Beach, Beach Access	High
	6	1	Beach	High
	9	1	Beach Access	High

Roads & Parking	1	1	Esplanade	High

4.2.2 Medium term scenario

The assets presented in Table 8 (inundation risk) and Table 9 (erosion risk) would be at High to Extreme risk for the medium term (2050) scenario, if a "Do Nothing" approach was taken. The location of assets at risk is shown in Appendix C.

Table 8: 2050 Inundation risk

Type	Segment	Number of assets	Details	2050 Risk
Private Properties	1	3	2x Esplanade, 1x North Trezise Street	High
		9	1x Bawden Street, 1x North Trezise Street, 1x West Terrace, 4x Lipson Road, 2x Carr Street	Extreme
	2	2	2x North Trezise Street	High
		1	1x Bratten Way	Extreme
	3	20	3x Butterfield Street, 8x Bratten Way, 6x O' Connor Street, 2x Trezise Street, 1x Church Street	High
		38	4x Butterfield Street, 3x Bratten Way, 8x O' Connor Street, 8x Trezise Street, 4x Church Street, 2x Tumby Terrace, 2x West Terrace, 7x Thuruna Road	Extreme
	4	28	10x Tumby Terrace, 2x Spencer Street, 1x Dutton Terrace, 2x Thuruna Road, 2x Brock Street, 2x Sidney Road, 1x Park Terrace, 5x Church Street, 1x Barraud Street, 2x Young Street	High
		38	8x Tumby Terrace, 8x Dutton Terrace, 1x Brock Street, 2x Church Street, 1x Young Street, 9x Robert Street, 8x Trezise Street, Yacht Club	Extreme
	5	5	3x Tumby Terrace, 1x Preece Street, 1x Yaringa Avenue	High
	6	1	1x Elfrida Drive	Extreme
Public	3	1	Public Toilet	High
	4	1	Public Toilet	Extreme
Roads & Parking	1	5	Lipson Road, North Trezise Street, Fergusson Court, Elanora Avenue, Bawden Street	High

		1	Esplanade	Extreme
	3	2	Tumby Terrace, Bratten Road	High
		3	Butterfield Street, O'Connor Street, Trezise Street	Extreme
	4	2	Young Street, Sidney Road	High
		6	Tumby Terrace, Church Street, Tumby Terrace, Park Terrace, Preece Street, Dutton Terrace	Extreme
	5	2	Goode Avenue, Elfrida Drive	High
	6	3	Elfrida Drive, Yaringa Avenue, Graham Smelt Causeway	Extreme

Table 9: 2050 Erosion risk

Type	Segment	Number of assets	Details	2050 Risk
Private Properties	3	2	The Ritz Café, 1x Tumby Terrace	High
		1	1x Tumby Terrace	Extreme
	6	17	17x Elfrida Drive	High
		1	1x Elfrida Drive	Extreme
	8	1	1x Harvey Drive	High
		1	1x Ski Beach Road	Extreme
	9	1	Clubhouse	Extreme
	11	1	1x Lipson Road	Extreme
Public	1	1	Dunes	High
		11	Beach, Foreshore Reserve Areas, Protection Structures, Footpaths, Public Toilet, 6x Beach Access	Extreme
	2	4	Beach, Foreshore Reserve Areas, Protection Structures, Beach Access	Extreme
	3	1	Rotunda Art Gallery	High
		12	Beach, Jetty, Foreshore Reserve Areas, Protection Structures, Public Toilet, War Memorial, Bratten Memorial, 2x Playgrounds, 3x Beach Access	Extreme

Public	4	6	Beach, Dunes, Foreshore Reserve Areas, Public Toilet, 2x Beach Access	Extreme
	5	6	Beach, Dunes, Foreshore Reserve Areas, Footpath, Playground, Beach Access	Extreme
	6	4	Beach, Dunes, Foreshore Reserve Areas, Protection Structures	Extreme
	7	1	Beach Access	Extreme
	8	2	2x Beach Access	High
	9	1	Beach Access	Extreme
Roads & Parking	1	1	Esplanade	Extreme
	4	1	Tumby Terrace	Extreme
	5	1	Elfrida Drive	High

4.2.3 Long term scenario

The assets presented in Table 10 (inundation risk) and Table 11 (erosion risk) would be at High to Extreme risk for the long term (2100) scenario, if a "Do Nothing" approach was taken. The location of assets at risk is shown in Appendix C.

Table 10: 2100 Inundation risk

Type	Segment	Number of assets	Details	2100 Risk
Private Properties	1	15	7x Esplanade, 1x Phyllis Street, 1x Tennant Street, 2x Carr Street, 2x Darling Avenue, 1x Pumpa Street, 1x Airport Road	High
		61	8x Esplanade, 1x Pumpa Street, 3x Bawden Street, 12 x North Trezise Street, 7x West Terrace, 4x Lipson Road, 6x Carr Street, 4x Fergusson Court, 5x Brougham Place, 1x Darling Avenue, 3x Wibberley Street, 1x Nelcebee Terrace, 4x Freeman Street, 1x Tennant Street, 1x Bawden Street	Extreme
	2	5	2x Lipson Road, 1x Excell Road, 1x Pumpa Street, 1x North Terrace	High
		10	2x Johns Street, 1x Esplanade, 3x Pumpa Street, 2x Bratten Way, 2x North Trezise Street	Extreme
	3	8	5x Tumby Terrace, 1x North Terrace, 1x Spencer Street, 1x Bratten Way	High
		98	3x Johns Street, 7x Butterfield Street, 1x Bratten Way, 20x O' Connor Street, 10x Trezise Street, 8x Church Street, 8x Tumby Terrace, 2x West Terrace, 12x Thuruna Road, 1x North Terrace, 3x Spencer Street, 22x Bratten Way, The Ritz Café,	Extreme
	4	20	3x Robert Street, 6x Lawrie Street, 1x Schramm Street, 3x Sidney Road, 1 x Barraud Street, 3x Dutton Terrace, 3x Nankivell Street	High
		141	9x Dutton Terrace, 2x Park Terrace, 2x Barraud Street, 9x Preece Street, 12x Sidney Road, 8x Thuruna Road, 3x Spencer Street, 6x Lawrie Street, 19x Tumby Terrace, 3x Brock Street, 18x Church Street, 9x Young Street, 33x Robert Street, 7x Trezise Street, Yacht Club	Extreme
	5	14	7x Lawrie Street, 1x Smith Street, 1x Goode Avenue, 1x Tumby Terrace, 4x Preece Street	High
		46	7x Lawrie Street, 6x Preece Street, 6x Nelcebee Terrace, 1x Thuruna Road, 12x Graham Smelt Causeway, 9x Tumby Terrace, 1x Wandanda Place, 3x McCallum Street, 1x Yaringa Avenue	Extreme

	6	25	4x Yaringa Avenue, 1x Wandana Place, 17x Elfrida Drive, 2x Nelcebee Terrace, 1x Graham Smelt Causeway	High
		58	10x Wandana Place, 18x Elfrida Drive, 8x Nelcebee Terrace, 15x Graham Smelt Causeway, 5x Viking Street, 2x Saxon Street	Extreme
	7	6	1x Berryman Street, 1x Morialta Drive, 1x Wandana Place, 1x Thuruna Road, 1x Minnipa Lane, 1x Ski Beach Road	High
		6	1x Berryman Street, 2x Moonta Court, 2x Graham Smelt Causeway, 1x Morialta Drive	Extreme
	8	6	3x Pearson Street, 2x Lakin Crescent, 1x Ski Beach Road	High
		16	3x Pearson Street, 4x Lakin Crescent, 1x Ski Beach Road, 7x Berryman Street, 1x Swaffer Street	Extreme
	9	1	1x Ski Beach Road	High
Public	1	12	Beach, Dunes, Protection Structures, Foreshore Reserve Areas, Footpaths, 7 x Beach Access	High
		1	Public Toilet	Extreme
	2	5	Beach, Protection Structures, Foreshore Reserve Areas, Footpaths, Beach Access	High
	3	10	Beach, Jetty, Protection Structures, Foreshore Reserve Areas, 2x Playgrounds, 3x Beach Access, War Memorial	High
		2	Public Toilet, Rotunda Art Gallery	Extreme
	4	6	Beach, Dunes, Foreshore Reserve Areas, Footpath, 2x Beach Access	High
		1	Public Toilet	Extreme
	5	6	Beach, Dunes, Foreshore Reserve Areas, Playground, Footpath, Beach Access	High
	6	7	Beach, Dunes, Foreshore Reserve Areas, Footpaths, Marina Protection Structures, Boat Ramo, Pontoon	High
	7	4	Foreshore Reserve Areas, Footpath, 2x Beach Access	High
		1	Beach Access	Extreme

	8	5	Footpath, 4x Beach Access	High
	9	1	Beach Access	High
	11	2	1x Lipson Road, 1x Thuruna Road	High
Roads & Parking	1	2	Tennant Street, Back Street	High
		13	Pumpa Street, Excell Road, Wibberley Street, West Terrace, Carr Street, Thompson Street, Lipson Road, North Trezise Street, Fergusson Court, Elanora Avenue, Bawden Street, Brougham Place, Esplanade	Extreme
	2	2	Borthwick Street, Esplanade	Extreme
	3	8	Mortlock Street, Thuruna Road, John Street, Tumby Terrace, Bratten Road, Butterfield Street, O'Connor Street, Trezise Street	Extreme
	4	4	Lawrie Street, West Terrace, Brock Street, Yacht Club car park	High
		9	Robert Street, Barraud Street, Preece Street, Young Street, Sidney Road, Tumby Terrace, Church Street, Park Terrace, Dutton Terrace	Extreme
	5	5	Goode Avenue, Elfrida Drive, Preece Street, Lawrie Street, Yaringa Avenue	Extreme
	6	1	Marina Carpark	High
		5	Wandana Place, Nelcebee Terrace, Elfrida Drive, Yaringa Avenue, Graham Smelt Causeway	Extreme
	7	1	Minnipa Lane	High
		1	Morialta Drive	Extreme
	8	4	Pearson Street, Berryman Street, Swaffer Street, Lakin Crescent	Extreme

Table 11: 2100 Erosion risk

Type	Segment	Number of assets	Details	2100 Risk
Private Properties	1	12	11x Esplanade, 1x Tennant Street	High
		4	4x Esplanade	Extreme
	2	2	2x Esplanade	High

		4	4x Esplanade	Extreme
	3	8	8x Tumby Terrace	High
		3	2x Tumby Terrace, The Ritz Café	Extreme
	4	15	13x Tumby Terrace, 1x Barraud Street, 1x Brock Street	High
		3	2x Tumby Terrace, Yacht Club	Extreme
	5	1	1x Tumby Terrace	High
	6	20	20x Elfrida Drive	High
		18	18x Elfrida Drive	Extreme
	7	1	1x Ski Beach Road	High
	8	1	1x Ski Beach Road	High
		4	2x Harvey Drive, 1x Pearson Street, 1x Ski Beach Road	Extreme
	9	1	Clubhouse	Extreme
	10	1	1x Ski Beach Road	Extreme
	11	1	1x Lipson Road	Extreme
Community	1	12	Dunes, Beach, Foreshore Reserve Areas, Protection Structures, Footpaths, Public Toilet, 6x Beach Access	Extreme
	2	4	Beach, Foreshore Reserve Areas, Protection Structures, Beach Access	Extreme
	3	13	Beach, Jetty, Foreshore Reserve Areas, Protection Structures, Public Toilet, War Memorial, Bratten Memorial, 2x Playgrounds, 3x Beach Access, Rotunda Art Gallery	Extreme
	4	6	Beach, Dunes, Foreshore Reserve Areas, Public Toilet, 2x Beach Access	Extreme
	5	6	Beach, Dunes, Foreshore Reserve Areas, Footpath, Playground, Beach Access	Extreme
	6	4	Beach, Dunes, Foreshore Reserve Areas, Protection Structures	Extreme
	7	1	Footpath	High

		1	Beach Access	Extreme
	8	4	4x Beach Access	Extreme
	9	2	Public Toilet, Beach Access	Extreme
Roads & Parking	1	3	Back Street, Elanora Avenue, Tennant Street	High
		1	Esplanade	Extreme
	2	1	Esplanade	Extreme
	3	1	Tumby Terrace	Extreme
	4	1	Barraud Street	High
		2	Yacht Club Carpark, Tumby Terrace	Extreme
	5	2	Yaringa Avenue, Tumby Terrace	High
		1	Elfrida Drive	Extreme
	6	1	Elfrida Drive	Extreme
	8	1	Harvey Drive	High
	9	1	Harvey Drive	High

5 Community and stakeholder engagement

The approach to engagement and communication is fundamental to the successful progression of coastal hazard adaptation planning and action. Development of the approach is best undertaken/ supported by a co-design process with key decision makers and Council members who understand the place based context for their community.

When planning and designing the engagement process there are three key objectives in mind to support the adaptation plan:

1. Gather anecdotal evidence to provide further confidence in the coastal process assessment, and subsequent coastal erosion and flood mapping.

2. Identify and record the immediate concerns and priorities as perceived by various stakeholders.

3. To gauge the community appetite and social acceptance of various adaptation options.

Notwithstanding the above the community and stakeholder engagement activities provide an opportunity to build trust and confidence in the process, provide capacity building and education opportunities and work towards buy in and consensus.

Table 12 below provides a summary of the engagement activities co-designed with Council throughout the adaptation planning process, the stage of the process and the intended purpose or objective.

A summary of the key learnings from the series of community and stakeholder engagement activities is as follows:

1. **Anecdotal commentary on coastal processes and coastal management issues**
   - Stormwater runoff has had a significant impact to coastal erosion, community noting there are 22 stormwater outfalls, causing erosion on the beach.
   - Chronic erosion noted on the northern beaches, 'large trees falling into the ocean'.
   - A number of historical photos were provided by the community including during significant events, showing the extend of evaluated tide levels relevant to exist coastal assets such as the jetty and also showing the impacts of stormwater runoff.
   - Historical photos provided by the community were also able to show the rocky outcrops of the coastline south of the marina.
   - A number of community members noting little to no change of the coastline south of the marina over a significant period.
   - Understanding that whilst low levels of sediment (sand) are moving along the foreshore there is sand building up in areas outside of Tumby Bay (e.g. in the lee of islands) which needs to be better understood.
   - Consensus that there is limited knowledge and measured data to understand the currents and hydrodynamics within the Bay, a number of community members noting that current eddies can form and influence the movement of sand.
2. **General concerns, perceived priorities and values:**
   - There is a strong consensus that the priority area for action is the section between the Blue Water Café and the Lions Park
   - There is a strong consensus that action is required, the foreshore is a values asset to the community and 'something needs to be done'.
   - Jetty is important to the town and needs to be reopened.

- General acceptance that the existing protection structures were 'put in the wrong place' and are too far seaward.
- The most common way the community enjoy the beach and foreshore is walking on the walking trail and swimming.
- The most important thing identified by the community was considered to be access to water followed by ensuring the long-term protection of the towns assets and infrastructure.
- In terms of what the community would like to see considered the most when planning for any form of change to the foreshore and beach the most common answer was the foreshore amenities such as place space, BBQs, shelters, seating and gathering areas. The second most common response was the need to consider and maintain access to the beach and waters.
- First Nations communities need to be considered and acknowledged.
- Support for broader master planning, concepts were put forward by the community (the need for an attraction e.g. park run, extend walking track).
- Support for a community group to help lead/facilitate the options discussion moving forward

3. General sentiments and attitudes toward adaptation options

- Equally mixed sentiment amongst the community on the appropriate action forward:
  - Strong support and equal strong opposition for a rock revetment structure.
  - Some interest and acceptance of the existing GSC sandbag wall.
  - Some support for a retreat (move back) of the main foreshore to restore natural vegetation, extending the established dune vegetation south of the Lions Club.
  - Given the state of the existing vertical wall here, there is little acceptances that a vertical wall would work as a solution.
- Any protection design needs to:
  - Be underpinned by locally measured data.
  - Look for opportunities to move back as much as possible to allow for a wider sandy beach and promote revegetation opportunities, this could mean reducing the width of the road, moving carparks and assets such as the playground.
  - Consider complementary coastal management opportunities to support the natural environment, retain a beach and support revegetation. Examples provided included:
    - Natural based options such as Sandsavers as used in places like Kenya.
    - Promote mangrove growth with can support erosion control.
    - Groynes near the Marina to promote the capture of more sediment, which could also allow people to fish in the absence of a Jetty.
    - Sand sourcing investigations to look for opportunities of where sand is building up and could be brought.
  - Consider the existing stormwater network and look for design opportunities to limit or reduce stormwater runoff and erosion impacts on the beach.
  - Look for complementary design opportunities to 'green the grey' of a rock revetment wall. Look for opportunities to support marine habitats and vegetation growth.
  - Look for town planning opportunities to promote the usability of the foreshore space, examples provided included:
    - Promenade stairs, seating and lighting similar to Henley square .
  - Consider the importance of access to the beach and water, access will need to be designed in a way that does not promote further erosion and allow for access by all (e.g. ramps).

Table 12: Summary of community and stakeholder engagement activities

Adaptation stage	Engagement activity	Purpose or objective
Stage 1 Data Review and Stocktake	Inception meeting with Council executives and staff.	• Gather anecdotal evidence to provide further confidence in the coastal process assessment, and subsequent coastal erosion and flood mapping. • Identify and record the immediate concerns and priorities.
Stage 1 Data Review and Stocktake	Inception meeting with CPB representatives	• Gather anecdotal evidence to provide further confidence in the coastal process assessment, and subsequent coastal erosion and flood mapping. • Identify and record the immediate concerns and priorities.
Stage 1 Data Review and Stocktake	Community drop in sessions (1:1)	• Gather anecdotal evidence to provide further confidence in the coastal process assessment, and subsequent coastal erosion and flood mapping. • Identify and record the immediate concerns and priorities as perceived by various stakeholders; and • To gauge the community appetite and social acceptance of various adaptation options. • Provide opportunity for capacity building and education on coastal management.
Stage 1 Data Review and Stocktake	Community survey	• Gather anecdotal evidence to provide further confidence in the coastal process assessment, and subsequent coastal erosion and flood mapping. • Identify and record the immediate concerns and priorities as perceived by various stakeholders; and • To gauge the community appetite and social acceptance of various adaptation options.
Stage 2 Hazard Assessment	Workshop with Council Executives and Elected Members	• Present DRAFT hazard mapping results • Discuss community engagement feedback • Preliminary discussion option risk framework
Stage 2 Hazard Assessment	Online workshop with CPB representatives	• Present DRAFT hazard mapping results • Preliminary discussion option risk framework and options assessment process
Stage 3 Risk Assessment	In person workshop with Council Executives and Elected Members	• Present risk assessment results, discuss priority areas and assets • Discuss first pass options assessment and viable options to process to MCA
Stage 4 Adaptation options assessment	Online presentation and workshop with Council Executives and Elected Members	• Discuss and confirm MCA criteria • Discuss and confirm options to be assesses
Stage 4 Adaptation options assessment	Information fact sheet	• Communicate hazard mapping and risk assessment results • Communicate options assessment MCA process and preliminary findings

Stage 4 Adaptation options assessment	Community drop in sessions (1:1)	• Communicate hazard mapping and risk assessment results • Communicate options assessment MCA process and preliminary findings • To gauge the community appetite and social acceptance of various adaptation options. • Provide opportunity for capacity building and education on coastal management.

6 Adaptation options assessment

6.1 Options overview

Adaptation planning guidelines set out a number of pathways that may be taken to respond to the rising threat to existing coastal assets, as summarised below:

- Retreat – a planned and managed retreat involves the abandonment or relocation of assets, moving development inland in the face of sea level rise and coastal recession. The Framework includes the buyout of properties at risk as a key part of the Retreat pathway. Future development is prohibited in at risk areas.
- Accommodate – maintain the current level of use within coastal hazard areas and raise the tolerance to periodic flooding or erosion events by means of innovative designs for buildings and infrastructure, and remedial works (sand renourishment, revegetation) after storm events, and emergency plans (procedures in place before, during and after events for safety).
- Defend – the use of either (or both) soft and hard protection options to defend existing development. Protection measures such as seawalls, groynes, offshore breakwaters, levees, flood barriers, regular beach and dune nourishment, and revegetation will be considered.
- Defer (No Regrets) – coastal risks and adaptation options assessed and acknowledged, however action deferred to a later date based on identified triggers for the required actions.
- Do Nothing – Accept the identified risks and no action taken. Assets are left unprotected and loss is accepted. No limits on future development.

Table 13 provides further details on these options and their potential application to the study area. The short and long term feasibility of these options is assessed further in Section 6.3.

Table 13 Adaptation options descriptions

Pathway	Description
Retreat	The retreat pathway aims to allow natural coastal processes to unfold as much as possible and with as little inhibition from development as possible in the future. New development within the coastal zone would be prohibited within high-risk areas. Where possible, dunes would be restored or enhanced to maintain or create a buffer against storm erosion. This pathway will result in the loss of public and private land as beach environments migrate landward. Beach amenity and environmental values of coastal habitats would be largely retained or enhanced. A retreat approach would entail the relocation of Council assets identified at risk. Consideration may be given to the appropriate long-term management of these assets given the remaining life of the assets may be approximately equivalent to the time when emerging hazards will affect the essential function of the asset. Should this be a preferred adaption option, an audit of Council assets should be undertaken in terms of the remaining functional life in relation to the timeframe of the impending coastal hazard to inform if the asset should be 'managed to fail' or replaced and relocated inland. The buyout of properties at risk to avoid any future damage as a key part of the Retreat pathway, therefore an assessment of liability and responsibility would be required to inform the retreat process for the private property identified in the area at risk.
Accommodate	The accommodate adaptation option covers a wide range of measures. For the purposes of this study, short term accommodation measures involve modifying or designing assets in a way that minimises the consequences of erosion and/or

Pathway	Description
	flooding. The cost and complexity of implementing these measures can be wide ranging. Some of the accommodate strategies that could be implemented in the short to medium term are outlined below. • Apply appropriate minimum site and floor levels and erosion setbacks in new developments. • Raising lot and road levels above the 100-year ARI flood levels (+3.15m AHD) to minimise flood risks. • Storm preparedness and emergency plans, including physical actions such as sandbagging or flood barriers to prevent low levels of flooding, along with community awareness programs and evacuation planning. • Retrofitting or redesign of assets such as public toilets to minimise flood impacts and improve resilience. These measures could also be implemented in conjunction with the long-term options to improve the overall resilience of assets to coastal hazards.
Defend	This option would require the construction and ongoing maintenance of a number of soft and hard protection strategies. Potential measures include seawalls, groynes, offshore breakwaters, levees, flood barriers, regular beach and dune nourishment, and revegetation will be considered. Hard protection options provide the greatest certainty for protecting all assets for the long term, however there are significant capital and ongoing maintenance costs. Further to this, protection structures for coastal erosion often create other coastal management issues, potentially shifting and exacerbating erosion issues downdrift and reducing beach amenity. In this regard, significant consideration would need to be given to the detailed design requirements for such structures. Soft protection measures include regular beach and dune nourishment, and revegetation. The advantages of these options as an erosion management strategy are that they have virtually no adverse impacts on adjacent foreshores, and maintains (or may even enhance) beach amenity. Over the longer-term soft protection measures can be difficult to maintain due to uncertainty and variability in longshore sand movements, sand availability for nourishment, and the volumes and frequency of works required. An additional soft protection measure is re-establishing the seagrass communities, in the attempt to trap sediment and reduce the wave energy reaching the beach, thus potentially reducing storm erosion. Reproducing the environmental and metocean parameters to promote growth can be difficult and whilst R&D is progressing in this field the success rates for larger scale replanting campaigns is still very low. Road raising and levees for coastal flood protection are designed with a freeboard above the required flood level. Lower or higher levels of protection could be accepted depending on the assets at risk.
Defer	This option implies that nothing would be done unless repair works are needed and only adopting the option of accommodate, retreat or defend to be implemented at a point in time when an identified trigger level for actioning these. The rate of coastal erosion and flooding would continue to be monitored to reconfirm the projected risk. At a point in time which it is no longer feasible to defer action and a physical trigger is reached, the suggested pathways for accommodate, retreat and defend options outlined above would be adopted. The need for monitoring to be adopted as part of good coastal management practice is recommend irrespective of the Defer pathway being adopted.

Pathway	Description
Do Nothing	Similar to retreat however this option implies no changes are implemented between now and 2100 and there is an acceptance of the loss of all assets. Under this scenario Council would continue to repair and maintain only the infrastructure that they are responsible for, such as roads, lighting and stormwater.

6.2 Approach

The approach adopted for the options assessment was a two-staged approach.

1. A first pass assessment was undertaken of all possible options to provide an initial screening and removal of unfeasible options to be disregarded for further assessment. Some options may be feasible in some sections but not in others. Some adaptation options are considered feasible in the short term but would need to be replaced with medium to longer term strategies. The results of the first pass assessment are presented in Section 6.3.2.

2. A Multi Criteria Assessment (MCA) was then completed on the feasible options, which considered the adaptation costs in conjunction with the social and environmental aspects of each viable option to inform the adaptation pathway. The method and results of the MCA are presented in Section 6.6.

6.3 First pass assessment

6.3.1 Approach

Not all options need to be assessed through a comprehensive evaluation. Certain options may be rejected through an initial screening approach because they contravene certain requirements. This approach is taken to focus the more detailed assessment on realistic actionable adaptation strategies.

Given a similar level of risk exposure and continuity of adaptation pathways, recommended adaptation pathways have been developed for the following key areas:

1. Tumby Bay Townsite (Segments 1 to 6)
    - High to Extreme erosion and inundation risk by 2050.
2. Southern shoreline (Segments 7 to 11)
    - High to Extreme erosion risk by 2050.
3. Estuary connected areas (low-lying inland areas Segments 1 to 8)
    - High to Extreme inundation risk by 2050

Only options relevant to a particular hazard(s) impacting assets in a given segment were considered.

6.3.2 Options screening

The first pass assessment has screened the following adaptation options from further assessment within each segment.

1. Retreat
    - o As a long-term option, Retreat is expected to have an unacceptable impact on the community, requiring relocation of significant numbers of private properties and critical infrastructure, such as the hospital. Retreat is feasible in the southern shorelines where more space is available.
2. Accommodate
    - o As a long term option, accommodate is not considered effective at managing erosion and/or inundation hazards. Constructing buildings on stilts can accommodate some minor erosion but piles will be undercut by erosion and footpaths and access roads will be cut-off.
3. Defend
    - o Defend options such as offshore breakwaters, artificial reefs and groynes are not considered feasible at Tumby Bay. These structures can be effective at maintaining shoreline widths in areas of significant longshore transport. Their effectiveness at controlling significant cross-shore erosion that typically occurs during storms is limited. This is particularly true on this coastline, where the shoreline has been pushed towards the ocean with the flattening of the dunes. Given sediment movement during storm events is a significant driver of erosion hazards along this shoreline, offshore breakwaters, artificial reefs and groynes are considered unlikely to be viable options for this section of coastline.
    - o Nourishment is considered feasible in the short term to manage erosion and inundation, however, as a long-term option, sand nourishment has been precluded as a standalone option due to the uncertainty and variability of long-term sand movements, the potential lack of available sand for nourishment, and the volume and frequency of works required when sea levels are predicted to rise in the latter part of the century and the community's perspective.
4. Do Nothing
    - o The Do-Nothing option is not considered a viable option in relation to existing coastal structures along the foreshore and from DCTB or the community's perspective.

Given the significant number of assets at risk of inundation in the low-lying inland areas connected to the estuary, Accommodate and Retreat adaptation options were not considered feasible over the short to long term.

Defer has not be assessed as a comparative pathway option. Instead, defer will be adopted in the instances where an accommodate, retreat or defend strategy has been identified, but the trigger for actioning these options lies in the future. It is also assumed that monitoring is a requirement of any adaptation strategy and has therefore not been assessed as standalone option but is included in the strategies for all sections.

6.4 Feasible options

The feasible short-term options to 2050 and long term options from 2050 to 2100 are presented for the key three areas below.

6.4.1 Townsite (Segments 1 to 6)

The following adaptation options were considered feasible to reduce the risks of erosion and inundation along the town foreshore. Short-term options to manage inundation are only considered necessary for segments 4 and 5.

Short term options to manage erosion and inundation include:

1. Retreat (Move back with dune strengthening)
2. Defend (Rock revetment and levee)
3. Defend (Vertical seawall and levee)
4. Defend (Nourishment with dune strengthening)

Long term options to manage erosion and inundation include:

1. Defend (Rock revetment and levee)
2. Defend (Vertical seawall and levee)

6.4.2 Southern shoreline (Segments 7 to 11)

A number of adaptation options were considered feasible to reduce the risks of erosion along the southern shoreline.

Short term options to manage erosion include:

1. Retreat (Move back)
2. Defend (Rock revetment)
3. Defend (Vertical seawall)
4. Defend (Nourishment)

Long term options to manage erosion include:

1. Retreat (Move back)
2. Defend (Rock revetment)
3. Defend (Vertical seawall)

6.4.3 Estuary connected areas (low-lying inland areas Segments 1 to 8)

The only feasible adaptation option to reduce the risk of inundation in the Estuary connected areas is:

- Defend (combination of road raising and levees)

6.5 Options description

The following sections provides an overview of how each of the adaptation options could play out for the study area. Given that the timing and extent for the adaptation options vary for each section of the coast, a more detailed assessment of each option in terms of economic, social and environmental benefits and constraints (i.e. the MCA) is presented in Section 6.6.

6.5.1 Retreat

The retreat pathway aims to allow natural coastal processes to unfold as much as possible and with as little inhibition from development as possible in the future. New development within the coastal zone would be prohibited within high risk areas. This pathway will result in the loss of public and private land as beach environments migrate landward. Beach amenity and environmental values of coastal habitats would be largely retained or enhanced.

An advantage of the retreat option is that a beach would be maintained, with the potential for dune re-establishment to occur naturally with intervention.

A retreat approach would entail the relocation of Council and private assets identified at risk. Consideration may be given to the appropriate long-term management of these assets given the remaining life of the assets may be approximately equivalent to the time when emerging hazards will affect the essential function of the asset. If this was the preferred option, an audit of Council assets would need to be undertaken in terms of the remaining functional life in relation to the timeframe of the impending coastal hazard to inform if the asset should be removed, 'managed to fail' or replaced and relocated inland.

The buyout of private properties at risk is a consideration of the Retreat pathway,] an assessment of liability and responsibility would be required to inform the retreat process for the private property identified at risk. Where possible, houses would be relocated to more suitable land. If a house can't be relocated it would need to be demolished to prevent pollution of the beach and ocean when erosion occurs.

The retreat concepts presented in this report are conceptual only and further refinement of costs, planning and timing would be required if this was the preferred adaptation option.

6.5.2 Defend (seawalls)

In areas of the coastline where the erosion and flood hazards are unacceptably high and assets cannot be relocated easily, a seawall can be built to protect these assets. Whilst seawalls provide a high level of certainty in terms of protection of assets, they can impact public access, reduced beach amenity and environmental impact and can also shift and exacerbate coastal management issues (erosion) downdrift, creating a terminal scour or erosion hotspot at the end or gap in the wall.

Where assets are at high risk from flooding, the seawall would need to be constructed above the 100yr ARI flood level in conjunction with a levee. Similarly, if assets are at high risk from erosion, the seawall must be armoured on the seaward side and crest to prevent erosion and wave overtopping.

The seawalls presented in this report are conceptual only and are not for construction. Detailed design of the defend adaptation option is required prior to implementation. Additionally, should this be the preferred option, a seawall alignment study is recommended to be completed prior to detailed design to determine the appropriate staging and alignment based on forecast risk and existing asset locations.

Sloped Rock Revetment
For this study, concepts and costings have been developed for rock armoured seawalls given the availability of local rock and cost effectiveness. Other armouring options include geotextile sand containers, which are typically more expensive but are easier to walk on, providing better public access.

Conceptual seawall cross-sections have been developed for the foreshore area (AECOM, 2014), as presented in Figure 7. This conceptual design is considered applicable to other locations along this coastline where seawalls are an option. In the longer term, it's assumed that the seawall would be upgraded to accommodate SLR and associated larger waves, through addition of another layer of larger armour over the slope and face.

As noted previously, seawalls can increase the rate of beach erosion in front of and downdrift from the seawall. Over time, this results in loss of the beach width and hence beach amenity.

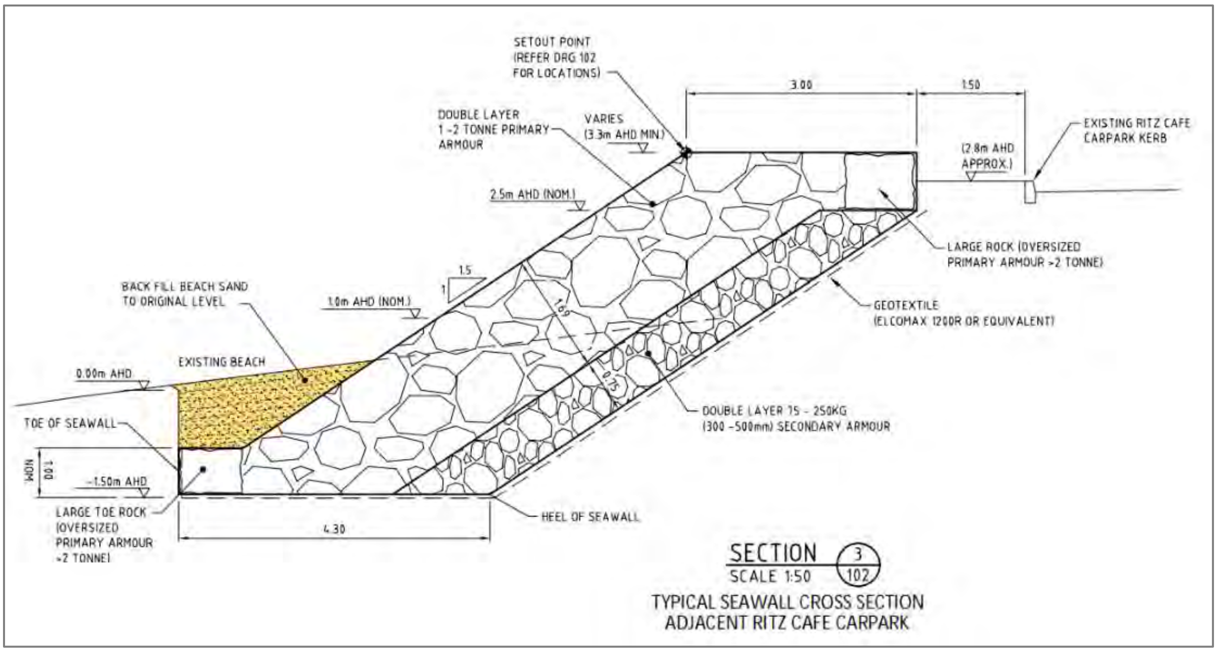

Figure 7: Rock revetment concept (AECOM, 2014)

Vertical seawall
Vertical seawalls can be constructed from a range of materials, including precast or in-situ concrete panels, steel sheet piles or even vinyl sheet pile. Vertical seawalls typically cost more than a rock revetment due to the higher costs of materials, more complicated construction methodology and fewer skilled contractors who can undertake this work in remote locations.

Whilst having a smaller footprint than a sloped rock revetment, vertical seawalls cause more wave reflections and thus result in a faster loss of beach width in front of the seawall compared to a rock revetment.

Figure 8: Glenelg Beach Vertical Seawall (from beachtraveldestinations.com)

6.5.3 Defend (nourishment and dune strengthening solutions)

Sand nourishment involves carting and placing sand on the beach and dune to counter the effects of longshore and/or cross-shore erosion. Nourishment can also be used to raise and strengthen existing dunes to provide protection against inundation. An example photograph of beach nourishment at Wyomi Beach in Kingston SE, is shown in Figure 9

Figure 9: Wyomi Beach Nourishment (Patrick Hesp, 2021)

No known local sources of sand were identified in the area. For this study, it's assumed that the sand would be sourced from a nearby local quarry and placed on the beach. The volume of material has been estimated to counter any on-going longshore erosion trends plus future sea level rise.

It is important to note that a significant number of truck movements would be required to access the beach during the nourishment campaigns, which would have a short-term impact on the community and environment, and must be done in a way that does not negatively impact on the existing dune vegetation. Wind blown sand can also be an issue following sand nourishment campaigns and must be managed properly.

The nourishment approach presented in this report is conceptual only and is not for construction. Detailed design of the nourishment adaptation option is required prior to implementation.

6.5.4 Defend (Levees / Road Raising)

For this study, concepts and costings have been developed for vegetated earthen levees as a flood protection measure. These structures are the same as those used for riverine flood protection as the risk from wave induced erosion is low for all locations at risk of flooding.

Earthen levees, if properly constructed and maintained, effectively have an indefinite life span. A typical design cross-section for an earthen levee is shown below. The crest elevation for the levee is based on the design flood level, which has been assumed to be 2100 storm tide elevation. This has been adopted as the costs of upgrading the structures over time likely to be significant compared to the initial construction.

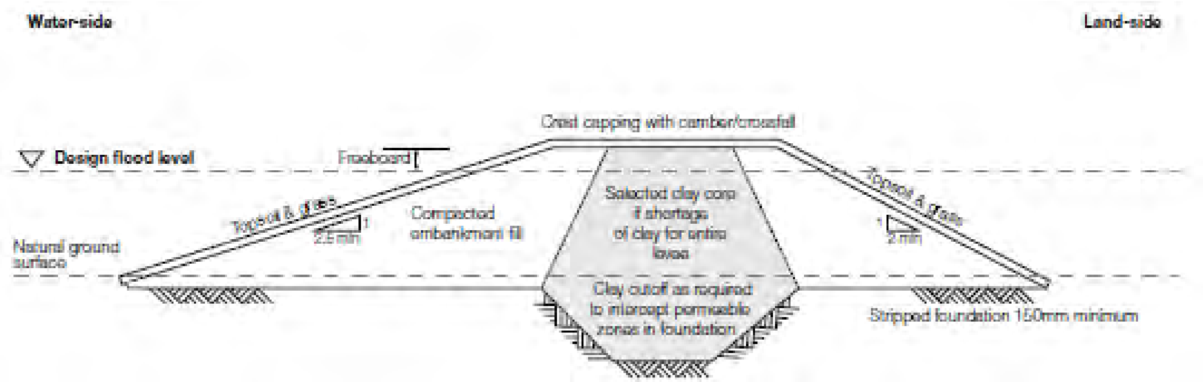

Figure 10: Components of a typical earthen levee (Levee Management Guidelines, 2015)

An alternative to an earthen levee is to consider raising of an existing roadway. This provides a levee with no access problems for maintenance and the 'crest' is maintained as part of normal road maintenance arrangements. If the roadway is, or can be, sealed, this is an advantage because the levee / road moisture level is then maintained. Access during times of flood events is not an issue in either.

Road raising can be done incrementally over time as SLR increases are realised and therefore is more adaptable than construction of an earthen levee.

The levee and road raising concepts presented in this report are conceptual only and are not for construction. Detailed design of the defend adaptation option is required prior to implementation.

6.6 Multi criteria assessment

6.6.1 Approach

The aim of the MCA is to provide a straightforward overview of the options. It is aimed at presenting quickly and clearly the benefits and trade-offs of a particular option, to assist in the selection of a preferred option(s). The results of the MCA act to inform the adaptation pathway rather than dictate an absolute approach. The assessment criteria applicable for the MCA was discussed and co-designed with Council Executives and Elected Members, as presented in Table 14.

The assessment was broken down into the two key areas; Townsite and Southern shoreline. Analysis of viable options was undertaken for these coastal areas rather than by each individual asset, as the adaptation pathway was assessed to be similar for the different asset types within these at risk areas.

The MCA was completed for assets at unacceptable coastal risks (High to Extreme) to 2050, providing an indication of the merits of each adaptation option. Consideration of assets at risk in the longer term to 2100 is included in the adaptation pathways maps prepared for each area in Sections 6.7 to 6.9 .

Table 14 MCA Criteria & Scaling

Score	Category	Planning and implementation	Environmental Impact	Social Impact	Flexibility	Effectiveness	Financial
	Description	How easy is the option to plan and implement?	Does the option have a detrimental or beneficial impact to the environment?	How significant are the impacts on properties?	Is the option reversible / adaptable in the future?	How effective is the solution at mitigating erosion and inundation risks?	How much does the option cost?
	Considerations	- Implementation timeframe - Approval processes -Practicalities of sourcing materials - Contractors available with the required skill set	- Amenity and public health (noise, dust, noise, odors) impacts - distance to sensitive receptors - Scale of disturbance to marine habitat, water quality vulnerable/ protected species - Promotes marine and natural environment	- Social appetite of option - Disruption and promotion to everyday way of life - Disruption to local businesses - Impacts or supports what community values	- Reversibility of option - Adaptable to unforeseen changes in climate conditions - Alignment with potential long term adaptation pathways, including reclamation with seawalls	- Effectiveness against erosion - Effectiveness against inundation	-Combined capital and maintenance costs -Potential for external funding sources
5	Insignificant impacts OR Very low risk	Abundant and sustainable source of material Approval process straightforward Number of contractors with required skills to perform works Planning and design straightforward Considered a 'Shovel Ready' project	Preserves and repairs	Improves everyday way of life and to what community value No opposition to option	Easily reversible or adaptable	Effective, long term mitigation	<$5 million
4	Minor impacts OR Low risk	Sustainable source of material Approval process likely to take time however unlikely to be challenging Contractors required skills to perform works are within the state however not local/regional Planning and design OK	Maintains status quo	Some improvement on everyday way of life and to what community value Minor opposition to option	Reversible or adaptable	Effective, mid-term mitigation	$5 to $10 million
3	Moderate impacts OR Medium Risk	Sustainable source of material beyond 2050 becomes challenging Approval process and planning likely to be challenging Contractors required skills to perform works are within the state however not local/regional Planning and design likely to be challenging	May result in impact and damage	Short term minor impact everyday way of life and to what community value however longer term improvement Both opposition and support for the option	Reversible or adaptable but with some cost	Effective, short term mitigation	$10 - $25 million
2	Major impacts OR High risk	Complex planning and approvals process, Material challenge to source Some examples of like for like projects or contractors with required skills to perform	Likely to result in impact and damage	Short term significant impacts to everyday way of life and to what community value, minor long term impacts to everyday way of life and what the community value More opposition to the option thank support	Difficult to reverse or adapt	Limited effectiveness	$25-$60 million
1	Severe impacts OR Very high risk	Extremely complex planning and approvals process, Ongoing sustained sourcing of materials unclear No examples of like for like projects or contractors with required skills to perform	Will result in impact and damage	Major short term impact everyday way of life and to what community value, irreversible long term impacts to the what the community value Strong opposition to option	Irreversible or unadaptable	Ineffective and/or suitable only for minor events	>$60 million

6.6.2 Weighting

Following development of the MCA criteria, the MCA criteria were compared against each other to determine the relative weighting of each criterion. This process was undertaken via discussed and co-design with Council Executives and Elected Members.

Each criteria was compared against the others using a pairwise comparison methodology, as described below:

1. Compare each criteria against each of the other criteria separately.
2. For the two criteria being compared, respondents selected the most important of the two criteria.
3. The scores for each criteria were counted and then normalised against the others to give a percentage value out of 100%.

The final weightings are presented in Figure 11. In general, 'Financial' and 'Effectiveness' criteria were weighted the highest, with 'Flexibility' weighted the lowest at 0%.

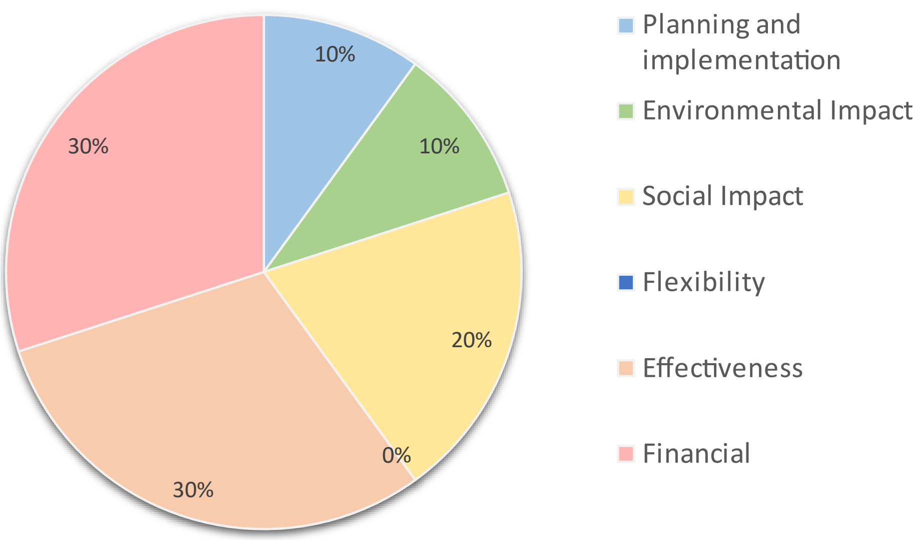

Figure 11: MCA criteria weighting

6.6.3 Triggers

Triggers are used to identify when an adaptation option needs to be implemented for an asset to prevent an unacceptable level of erosion or flood risk (High or Very High risk). Triggers have been established for two categories, for when physical action on the ground is required (ACTION TRIGGER) and for the planning and pre-works required for the action to be implemented (PLANNING TRIGGER).

Planning and action triggers were determined on a case-by-case basis dependent on the nature of the risk and the asset type.

6.7 Townsite (Segments 1 to 6) Results

6.7.1 Short term

The MCA for the Townsite is presented in Table 16, with a full breakdown of costs for each option presented in Appendix D.

Review of adaptation options considered in the MCA suggest that the coastal risk could best be managed through implementation of a Defend pathway, more specifically a rock revetment with levee structure. The potential staging for this option is presented in Table 15 and Figure 12. The timing for implementation is indicative only and is based on the relative erosion and inundation risk profiles in the 6 segments. The actual implementation timeframe is likely to be driven by funding availability and the results of the concept study as discussed in Section 7.1.

This approach should be combined with an Avoid pathway, where no new assets are placed within the erosion and inundation hazard areas unless a specific risk assessment, based on the design life and function of the asset, shows this is safe to do.

Table 15 Townsite short term pathway staging

Timeframe	Staged construction and location
0 to 5 years	**Segments 1 & 3 :** New rock revetment (Inc. demolish seawall)
5 to 10 years	**Segments 4 & 5:** New rock revetment and levee **Segment 6:** Replace existing revetment with new rock revetment
10 to 15 years	**Segment 2:** Replace existing GSC revetment with new rock revetment
15 to 25 years	**Segments 1 to 3 & 6:** New levee at rear of seawall

Table 16: Townsite short term MCA results

Adaptation Type	Name	Description	Planning and implementation	Environmental Impact	Social Impact	Flexibility	Effectiveness	Financial	Unweighted Score	Weighted Score
Planned/Managed Retreat	**Demolition/ removal/ relocation of assets from inside hazard area with dune strengthening**	• To 2050: $34M (no assets replaced) to $40M (foreshore assets replaced, Inc. Café and Yacht Club) • Effective in the short to medium term, not feasible beyond 2050 due to social impacts and costs, would need to transition to an alternative adaptation pathway. • Somewhat flexible, once assets moved may not be adequate space to replace • Highly challenging implementation and planning, requires high level of co-ordination and planning (e.g. consideration for utilities, asset removal, redesign of road, parking, maintaining access to businesses and properties). • Promotes the coastal and natural environment, allows for the reestablishment of natural environment • Social considerations: Maintains a wide sandy beach to 2050 Disruption during planning and implementation (trucking and wind blown sand, access to beach) Reduce usable grassed area for recreational activities (playground, shelters, BBQ areas etc.) Moving businesses (e.g. Cafe)	1	5	3	3	3	2	**17**	**45**
Defend	**Rock revetment and levee**	•To 2050: $22M • Highly effective at mitigating coastal hazard risks • Not a flexible option • Straightforward planning and implementation • Environmental impacts: results in loss of beach dune and vegetation, will result in greater loss of beach initially however in the longer term not as much as a vertical wall • Consideration of social impacts: Loss of beach width (Beach will narrow by approximately 20m by 2050), loss of vegetation and established dune Protect assets behind, provides protection to foreshore reserve 'grassed' area for recreational amenities (e.g. BBQ, shelter, provides a vista), change to the amenity and feel can create a separation between the active beach and reserve area.	5	1	3	1	5	3	**18**	**60**
	Vertical wall and levee	•To 2050: $53M • Highly effective at mitigating coastal hazard risks • Not a flexible option • Straightforward planning and implementation • Environmental impacts: results in loss of beach dune and vegetation, will result in great loss of beach width than other options in the longer term • Consideration of social impacts: Loss of beach width (Beach will narrow by approximately 20m by 2050), loss of vegetation and established dune Protect assets behind, provides promenade and foreshore reserve 'grassed' area for recreational amenities (e.g. BBQ, shelter, provides a vista), change to the amenity and feel can create a separation between the active beach and reserve area.	5	1	3	1	5	2	**17**	**55**
	Nourishment with dune strengthening	• To 2050: $138M • Effective in the short to medium term, not feasible beyond 2050, would need to transition to an alterative adaptation pathway. • Highly flexible option, can change pathway at any time • Difficult implementation and planning, approval process and may be challenging to obtain a sustainable sand source • Will promote the marine environment, have a positive impact on the coastal environment, supporting dune vegetation growth. • Social considerations: will allow for a wide sandy beach and promote the natural environment however trucking and wind blown sand during implementation will impact use of the beach.	2	5	3	4	3	1	**18**	**42**

Figure 12: Townsite Short Term Defend (Revetment and Levees) Pathway

6.7.2 Long Term

A review of the MCA results (Table 17) suggests that a continuation of the Defend (rock revetment and levee) pathway is the best approach to manage the coastal risk in the Townsite in the longer term to 2100. To maintain protection, this pathway would involve the following upgrades to the revetment to counter the impacts of SLR:

- Layer of larger armour rock on seaward face to accommodate larger wave conditions.
- Raised levee height to reduce flood through revetment.
- Layer of armour rock on the crest and levee reduce overtopping damage.

The implementation of these upgrades would be triggered by SLR when the design life for the initial stages of the revetment is ended, most likely after 2050.

Table 17: Townsite long term MCA results

Adaptation Type	Name	Description	Planning and implementation	Environmental Impact	Social Impact	Flexibility	Effectiveness	Financial	Unweighted Score	Weighted Score
Defend	**Rock revetment and levee**	•From 2050 - 2100: $31M (Total $53M) • Highly effective at mitigating coastal hazard risks • Not a flexible option • Straightforward planning and implementation • Environmental impacts: results in loss of beach dune and vegetation, will result in greater loss of beach initially however in the longer term not as much as a vertical wall • Consideration of social impacts: Loss of beach width, loss of vegetation and established dune • Protect assets behind, provides protection to foreshore reserve 'grassed' area for recreational amenities (e.g. BBQ, shelter, provides a vista), change to the amenity and feel can create a separation between the active beach and reserve area.	5	1	3	1	5	2	**17**	**55**
	Vertical wall and levee	•From 2050 - 2100: $42M (Total $95M) • Highly effective at mitigating coastal hazard risks • Not a flexible option • Straightforward planning and implementation • Environmental impacts: results in loss of beach dune and vegetation, will result in great loss of beach width than option options in the longer term • Consideration of social impacts: Loss of beach width, loss of vegetation and established dune • Protect assets behind, provides promenade and foreshore reserve 'grassed' area for recreational amenities (e.g. BBQ, shelter, provides a vista), change to the amenity and feel can create a separation between the active beach and reserve area.	5	1	3	1	5	1	**16**	**50**

6.7.3 Adaptation pathway

The sequence for recommended adaptation pathways for the Townsite (Segments 1 to 6) is presented in Table 18 below.

It's important to note that the beach will be lost in front of the revetment over time. The rock revetment could be setback further from the beach to provide a wider beach for longer, however, this could impact on existing assets and recreational space, such as lawns and footpaths.

Given the existing erosion risk levels, proximity of assets to the coastline and beach impacts, a Concept Protection Alignment Study is recommended to be completed as soon as possible. This is the planning trigger outlined above and would set out the action triggers and implementation timeframes for the different sections. This should involve a comprehensive community engagement program to identify what's most important to the community, so that the revetment alignment can be optimised.

Table 18: Adaptation pathways map – Townsite (Segments 1 to 6)

		PRESENT DAY	2050	2100
	EROSION HAZARD RISK	High	Extreme	Extreme
	INUNDATION HAZARD RISK	High	Extreme	Extreme
PLANNING	CONCEPT ROCK REVETMENT ALIGNMENT STUDY			
AVOID	SEGMENTS 1 TO 6	Avoid placing new non-relocatable uses in hazard areas (on-going)		
DEFEND	SEGMENTS 1 & 3 - NEW ROCK REVETMENT			
	SEGMENTS 4 & 5 - NEW ROCK REVETMENT AND LEVEE			
	SEGMENT 6 - REPLACE EXISTING REVETMENT WITH NEW REVETMENT			
	SEGMENT 2 - REPLACE EXISTING GSC REVETMENT WITH NEW ROCK REVETMENT			
	SEGMENTS 1 TO 3 & 6 - NEW LEVEE AT REAR OF SEAWALL			
	SEGMENTS 1 TO 6 - UPGRADE REVETMENT ARMOUR & CREST			

6.8 Southern shoreline (Segments 7 to 11) Results

6.8.1 Short term

For Segments 7 and 8, a geotechnical investigation is recommended to be completed in the coming 5 years. This investigation should identify the elevation, extent and competency of the underlying bedrock in these segments to determine the potential natural protection offered by this rock. The hazard maps should be updated to reflect these results.

For Segment 9 given the uncertainty associated with SLR impacts on beach erosion, a monitoring pathway is recommended to understand when planning and action is required to consider assets such as the Ski Beach Clubhouse. A monitoring pathway is also recommended for Segment 8.

The recommended planning and action triggers are outlined below and presented for Segments 8 and 9 in Table 19:

- Planning trigger – coastal vegetation line within S1 distance + 5m of asset.
- Action trigger – coastal vegetation line within S1 distance +2m of asset.

This would provide approximately 5 years between the planning trigger and action trigger based on potential future shoreline movements assessed in this study.

The timing should be identified through installation of trigger markers seaward of critical assets. For example, placement of markers in the dune in front of the Clubhouse at the two trigger distances. Council may also wish to establish a coastal monitoring profile at the Ski Beach Clubhouse to help monitor this approach.

Table 19 Southern shoreline recommended triggers

Segment Number	Segment Name	S1 Distance (m)	**Planning Trigger –** coastal vegetation line distance from asset (m)	**Action trigger -** coastal vegetation line distance from asset (m)
8	Southern township south of rocky headland	9	14	11
9	Ski Beach north - Clubhouse	18	23	20

Table 20: Adaptation pathways map – Southern shoreline

		PRESENT DAY	2050	2100
	EROSION HAZARD RISK	High	Extreme	Extreme
	INUNDATION HAZARD RISK	Low		
PLANNING	SEGMENTS 7 & 8 - GEOTECHNICAL INVESTIGATIONS			
AVOID	SEGMENTS 7 TO 11	Avoid placing new non-relocatable uses in hazard areas (on-going) →	→	→
MONITORING	SEGMENTS 8 & 9 - MONITOR SHORELINE POSITION AGAINST TRIGGER VALUES	→	→	→

6.9 Estuary connected areas (low-lying inland areas Segments 1 to 8) Results

The first pass assessment of options identified only one feasible option to manage inundation for low lying areas connected to the estuary inland from the town. A full breakdown of costs presented in Appendix D.

The potential staging for this option is presented in Table 21. The short term road raising extents are presented in Figure 13.

The two McCallum St raising works could be completed separately, with the eastern edge completed first and center completed second. However, there is likely to be some construction cost benefit in completing both at the same time.

Table 21 Estuary connected areas short term pathway staging

Timeframe	Staged construction implementation and location
Short Term **5 to 10 years**	• Segments 1 to 5 (north of McCallum St): o 0.3m road raising on eastern edge o 0.1m asphalt resheet McCallum St above culvert
Long Term **2070 to 2100**	• Segments 1 to 5 (north of McCallum St): o 0.5m to 1m road raising McCallum St • Segment 6: o 0.5m to 1m road raising Graham Smelt Causeway • Segment 7: o Levees along Berryman St in Segment 7 (island south of marina)

Figure 13: Estuary Inundation Short Term Defend (Levees and Road Raising) Pathway

6.9.1 Adaptation pathway

The sequence for recommended adaptation pathways for the inland areas connected to the Estuary is presented in Table 23 below.

The planning and action triggers are dependent on future SLR and are outlined below and presented in Table 22:

- Planning trigger – 100 year ARI flood level (+SLR) within 10cm of road/asset level
- Action trigger – 100 year ARI flood level (+SLR) within 5cm of road/asset level

This would provide approximately 5 years between the planning trigger and action trigger based on potential future SLR assessed in this study. The McCallum St east section is already within the 0.1m planning trigger, so planning should commence to raise this

Table 22: Estuary connected areas recommended short term triggers

Segment Number	**Road Section**	**Road Elevation (mAHD)**	**Planning Trigger** – SLR from 2023 (m)	**Action trigger -** – SLR from 2023 (m)
1 to 5	McCallum St East	+2.25	0 (now)	0.05
	McCallum St Center (above culvert)	+2.45	0.2	0.25

Table 23: Adaptation pathways map – Estuary inundation

		PRESENT DAY	2050	2100
	EROSION HAZARD RISK	Low		
	INUNDATION HAZARD RISK	High	Extreme	Extreme
PLANNING	SEGMENTS 1 TO 5 - McCALLUM ST RAISING DESIGN			
AVOID	SEGMENTS 1 TO 8 - INLAND AREAS	Avoid placing new non-relocatable uses in hazard areas (on-going)		
MONITORING	SEGMENTS 1 TO 8 - MONITOR WATER LEVELS AGAINST TRIGGER VALUES			
PROTECT	SEGMENTS 1 TO 5 - RAISE McCALLUM ST EAST END 0.3m			
	SEGMENTS 1 TO 5 - RAISE McCALLUM ST CENTER 0.1m	Timing dependent on SLR trigger		
	SEGMENTS 1 TO 5 - RAISE McCALLUM ST 0.5m TO 1m		Timing dependent on SLR trigger	
	SEGMENT 6 - RAISE GRAHAM SMELT CAUSEWAY 0.5m TO 1m		Timing dependent on SLR trigger	
	SEGMENT 7 - CONSTRUCT LEVEES ALONG BERRYMAN ST (ISLAND SOUTH OF MARINA)		Timing dependent on SLR trigger	

7 Summary of recommendations

Recommended adaptation pathways have been developed for the three main areas in Sections 6.7 to 6.9. These pathways show the sequencing of actions through time against identified planning and action triggers.

To implement these adaptation pathways the following actions are recommended, which are summarised in the following sections.

7.1 Immediate and Short Term Planning

The following lists the immediate planning actions that should be undertaken to guide the short term physical works (Section 7.2).

1. Immediate Planning (coming 12 months)
    - Concept Protection Alignment Study - Townsite (Segments 1 to 6)
    - McCallum St East Raising Design – Estuary Connection (Segments 1 to 5)
2. Short Term Planning and Review (0 to 5 years)
    - Monitoring of shoreline position against triggers – Southern Shoreline (Segments 8 and 9)
    - Geotechnical Investigations - Southern Shoreline (Segments 7 and 8)
    - Adaptation Plan Review

Further details on these planning actions are presented in Table 24 on the following page. The potential costs and timeframes are indicative only and should be refined through development of detailed scope of works and cost estimation.

Table 24: Coastal Adaptation Action and Prioritisation Plan

Priority	Title	Segment	Description	Cost	Timeframe
Immediate	Concept protection alignment study	Townsite (Segments 1 to 6)	A concept protection alignment study is recommended to be completed as soon as possible. The aim of the concept study is to select a protection alignment for each segment to best meet the community's preferences, balancing trade-offs between foreshore assets, recreation space, water access and a usable beach. The general steps would include: 1. Community engagement o comprehensive community engagement program to identify what's most important to the community, so that the protection alignment can optimized for what community values most. o Consult on potential alignments, including design type, access and supporting or complementary nature based options to promote maintaining beach width and the natural environment. 2. Stakeholder engagement o discussions with Coast Protection Board 3. Concept design of typical protection section o review previous concept design from 2014 study o update section based on discussions with Coast Protection Board and outcomes from community engagement o consider and prepare concepts for complementary management options to promote maintaining beach width and the natural environment. This may include sand sourcing investigations, trial of sand trapping mechanisms such as SandSavers and investigating opportunities to promote the existing mangrove communities. 4. For each segment identify prepare communication material for engagement purposes which shows: o Potential alignment options, balancing: i. Key foreshore assets position, costs and remaining design life ii. Beach access locations iii. Remaining beach widths o Develop list of trade-offs for different alignments o Consider stormwater design o Consider complementary options to provide and support the natural environment o Consider and design access requirements Subsequently, supporting Council and the community with the alignment selection. 5. Develop staging and cost plan and progress detail design documentation	$200,000	6 to 9 months
	McCallum St East Raising Design	Estuary Connection (Segments 1 to 5)	The planning triggers suggests that the 100 year ARI ocean flood level is approximately 0.1m lower than the eastern end of McCallum St. As such, McCallum St could be overtopped by the 100 year ARI ocean flood event in the coming 10 years depending on the rate of SLR experienced in the short to medium term. Council should commence planning to raise the eastern end of McCallum St. This should include concept through detailed design of the road raising works, including potential widening of the causeway embankment to allow the road to be raised. This should also consider the merits of re-asphalting the center of McCallum St whilst the larger works in the eastern end are undertaken.	$70,000	6 to 9 months

Short term (0 to 5 years)	**Monitoring**	**Southern Shoreline (Segment 9)**	The Ski Beach Club carpark and beach access ways in Segment 9 are currently within the S1 erosion distance (i.e. 100 year ARI storm erosion extent). Council needs to monitor the erosion setback here, this may be undertaken via a community representative, where a physical maker is placed seaward of the assets and 3 monthly recording and reporting is undertaken by a community member to Council.	Nil	0 to 6 months
	Geotechnical Investigations	**Southern Shoreline (Segments 7 & 8)**	A geotechnical investigation is recommended to be completed in Segments 7 and 8 in front of the southern townsite area. Rocky headlands and platforms are present along the coast in these segments; however, the strength, depth and extent of this bedrock is unknown. Understanding the geotechnical conditions in this area would provide further confidence in the erosion hazard and risk assessment results and confirm the assumed level of erosion risk for these segments. The geotechnical works would generally include: 1. Borehole testing: o Undertake approximately 20 boreholes, spaced approximately every 50m across Segment 7 and the northern end of Segment 8. o Boreholes should be completed using a diamond corer, allowing bedrock cores to be extracted to at least -1mAHD. o Cores are preferred as they can show any layering and allow samples to be taken for strength testing below. 2. Strength testing of bedrock samples to show consolidation and likely resistance to erosion. 3. Update erosion hazard maps based on results. A detailed geotechnical scope of works and cost should be developed to guide this process.	$150,000	6 to 12 months depending on rig availability
	Planning & Review	**All segments**	The following is recommended to be implemented by Council: • Ensure that future planning decisions are made in line with the recommendations of this adaptation plan and that the coastal hazard maps developed as part of this study (and updated with monitoring data collected over time) are used to inform future decisions regarding development within Tumby Bay. • Coastal adaptation planning for this area should be reviewed every five years (or sooner as required) taking into account: o improved/updated understanding of coastal hazard risks for the DCTB area; o changes to relevant planning policies; o any significant changes to current coastal infrastructure and management requirements .	$50,000 every 5 years	6 months

7.2 Short Term Physical works

The following works should be prioritised in the coming 25 years:

1. 0 to 5 years:
    - Segments 1 & 3: Subsequent to alignment study commence protection design and foreshore realignment (i.e. remove existing seawall, potentially relocate and remove foreshore assets)
    - Segment 9: Monitoring of erosion set back using a physical maker and potential community support to monitor, record and report to Council.
2. 5 to 10 years:
    - Raise McCallum St
        - i. 0.3m road raising on eastern edge
        - ii. 0.1m asphalt resheet McCallum St above culvert
    - Segments 4 & 5: New rock revetment and levee
    - Segment 6: Replace existing revetment with new rock revetment
    - Segment 8 (if geotechnical investigation shows risk)
        - i. New beach access ways
        - ii. Relocation of foreshore path
3. 10 to 15 years:
    - Segment 2: Replace existing GSC revetment with new rock revetment
4. 15 to 25 years:
    - Segments 1 to 3 & 6: New levee at rear of seawall

7.3 Medium to Longer Term Physical Works

The following works are likely to be required in the longer term (beyond 2050):

- Townsite (Segments 1 to 6):
    - Upgrade seawall and levee
- Estuary connected areas:
    - Segments 1 to 5 (north of McCallum St):
        - i. 0.5m to 1m road raising McCallum St
    - Segment 6:
        - 0.5m to 1m road raising Graham Smelt Causeway
    - Segment 7:
        - Construct levees along Berryman St (island south of marina)

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Appendix A: Technical Note Erosion and Flood Mapping Calculations

Technical Note

Date: 05/04/2024

Client: District Council of Tumby Bay

Subject: Tumby Bay CAS - Preliminary coastal hazard mapping

1 Introduction

The District Council of Tumby Bay (Council) commissioned Wavelength Consulting Pty Ltd (Wavelength) to undertake the Coastal Adaptation Strategy (CAS) in accordance with the South Australian LGA Coastal Adaptation Guidelines (hereafter referred to as "the Guidelines"). This Technical Note outlines the calculations undertaken to support the preliminary erosion and inundation mapping.

For ease of assessment, the study area has been split into two main coastal areas and eleven segments (as shown in Figure 1). These areas and segments are based on the underlying geomorphology and specific features such as coastal structures and dune systems:

- **Tumby Bay Townsite:**
  - **Segment 1:** Tumby Bay north
  - **Segment 2:** Geotextile Sand Container (GSC) seawall
  - **Segment 3:** Vertical seawall
  - **Segment 4:** Tumby Bay south of seawall
  - **Segment 5:** Tumby Bay north of rock revetment
  - **Segment 6:** Rock revetment
- **Southern shoreline:**
  - **Segment 7:** Rocky headland
  - **Segment 8:** Southern township south of rocky headland
  - **Segment 9:** Ski Beach north
  - **Segment 10:** Ski Beach south
  - **Segment 11:** Back Beach

Figure 1: Definition of assessment segments

2 Existing coastal management

Tumby Bay is a developed coastline, with a number of existing coastal management measures. These management measures play an important role in reducing erosion and inundation risk and have been considered as part of the preliminary hazard and risk assessment.

Before 1970, the Tumby Bay Foreshore area consisted of a natural, low-lying sand dune shoreline, featuring playground equipment, car parking, and a café. In the 1970's, most of the vegetation was cleared, with the dunes flattened and replaced by lawn areas. Consequently, the coastal edge exhibited a flatter, sloped profile and faced frequent erosion, a condition that prompted the installation of coastal management measures.

The following provides a summary of the existing coastal management measures:

Vertical seawall:

- Parts of the Tumby Bay coastline (Segment 3) are back by a vertical seawall (1.8 m high, interlocking L shaped precast vertical wall panelling), which was constructed in the late 1990's to reduce erosion impacts.
- Over time, sections of the seawall have failed and have been removed, replaced, or reinforced.
- The remaining sections are in poor condition and the present wall height is below the current 1 in 100-year ARI storm level.

GSC seawalls:

- In 2005, a trial GSC seawall was implemented directly north of the jetty, accompanied by a revegetation effort above the wall.
- In 2022, a GSC seawall (Segment 2) consisting of 7 vertical layers with a crest height of 3.2 m AHD was constructed. The seawall is in reasonable condition and effective in controlling erosion impacts.

GSC groynes:

- In the mid-2000s, 3 trial GSC groynes were installed to the south and north of the jetty and at the northern end of the township.
- The groynes have had only a minimal impact at reducing longshore transport because the crest height is considered to be too low.

Beach nourishments and re-vegetation:

- In 2003, a nourishment of 10,000 m^3 was undertaken North of the Yacht Club.
- Additionally, a dune restoration and revegetation project was carried out North of the Ritz Café.

Rock revetment:

- A rock revetment was constructed to protect the houses located to the north of the marina. The revetment armour layer consists of relatively small rocks.

Marina entrance channel:

- The Marina entrance channel is likely to have altered sand movement dynamics at the south end of the beach (Segment 6). The low training wall may stop sand from moving further southwards and trap sand in the wave shadow.
- The channel remains open mainly through tidal flows. Occasionally, maintenance dredging is needed.

3 Erosion mapping

3.1. Approach

The South Australian Coast Protection Board's Policy for coastal erosion, flooding, and sea level rise (SLR) states that for consideration of erosion setbacks, estimates need to be made of the potential coastal retreat during the next 100 years.

The policy recommends that local long-term erosion or accretion trends be considered, as well as potential storm erosion, and likely recession due to SLR (CPB, 1992). These three factors have been considered in establishing the erosion mapping for the relevant planning horizons (present day, 2050 and 2100) and are discussed in more detail below, they are referred to throughout this technical note as follows:

- **S1 -** Storm erosion;
- **S2 -** Long-term erosion or accretion;
- **S3 -** Recession due to SLR

The calculated setback distances provide a first pass assessment of the areas at risk to inform future adaptation planning. Recognising these limitations, a conservative approach has generally been adopted throughout the calculations.

4 Storm erosion modelling (S1)

4.1. Software

SBEACH (Storm-induced BEAch CHange) software was used to predict and analyse short–term, storm-induced erosion at the site. The SBEACH model is the most commonly used model within industry for evaluating beach response to storms and has been successfully calibrated and verified for a number of Australian beaches (Carley, 2001).

SBEACH simulates cross-shore beach, berm, and dune erosion produced by storm waves and water levels. The software has the following inputs:

- varying input water levels (from combined storm surge and tide),
- varying wave heights and periods,
- nearshore bathymetry, beach and dune profiles, and
- sediment grain size.

4.2. Model inputs

4.2.1. Bathymetry profiles

A review was undertaken of the 10 cross-shore profiles obtained from DEW which cover the length of Tumby Bay. This is outlined below:

- Of the 10 profiles, 4 profiles were selected to represent conditions in Segments 1 to 11 of the coastline as detailed in Table 1.
- For Segments 2, 3, 4, and 8, which show a similar beach orientation, facing to the east-south-east, the same DEW profile elevation was used but with different configurations accounting for the GSC seawall (Segment 2), the vertical seawall (Segment 3) and no seawall (Segments 4 and 8).
- The same holds for Segments 5, 6, 9, and 10, where the same DEW profile elevation was used but with two different configurations accounting for no rock revetment (Segments 5, 9, and 10) and rock revetment (Segment 6).

The cross-shore profiles 340004, 340009, and 340007 used in the SBEACH modelling were interpolated to a grid resolution of 1 m for the first 500 m on the landward side of the profiles and to a grid resolution of 2 m for the remaining distance on the seaward side of the profiles. For profile 340011, which was the longest profile, a spatially varying grid resolution, with finer grid cells closer to the shore was chosen. The first 250 m on the landward side have a grid resolution of 1 m, continuing with 2 m for the following 500 m, 4 m for the following 1000 m and 5 m for the last 900 m on the most seaward side of the profile.

Table 1: Summary of shoreline profiles used for SBEACH modelling

Segment	DEW Profile No.	Location	Date
1	340004	Tumby Bay north	30/05/2023
2	340009	GSC seawall	30/05/2023
3	340009	Vertical seawall	30/05/2023
4	340009	Tumby Bay south of seawall	30/05/2023
5	340007	Tumby Bay North of rock revetment	30/05/2023
6	340007	Rock revetment	30/05/2023
7	N/A	Rocky headland	30/05/2023
8	340009	Southern township south of rocky headland	30/05/2023
9	340007	Ski Beach north	30/05/2023
10	340007	Ski Beach south	30/05/2023
11	340011	Back Beach	30/05/2018

4.2.1. Horizontal Setback Datum

The Horizontal Setback Datum (HSD) or baseline, which is typically defined as the base of the erosion scarp on an eroding shoreline, or the vegetation line on an accreting coastline. The HSD was estimated using aerial photographs, cross-shore profiles, and LiDAR data. The HSD value depends on how exposed a coastal section is to hydrodynamic forces. In general, the more exposed a section of coastline is, the higher the HSD value. The HSD values for the different coastal segments are summarised in Table 2.

Table 2: Horizontal Setback Datum

Segment	HSD (m AHD)	Location
1	1.7	Tumby Bay north
2	1.0	GSC seawall
3	1.0	Vertical seawall
4	1.5	Tumby Bay south of seawall
5	1.0	Tumby Bay north of rock revetment
6	1.0	Rock revetment
7	1.6	Rocky headland
8	1.6	Southern township south of rocky headland
9	1.5	Ski Beach north
10	1.4	Ski Beach south
11	1.5	Back Beach

4.2.2. Sediment grain size

Sand characteristics were obtained from a sediment sample collected as part of the Tumby Bay site visit on 03/07/2023. The sample was analysed by Australian Geotechnical Testing and showed medium sand with a mean (D_{50}) sediment diameter of 0.38 mm as shown in Figure 2.

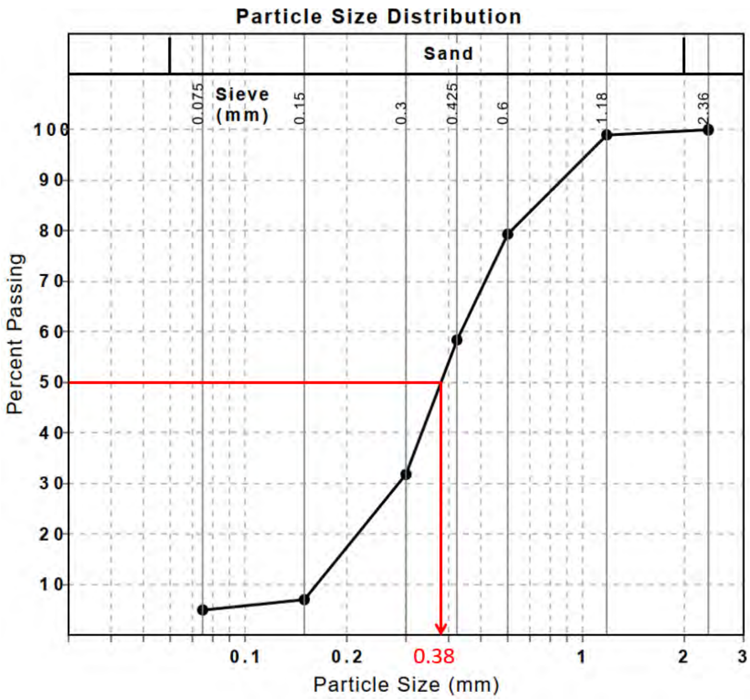

Figure 2: Particle size distribution of sediment sample collected from Tumby Bay on 03/07/2023

4.2.3. Design storm inputs

Site specific wave data was not available for this study, which is noted as a significant limitation. The wave parameters applied to the storm beach modelling are summarised in Table 3 below. Slightly different storms were designed for the more sheltered beaches of Segments 1 to 10 and the more exposed beach at Segment 11.

Table 3: Design storm parameters

Model Parameter	Value	Justification
Design storm event	1% Annual Exceedance Probability (AEP)	The policy establishes the 100yr Average Recurrence Interval (ARI), equivalent to the 1% AEP, as the standard for assessing coastal development in South Australia (CPB, 1992).
Storm duration and shape	64 hrs (Segments 1-10) 71 hrs (Segment 11)	Based on the results of the analysis of the Cape de Couedic wave buoys (approx. 200km from Tumby Bay) the median storm duration was found to be 43 hrs (Shand et al., 2011). The storm shape and tidal signal were based on a large storm event from May 2016. This storm event had elevated water levels for approximately 60 to 70 hours and coincided with a peak tidal level of approximately 0.2m below Highest Astronomical Tide. Unlike the May 2016 storm event, the storm event modelled in SBEACH was assumed to pass to the north of Tumby Bay, resulting in wind waves generated across the easterly and south-easterly Spencer Gulf fetches. This is considered a conservative but not unreasonable estimate of extreme storm conditions at Tumby Bay and is in line with the approach taken in AECOM (2014).
1% AEP water level	1% AEP water level = +2.15 m AHD	A 1% AEP water level estimate of +2.15 m AHD at Tumby Bay was calculated by the Coast Protection Board. The 2016 storm event was disaggregated into tide and tidal anomaly, with the tidal anomaly then factored and added back to the tidal signal so that the peak water levels corresponded with a 100yr ARI water level. This is considered a conservative but not unreasonable estimate of conditions given low pressure systems are responsible for large waves, strong winds and storm surges (WRL, 2013).
5% AEP wave height	3.8 m at -7 mAHD contour (Segments 1-10) 5.0 m at -7 mAHD contour (Segment 11)	Due to its coastal orientation, the exposure of Segments 1 to 10 to swell waves from the South is limited. Thus, only wind waves were considered for these segments. A 20-year ARI peak wind wave height of 3.8 m in 7 m water was calculated using the effective fetch from an ESE direction. Segment 11 is more exposed to swell waves from the South. Based on the swell wave modelling of the South Australian Sea by Hemer and Bye (1999), a swell wave height of 3.2 m was found. For Segment 11, a 20-year ARI peak wind wave height of 3.8 m was calculated using the effective fetch from a SSE direction. The combined peak wave height due to wind and swell was estimated to be 5.0 m at 7 m water.
5% AEP wave period	7.8 s (Segments 1-10) 7.7 s (Segment 11)	Mean wave periods were calculated using the effective fetch from an ESE direction for Segments 1 to 10 and from a SSE direction for Segment 11, respectively.

Model Parameter	Value	Justification
Wave angle	Shore normal	Conservative approach for modelling storm erosion in SBEACH.

4.3. Results

4.3.1. Seawall failure

As noted, seawalls/revetments of varying type exist along most of the study area. A first pass assessment of potential seawall failure was completed for the 1% AEP storm event presented in Table 3. The following seawall failure mechanisms were investigated:

Armour damage:

- Large waves can cause armour rocks to move and with sufficient storm duration expose the underlying filter layers, leading to seawall failure.
- Armour damage is assessed based on the visual inspection of the quality and size of the armour layer.

Undercutting:

- Seawalls can fail due to undercutting, as the beach in front of the seawall is eroded, causing the seawall to slump and armour/concrete to fail.
- The seawall profile was entered into SBEACH, allowing the erosion depth to be calculated for the 1% AEP storm event. The toe depths for the for the GSC- and vertical seawall (Table 4) were determined based on technical reports and drawings provided by DCTB. The toe depth for the rock revetment (Table 4) was determined based on aerial imagery and the DEM provided by DEW.
- Undercutting failure was assumed to occur if the erosion depth exceeded the toe depth.

Overtopping:

- Wave overtopping occurs when high water levels allow waves to break over a seawall, scouring and dislodging the crest rocks and filter layers.
- 1% AEP waves and water levels were output from SBEACH at the seawall locations.
- Seawall crest levels were calculated using the 2018 LiDAR data.
- Overtopping rates were calculated using the formulas available on CRESS.nl (CRESS, 2018).
- The following rates were used to assess seawall damage based on Coastal Engineering Manual values (USACE, 2006):
    - Damage to **unpaved crests: 50 to 200 litres per second**
    - Damage to **paved crests: >200 litres per second**

Results of the preliminary seawall failure review are presented in Table 4 for the 1% AEP storm event. Values have been colour coded as below:

- Green – values are well below established limits, with a low risk of failure.
- Yellow – values are close to established limits, with a moderate risk of failure.
- Red – values are well over established limits, with a high risk of failure.

Table 4: Seawall failure mechanisms for 1% AEP event

Segment	Location	Seawall type	Armour damage	Undercutting		Overtopping		Result
				Toe level (mAHD)	Scour Depth (mAHD)	Crest Level (mAHD)	Overtopping rate (l/s)	
2	Tumby Bay township	GSC seawall	• Sandbags are in good condition and of adequate size	-0.2	1.6	+3.2	22.6	• Seawall does not fail in 1% AEP event • Some damage from overtopping and scour; repairs required • Design life of structure ~15 years • S1 = 0 m for 15 years after construction
3	Tumby Bay township	Vertical seawall	N/A	0.7	1.3	+2.5	177.8	• **Seawall failure** due to overtopping and undercutting in 1% AEP event • S1 = 4.5 m (50 % of unprotected erosion)
6	North of marina	Rock revetment	• Relatively small armour rock size ~ 0.3 m	~0.0	1.5	+2.6	35.9	• **Seawall failure** due to armour movement in 1% AEP event • S1 = 9 m (50% of unprotected erosion)

4.3.2. S1 Erosion

Following review of seawall failure, the potential storm erosion was modelled using SBEACH. The S1 erosion is measured from the HSD or baseline. The results of the SBEACH modelling are summarized in Table 5 below. An example of the SBEACH modelling results is provided in Figure 2 below.

Table 5: Setback allowances

Segment	DEW Profile	Location	Storm erosion allowance (m)
1	340004	Tumby Bay north	14
2	340009	GSC seawall	0
3	340009	Vertical seawall	4.5[1]
4	340009	Tumby Bay south of seawall	9
5	340007	Tumby Bay north of rock revetment	18
6	340007	Rock revetment	9[1]
7	N/A	Rocky headland	0
8	340009	Southern township south of rocky headland	9
9	340007	Ski Beach north	18
10	340007	Ski Beach south	18
11	340011	Back Beach	12

Notes: 1. Values are 50% of unprotected erosion to account for the supporting effect of the existing structures within these segments

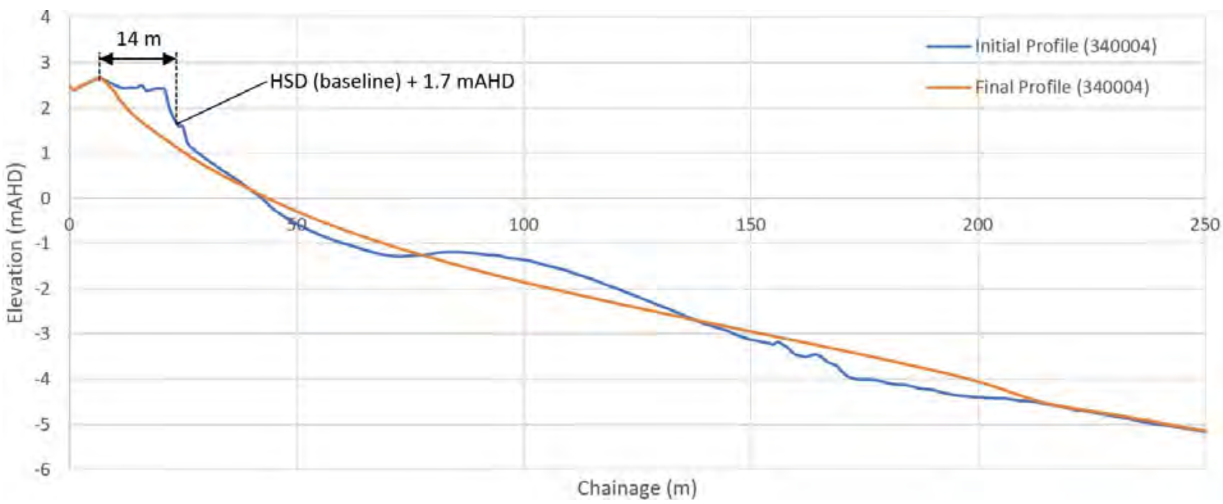

Figure 3: Example of SBEACH Results for Segment 1

5 Long term shoreline recession (S2)

5.1. Summary of trends in shoreline movement

The following presents a summary of the key assumptions and shoreline movement trends adopted for the preliminary erosion hazard mapping. Historical shoreline movement trends were determined based on the following:

- The following presents a summary of the key assumptions and shoreline movement trends adopted for the preliminary erosion hazard mapping. DEW profile analysis of the profiles present in the different segments, or
- mapping of the coastal vegetation line based on ortho-rectified aerial imagery from the years 1982, 2011, and 2023 (sourced from DEW Mapland).

The DEW profiles used for analysis for the different segments and the results of the shoreline movement analysis are summarised in Table 6 below.

Table 6: Long term shoreline recession allowances

Segment	DEW Profile	Location	S2 allowance (-m/yr)
1	340004, 34005, 340013	Tumby Bay north	0.20
2	340009, 340006	GSC seawall	0.15[1]
3	340009, 340006	Vertical seawall	0.15
4	340009, 340006	Tumby Bay south of seawall	0.15
5	340007	Tumby Bay north of rock revetment	0
6	340007	Rock revetment	0
7	N/A - aerials	Rocky headland	0
8	N/A - aerials	Southern township south of rocky headland	0.12
9	N/A - aerials	Ski Beach north	0.21
10	N/A - aerials	Ski Beach south	0
11	340010 - 340012	Back Beach	0.15

Notes: 1. Value is applied from 2035 onwards (after the design life of ~15 years is over) assuming that the seawall is not replaced/upgraded by another structure

6 Recession due to SLR (S3)

The most widely used method for estimates of recession as a result of SLR is the Bruun Rule (Bruun 1962, 1988). The limitations of this method are well recognised (Ranasinghe et al., 2007) however no robust and scientifically recognised alternative currently exists (WRL, 2013) and the application of the Bruun Rule remains a part of standard practice and is supported by several state planning policies (WA, NSW and QLD) (Mariani et al, 2012).

A key assumption for application of the Bruun Rule is that the profile is modified by cross shore sand transport only and that longshore sand transport does not contribute. In areas where there is high longshore sand transport and / or areas with groynes or breakwaters that intercept the longshore transport, the contribution to profile evolution by longshore transport is a consideration.

In instances where the Bruun Rule cannot be applied, and in the absence of long-term monitoring data, a Bruun factor "rule of thumb" is typically applied to provide a first pass assessment for setbacks due to sea level rise, based on the active slope of the shore profile. Analysis of the beach profiles and active slopes available in each segment are outlined in Table 7, along with the resultant Bruun Factor.

Table 7: Summary of Bruun factor estimates

Segment	Location	Active Slope V:H	Estimated Bruun Factor	Upper Limiting Bruun Factor
1	Tumby Bay north	1:31	31	50
2	GSC seawall	1:28	28	50
3	Vertical seawall	1:28	28	50
4	Tumby Bay south of seawall	1:41	41	50
5	Tumby Bay north of rock revetment	1:49	49	50
6	Rock revetment	1:49	49	50
7	Rocky headland	N/A	N/A	N/A
8	Southern township south of rocky headland	1:28	28	50
9	Ski Beach north	1:49	49	50
10	Ski Beach south	1:49	49	50
11	Back Beach	1:9	9	50

An **upper limit factor of 50** is proposed to account for factors not considered by the Bruun Rule, including changes in longshore transport, tidal currents, seagrass vegetation and wave penetration into Gulf St Vincent. By adopting this "rule of thumb" approach it provides a conservative approach to identifying areas potentially at risk.

The state planning policy recommends an allowance of 0.3 m for SLR to the year 2050, and 1 m by 2100, when considering coastal inundation and long-term recession effects and planning for coastal development. Table 8 below presents the estimates of mean SLR for the planning horizons 2050 and 2100 and the subsequent erosion setback distances using the upper limiting Bruun Factor.

Table 8: Sea level rise and erosion setback scenarios

Segment	Planning Horizon	Sea Level Rise (m)	Shoreline Setback (Upper limiting Bruun Factor, BR50)
1 to 5	**2050**	0.3	15
	2100	1.0	50

7 Summary of erosion set back

A summary of setback allowances from the proceeding information is presented in Table 8. The preliminary erosion hazard maps are presented in Appendix 1.

Key assumptions related to the combined effects of S1, S2 and S3 factors to develop the erosion hazard maps presented in Appendix 1 are outlined below:

- **Segment 2 (GSC seawall) –** it's assumed that the GSC seawall does not fail in the 1% AEP event. The S2 value is applied from 2035 onwards (after the ~15 years design lifetime of the structure).
- **Segment 3 (Vertical seawall) -** it's assumed that the vertical concrete seawall fails in the 1% AEP event. 50% of the calculated storm erosion allowances value (S1) for the unprotected case is applied.
- **Segment 6 (Rock revetment) -** it's assumed that the rock revetment fails in the 1% AEP event. 50% of the calculated storm erosion allowances value (S1) for the unprotected case is applied.
- **Segment 7 (Rocky headland)** – it's assumed that the rocky headland does not erode and is stable until 2100. This assumption would need to be confirmed through geotechnical assessment.

Table 9: Summary of setback allowances for present day, 2050 and 2100

Segment	Location	Present erosion setback (m) S1	Long term shoreline recession (m) S2		Recession due to SLR (m) S3		Future erosion setback (m) S1 + S2 + S3	
			2050	2100	2050	2100	2050	2100
1	Tumby Bay north	14	5	11	15	50	**34**	**75**
2	GSC seawall	0	2	10	15	50	**17**	**60**
3	Vertical seawall	4.5	4	12	15	50	**24**	**66**
4	Tumby Bay south of seawall	9	4	12	15	50	**28**	**71**
5	Tumby Bay north of rock revetment	18	0	0	15	50	**33**	**68**
6	Rock revetment	9	0	0	15	50	**24**	**59**
7	Rocky headland	0	0	0	0	0	**0**	**0**
8	Southern township south of rocky headland	9	3	9	15	50	**27**	**68**
9	Ski Beach north	18	6	16	15	50	**39**	**84**
10	Ski Beach south	18	0	0	15	50	**33**	**68**
11	Back Beach	12	4	12	15	50	**31**	**74**

8 Coastal inundation mapping

8.1. Approach

Bathtub modelling is a simplistic approach to identify areas of risk to coastal inundation. Bathtub models are elevation based, applying a deterministic line across a digital elevation model (DEM), identifying the areas below the given inundation scenario.

There are a number of limitations to the bathtub model approach, studies that have assessed bathtub models against dynamic models suggest that a dynamic mapping method is best used for site-specific hazard assessments where high accuracy is required at the property scale (New Zealand Government, 2017). Further to this, the quality of the DEM, which is a function of the spatial resolution and the vertical accuracy of the data source, has a great influence on the accuracy of the inundation mapping.

For the purposes of providing a first pass to identify areas at risk of coastal inundation, the bathtub model approach is considered sufficient for use in this study.

It is differentiated between coastal inundation, which accounts for the effects of wave run up, and estuary inundation. Coastal inundation was only mapped in low lying areas where a direct overland flow from the ocean to the inland was evident in the DEM. Estuary inundation was mapped where an estuary connection to the hinterland was found. Inland flood connectivity through the stormwater drainage network was considered.

8.2. Inundation parameters

The SA Coast Protection Board has utilised the parameters presented in Table 10 for the 1% AEP ocean water level event for Tumby Bay and the surrounds. Table 10 presents the coastal inundation parameters for the relevant horizons, which were applied in the coastal inundation mapping. It must be noted that run up was not included in the bathtub model for the year 2100 due to the presence of dense development (roads, houses etc.) in the 2100 flood extent. Accounting for run up in this scenario may overestimate the extent of flooding, as it would encompass a considerably larger area.

Table 10: Coastal Inundation Parameters for Tumby Bay (mAHD)

Parameter	Present day		2050		2100	
	Estuary	Coast	Estuary	Coast	Estuary	Coast
1% AEP Ocean water level	+1.95		+1.95		+1.95	
Wave set up	0.2		0.2		0.2	
Wave run up	-	0.5	-	0.5	-	
Sea level rise	-		0.3		1.0	
TOTAL	**+2.15**	**+2.65**	**+2.45**	**+2.95**	**+3.15**	

8.3. Results

The inundation mapping results are presented in Appendix 2.

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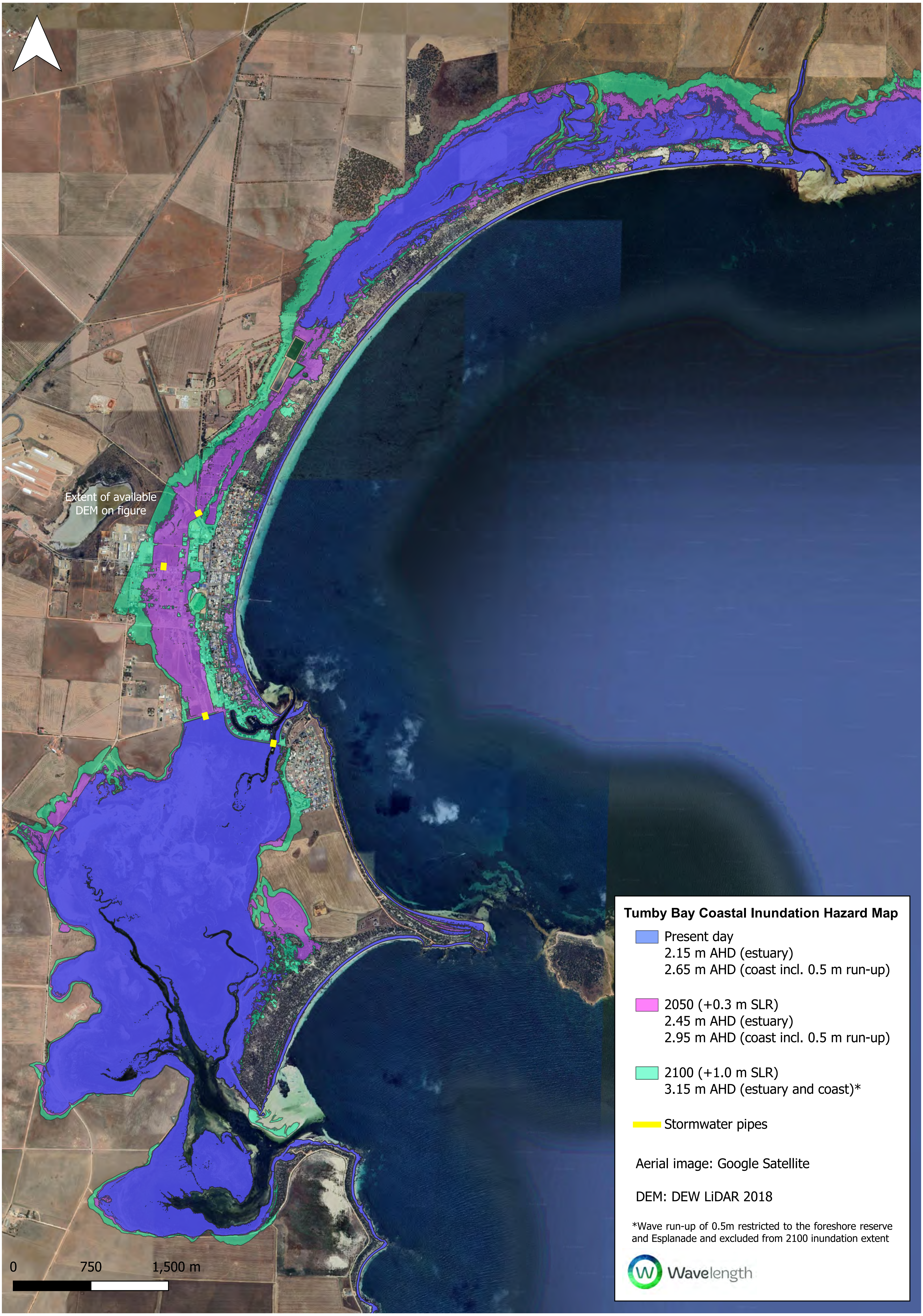
Appendix 1 – Coastal Erosion Mapping


Segment 1
GSC seawall
Segment 2
Vertical seawall
Segment 3
Segment 4
Segment 5
Segment 6
Rock revetment
Tumby Bay Coastal Erosion Hazard Map
Baseline
Present day
2050
2100
Aerial image: Google Satellite
Wavelength
0 100 200 m

Segment 6
Segment 7
Rocky Coastline
Segment 8
Segment 9
Segment 10
Segment 11
Tumby Bay Coastal Erosion Hazard Map
Baseline
Present day
2050
2100
Aerial image: Google Satellite
0
100
200 m
Wavelength

Appendix 2 – Coastal Inundation Mapping


Extent of available DEM on figure
Tumby Bay Coastal Inundation Hazard Map
Present day
2.15 m AHD (estuary)
2.65 m AHD (coast incl. 0.5 m run-up)
2050 (+0.3 m SLR)
2.45 m AHD (estuary)
2.95 m AHD (coast incl. 0.5 m run-up)
2100 (+1.0 m SLR)
3.15 m AHD (estuary and coast)*
Stormwater pipes
Aerial image: Google Satellite
DEM: DEW LiDAR 2018
*Wave run-up of 0.5m restricted to the foreshore reserve and Esplanade and excluded from 2100 inundation extent
Wavelength
0
750
1,500 m


Tumby Bay Coastal Inundation Hazard Map
Present day
2.15 m AHD (estuary)
2.65 m AHD (coast incl. 0.5 m run-up)
2050 (+0.3 m SLR)
2.45 m AHD (estuary)
2.95 m AHD (coast incl. 0.5 m run-up)
2100 (+1.0 m SLR)
3.15 m AHD (estuary and coast)*
Stormwater pipes
Aerial image: Google Satellite
DEM: DEW LiDAR 2018
*Wave run-up of 0.5m restricted to the foreshore reserve and Esplanade and excluded from 2100 inundation extent
Wavelength
Extent of available DEM on figure
Stormwater pipe can be closed to prevent present day inundation. McCallum Rd inundated in 2050 and 2100 scenarios.
0 100 200 m

Appendix B: Asset Risk Profile Tables and Asset Register

Table B1: Inundation risk profiles Segment 1

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 2, 3, 5, 6, 7, 9, and 11 ESPLANADE • 1 PHYLLIS STREET • 1A TENNANT STREET • 4 CARR STREET • 5 and 9 DARLING AVENUE	12	Low	Low	High
	• Lot 65 PUMPA STREET • Lot 343 CARR STREET • 41 AIRPORT ROAD	3	Low	Moderate	High
	• 4, 10, 12, 13, and 14 ESPLANADE • 13 PUMPA STREET • 19, 21, and 23 BAWDEN STREET • 1 and 3 FERGUSSON COURT • 1, 2, 3, and 5 BROUGHAM PLACE • 6, 8, 10, and 12 CARR STREET • 1, 3, 5, 7, 9, 11, 13, 14, 15, and 16 NORTH TREZISE STREET • 7 DARLING AVENUE • 16, 23 and 25 WIBBERLEY STREET • Lot 338, Lot 392, 2, 4, 6, and 8 WEST TERRACE • 6 NELCEBEE TERRACE • 12, 14, 16, and 18 FREEMAN STREET • 1 TENNANT STREET	45	Low	Low	Extreme
	• 15 ESPLANADE • 2 and 4 FERGUSSON COURT • 4 BROUGHAM PLACE	4	Low	Moderate	Extreme
	• 8 and 16 ESPLANADE • 12 NORTH TREZISE STREET	3	Low	High	Extreme
	• 25 BAWDEN STREET • Lot 1 NORTH TREZISE STREET • Lot 361 WEST TERRACE • 106B, 106C, 106D and 106E LIPSON ROAD • 18 and 20 CARR STREET	9	Moderate	Extreme	Extreme
Public	• Beach • Dunes • Protection Structures • Foreshore Reserve Areas • Footpaths • 7 x Beach Access	12	Low	Moderate	High
	• Public Toilet	1	Low	Low	Extreme
Roads & Parking	• Tennant Street • Back Street	2	Low	Low	High
	• Pumpa Street • Excell Road	6	Low	Low	Extreme

	• Wibberley Street • West Terrace • Carr Street • Thompson Street				
	• Brougham Place	1	Low	Moderate	Extreme
	• Lipson Road • North Trezise Street • Fergusson Court • Elanora Avenue • Bawden Street	5	Low	High	Extreme
	• Esplanade	1	Moderate	Extreme	Extreme

Table B2: Inundation risk profiles Segment 2

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 1 and 3 LIPSON ROAD • Lot 63 EXCELL • 14 PUMPA STREET • Lot 1 NORTH TERRACE	5	Low	Low	High
	• 1 and 3 JOHNS STREET • 1 ESPLANADE • Lot 377, Lot 378, and 16 PUMPA STREET • 9 BRATTEN WAY	7	Low	Low	Extreme
	• 20 and 22 NORTH TREZISE STREET	2	Low	High	Extreme
	• Lot 1025 BRATTEN WAY	1	Low	Extreme	Extreme
Public	• Beach • Protection Structures • Foreshore Reserve Areas • Footpaths • Beach Access	5	Low	Moderate	High
Roads & Parking	• Borthwick Street	1	Low	Low	Extreme
	• Esplanade	1	Low	Moderate	Extreme

Table B3: Inundation risk profiles Segment 3

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• Lot 312, 4, 5, 7, and 8 TUMBY TERRACE • 2A NORTH TERRACE	8	Low	Low	High

	• 13 SPENCER STREET • 1 BRATTEN WAY				
	• 5, 7, and 11 JOHNS STREET • Lot 64 BRATTEN ROAD • 20, 20A, 22, 22A, 24, and 26 O'CONNOR STREET • 13, 14, 15, 21, and 26 THURUNA ROAD • 1A NORTH TERRACE • 4A, 7, 8, 9, and 10 TUMBY TERRACE • 9-11 SPENCER STREET • Lot 2, Lot 426, 5, 24, 26, 28, 30, 32, 34, and 38 BRATTEN WAY • 2 CHURCH STREET • The Ritz Café	36	Low	Low	Extreme
	• 13 TUMBY TERRACE • 4A and 4B CHURCH STREET • 22 BRATTEN WAY	4	Low	Moderate	Extreme
	• 3, 5, 7 BUTTERFIELD STREET • 2, 4, 6, 8, 10, 11, 12, and 20 BRATTEN WAY • 1, 13, 14, 15, 16, and 18 O'CONNOR STREET • 2 and 4 TREZISE STREET • 4B CHURCH STREET	20	Low	High	Extreme
	• 14 and 16 BRATTEN WAY • 6 and 16 TREZISE STREET	4	Low	Extreme	Extreme
	• 5-11 THURUNA ROAD • 1, 2, 4, and 6 BUTTERFIELD STREET • 8, 6, 18, and 20 CHURCH STREET • 18 BRATTEN WAY • Lot 336 and 30 WEST TERRACE • 2, 4, 5, 6, 7, 8, 10, and 12 O'CONNOR STREET • 8, 10, 12, 14, 18, and 22 TREZISE STREET	32	Moderate	Extreme	Extreme
	• Lot 118 and Lot 312 TUMBY TERRACE	2	High	Extreme	Extreme
Public	• War Memorial	1	Low	Low	High
	• Beach • Jetty • Protection Structures • Foreshore Reserve Areas • 2x Playgrounds • 3x Beach Access	9	Low	Moderate	High
	• Rotunda Art Gallery	1	Low	Low	Extreme
	• Public Toilet	1	Low	High	Extreme
	• Mortlock Street	3	Low	Low	Extreme

Roads & Parking	• Thuruna Road • John Street				
	• Tumby Terrace • Bratten Road	2	Low	High	Extreme
	• Butterfield Street • O'Connor Street • Trezise Street	3	Moderate	Extreme	Extreme

Table B4: Inundation risk profiles Segment 4

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 1A, 5, and 7 ROBERT STREET • 3, 7, 12, 22, 24, and 41 LAWRIE STREET • 2 SCHRAMM STREET • 4, 17, and 19 SIDNEY ROAD • 4, 6, and 8 DUTTON TERRACE • 6, 8, and10 NANKIVELL STREET • 1 BARRAUD STREET	20	Low	Low	High
	• 1, 3, 3A, 5, 9, and 26 LAWRIE STREET • 1, 3, 11, and Lot 101 CHURCH STREET • 14 and 16 TUMBY TERRACE • 21 SPENCER STREET • Lot 22, 29, 31, 37, 43, and 48 THURUNA ROAD • 1, 2, 3, 4, 5, 6, 8, 9, 11, 13-15, 17, 18, 19, 20, 21, 22, 23, 24-26, 28, 30, and 31 ROBERT STREET • 1, 2, 5, 6, 14, 16, 18, 20, 22, and 24 SIDNEY ROAD • 2, 4, 6, and 8 PREECE STREET • 3 BROCK STREET • 4 BARRAUD STREET • 3 and 5 YOUNG STREET • 7 PARK TERRACE • 97 DUTTON TERRACE	58	Low	Low	Extreme
	• 24 TUMBY TERRACE • 15, 25, 27, 29, 31, 33, and 37 CHURCH STREET • 10, 12, 14, 16, and 20 PREECE STREET • 4, 6, 7, and 8 YOUNG STREET	17	Low	Moderate	Extreme
	• 17, 19, 20, 21, 25, 26, 27, 28, 35, and 36 TUMBY TERRACE • 25 and 27 SPENCER STREET • 85 DUTTON TERRACE • Lot 1033 and 95 THURUNA ROAD • 5 and 7 BROCK STREET • 2 and 3 SIDNEY ROAD • 1 PARK TERRACE • 17, 19, 21, 23, and 35 CHURCH STREET	28	Low	High	Extreme

	• 2 BARRAUD STREET • 2 and 10 YOUNG STREET				
	• 18 and 32 TUMBY TERRACE • Lot 31 ROBERT STREET • 24 DUTTON TERRACE • 1 BROCK STREET • 26 TREZISE STREET • 39 CHURCH STREET	7	Low	Extreme	Extreme
	• Lot 25, Lot 26, Lot 50, Lot 1032, 14, 16, and 24 DUTTON TERRACE • 6, 8, 10, 12, 14, 16, 32, and 36 ROBERT STREET • 29, 30, 31, 32A, 33, and 34 TUMBY TERRACE • Lot 51 CHURCH STREET • Lot 91, 24, 39, 41, 43, 45, and 47 TREZISE STREET • 9 YOUNG STREET • Yacht Club	30	Moderate	Extreme	Extreme
Public	• Beach • Dunes • Foreshore Reserve Areas • Footpath • 2x Beach Access	6	Low	Moderate	High
	• Public Toilet	1	Moderate	Extreme	Extreme
Roads & Parking	• Lawrie Street • West Terrace • Brock Street	3	Low	Low	High
	• Yacht Club car park	1	Low	Moderate	High
	• Robert Street	1	Low	Low	Extreme
	• Barraud Street	1	Low	Moderate	Extreme
	• Young Street • Sidney Road	2	Low	High	Extreme
	• Tumby Terrace • Church Street • Park Terrace • Preece Street	4	Moderate	Extreme	Extreme
	• Dutton Terrace	1	High	Extreme	Extreme

Table B5: Inundation risk profiles Segment 5

Type	Address/Asset	Quantity	Present day	2050	2100

Private Properties	• 1, 2, 3, 35, 39, 41, and 42 LAWRIE STREET • 12 SMITH STREET • 1A GOODE AVENUE • 42 TUMBY TERRACE • 22, 23, 27, and 40 PREECE STREET	14	Low	Low	High
	• 37, 43, 44, 45, 46, 48, and 50 LAWRIE STREET • 24, 38, 42, 44, and 46 PREECE STREET • Lot 611, Lot 612, 2, 8, 8A, and 10 NELCEBEE TERRACE • 27 THURUNA ROAD • Lot 74, 1, 1A, 3, 3A, 5, 7, 9, 11, 11A, 13, and 23 GRAHAM SMELT CAUSEWAY • 39, 40, and 41 TUMBY TERRACE • 11 WANDANA PLACE • Lot 100, 1, and 2 MCCALLUM STREET	38	Low	Low	Extreme
	• 43, 45, and 46 TUMBY TERRACE	3	Low	Moderate	Extreme
	• Lot 279, 37 and 38 TUMBY TERRACE • 21 PREECE STREET • 2 YARINGA AVENUE	5	Low	High	Extreme
Public	• Beach • Dunes • Foreshore Reserve Areas • Playground • Footpath • Beach Access	6	Low	Moderate	High
Roads & Parking	• Preece Street	1	Low	Low	Extreme
	• Lawrie Street • Yarringa Avenue	2	Low	Moderate	Extreme
	• Goode Avenue • Elfrida Drive	2	Low	High	Extreme

Table B6: Inundation risk profiles Segment 6

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 4, 6, 12, and 14 YARINGA AVENUE • 5 WANDANA PLACE • 10, 12, 14, 16, 17, 19, 21, 22, 23, 24, 25, 27, 29, 30, 31, 32, and 34 ELFRIEDA DRIVE • 24 NELCEBEE TERRACE	22	Low	Low	High
	• 1 NELCEBEE TERRACE • Lot 363 ELFRIEDA DRIVE • Lot 75 GRAHAM SMELT CAUSEWAY	3	Low	Moderate	High

	• 4, 14A, 18, 20, and 22 NELCEBEE TERRACE • 1, 2, 3, 4, 5, 7, 9, 13, 14, and Lot 100 WANDANA PLACE • 1, 2, 5, 17, 21, 25, 27, 29, 31, 33, 35, 37, 39, 41, and 43 GRAHAM SMELT CAUSEWAY • 1, 3, 5, 7, and 9 VIKING STREET • Lot 68 SAXON STREET • 1, 3, 6, 7, 8, 9, 11, 13, 20, 36, and 38 ELFRIEDA DRIVE	49	Low	Low	Extreme
	• Lot 251 SAXON STREET • 3, 3A, and 5 NELCEBEE TERRACE • 2-4, 5, 18, and 40 ELFRIEDA DRIVE	8	Low	Moderate	Extreme
	• Lot 17 ELFRIEDA DRIVE	1	Low	Extreme	Extreme
Public	• Beach • Dunes • Foreshore Reserve Areas • Footpaths • Marina protection structures • Boat ramp • Pontoon	7	Low	Moderate	High
Roads & Parking	• Marina Carpark	1	Low	Moderate	High
	• Wandana Place • Nelcebee Terrace	2	Low	Low	Extreme
	• Elfrida Drive • Yaringa Avenue	2	Low	Extreme	Extreme
	• Graham Smelt Causeway	1	High	Extreme	Extreme

Table B7: Inundation risk profiles Segment 7

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 2 BERRYMAN STREET • 4 MORIALTA DRIVE • 15 WANDANA PLACE	3	Low	Low	High
	• 174B THURUNA ROAD • Lot 99 MINNIPA LANE • Lot 354 SKI BEACH ROAD	3	Low	Moderate	High
	• 2A BERRYMAN STREET • 3 MOONTA COURT • 47 GRAHAM SMELT CAUSEWAY • 2 MORIALTA DRIVE	4	Low	Low	Extreme
	• 49 GRAHAM SMELT CAUSEWAY • 1 MOONTA COURT	2	Low	Moderate	Extreme

Public	• Foreshore Reserve Areas • Footpath	2	Low	Low	High
	• 2x Beach Access	2	Low	Moderate	High
	• Beach Access	1	Low	Moderate	Extreme
Roads & Parking	• Minnipa Lane	1	Low	Low	High
	• Morialta Drive	1	Low	Low	Extreme

Table B8: Inundation risk profiles Segment 8

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• Lot 504 and 3 PEARSON STREET • Lot 180 and 37 LAKIN CRESCENT	4	Low	Low	High
	• Lot 503 PEARSON STREET • Lot 354 SKI BEACH ROAD	2	Low	Moderate	High
	• Lot 198, 29, 31, and 33 LAKIN CRESCENT • 1, 2, and 4 PEARSON STREET • 18, 20, 22, 24, 26, 28, and 30 BERRYMAN STREET • 3 SWAFFER STREET	15	Low	Low	Extreme
	• 103 SKI BEACH ROAD	1	Low	Moderate	Extreme
Public	• Footpath • 4x Beach Access	5	Low	Moderate	High
Roads & Parking	• Pearson Street • Berryman Street • Swaffer Street • Lakin Crescent	4	Low	Low	Extreme

Table B9: Inundation risk profiles Segment 9

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 103 SKI BEACH ROAD	1	Low	Moderate	High
Public	• Beach Access	1	Low	Moderate	High

Table B10: Inundation risk profiles Segment 11

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• Lot 345 LIPSON ROAD • 431 THURUNA ROAD	2	Low	Moderate	High

Table B11: Erosion risk profiles Segment 1

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, and 16 ESPLANADE • 1A TENNANT STREET	12	Low	Moderate	High
	• 2, 3, 5, and 7 ESPLANADE	4	Low	Moderate	Extreme
Public	• Dunes	1	Moderate	High	Extreme
	• Protection Structures • Beach Access	2	Moderate	Extreme	Extreme
	• Beach • Foreshore Reserve Areas • Footpaths • Public Toilet • 5x Beach Access	9	High	Extreme	Extreme
Roads & Parking	• Back Street	1	Low	Low	High
	• Elanora Avenue • Tennant Street	2	Low	Moderate	High
	• Esplanade	1	High	Extreme	Extreme

Table B12: Erosion risk profiles Segment 2

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• Lot 1 ESPLANADE	1	Low	Low	High
	• 1 ESPLANADE	1	Low	Moderate	High
	• Lot 1, Lot 2, Lot 3, and Lot 4 ESPLANADE	4	Low	Low	Extreme
Public	• Foreshore Reserve Areas • Protection Structures • Beach Access	3	Moderate	Extreme	Extreme

	• Beach	1	High	Extreme	Extreme
Roads & Parking	• Esplanade	1	Low	Moderate	Extreme

Table B13: Erosion risk profiles Segment 3

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 4A, 6, 7, 8, 9, 10, 11, and 13 TUMBY TERRACE	8	Low	Low	High
	• The Ritz Café	1	Low	High	Extreme
	• Lot 118 TUMBY TERRACE	1	Moderate	High	Extreme
	• Lot 312 TUMBY TERRACE	1	Moderate	Extreme	Extreme
Public	• Rotunda Art Gallery	1	Low	High	Extreme
	• Public Toilet • War Memorial • Bratten Memorial	3	Low	Extreme	Extreme
	• Foreshore Reserve Areas • 2x Playgrounds	3	Moderate	Extreme	Extreme
	• Beach • Jetty • Protection Structures • 3x Beach Access	6	High	Extreme	Extreme
Roads & Parking	• Tumby Terrace	1	Low	Moderate	Extreme

Table B14: Erosion risk profiles Segment 4

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 14, 17, 18, 19, 20, 24, 25, 26, 27, 28, 29, 30, and 31 TUMBY TERRACE • 1 BARRAUD STREET • 5 BROCK STREET	15	Low	Low	High
	• 16 and 21 TUMBY TERRACE	2	Low	Low	Extreme
	• Yacht Club	1	Low	Moderate	Extreme
Public	• Public Toilet	1	Low	Extreme	Extreme

	• Dunes	1	Moderate	Extreme	Extreme
	• Beach • Foreshore Reserve Areas • 2x Beach Access	4	High	Extreme	Extreme
Roads & Parking	• Barraud Street	1	Low	Low	High
	• Yacht Club car park	1	Low	Moderate	Extreme
	• Tumby Terrace	1	Moderate	Extreme	Extreme

Table B15: Erosion risk profiles Segment 5

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 46 TUMBY TERRACE	1	Low	Low	High
Public	• Dunes • Foreshore Reserve Areas • Footpath • Playground	4	Moderate	Extreme	Extreme
	• Beach • Beach Access	2	High	Extreme	Extreme
Roads & Parking	• Yarringa Avenue	1	Low	Low	High
	• Tumby Terrace	1	Low	Moderate	High
	• Elfrida Drive	1	Low	High	Extreme

Table B16: Erosion risk profiles Segment 6

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, and 40 ELFRIEDA DRIVE	20	Low	Low	High
	• Lot 17, 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, and 31 ELFRIEDA DRIVE	17	Low	High	Extreme
	• Lot 363 ELFRIEDA DRIVE	1	Moderate	Extreme	Extreme
Public	• Dunes • Foreshore Reserve Areas • Protection Structures	3	Moderate	Extreme	Extreme

	• Beach	1	High	Extreme	Extreme
Roads & Parking	• Elfrida Drive	1	Low	Moderate	Extreme

Table B17: Erosion risk profiles Segment 7

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• Lot 354 SKI BEACH ROAD	1	Moderate	Moderate	High
Public	• Footpath	1	Low	Moderate	High
	• Beach Access	1	Moderate	Extreme	Extreme

Table B18: Erosion risk profiles Segment 8

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 103 SKI BEACH ROAD	1	Low	Moderate	High
	• Lot 2010 HARVEY DRIVE • Lot 200 PEARSON STREET	2	Low	Moderate	Extreme
	• Lot 2005 HARVEY DRIVE	1	Low	High	Extreme
	• Lot 354 SKI BEACH ROAD	1	Moderate	Extreme	Extreme
Public	• 2x Beach Access	2	Low	Moderate	Extreme
	• 2x Beach Access	2	Moderate	High	Extreme
Roads & Parking	• Harvey Drive	1	Low	Low	High

Table B19: Erosion risk profiles Segment 9

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• Clubhouse	1	Low	Extreme	Extreme
Public	• Public Toilet	1	Low	Moderate	Extreme
	• Beach Access	1	High	Extreme	Extreme

Roads & Parking	• Harvey Drive	1	Low	Low	High

Table B20: Erosion risk profiles Segment 10

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• 103 SKI BEACH ROAD	1	Low	Moderate	Extreme

Table B21: Erosion risk profiles Segment 11

Type	Address/Asset	Quantity	Present day	2050	2100
Private Properties	• Lot 345 LIPSON ROAD	1	Moderate	Extreme	Extreme

Appendix C: Risk Profile Maps

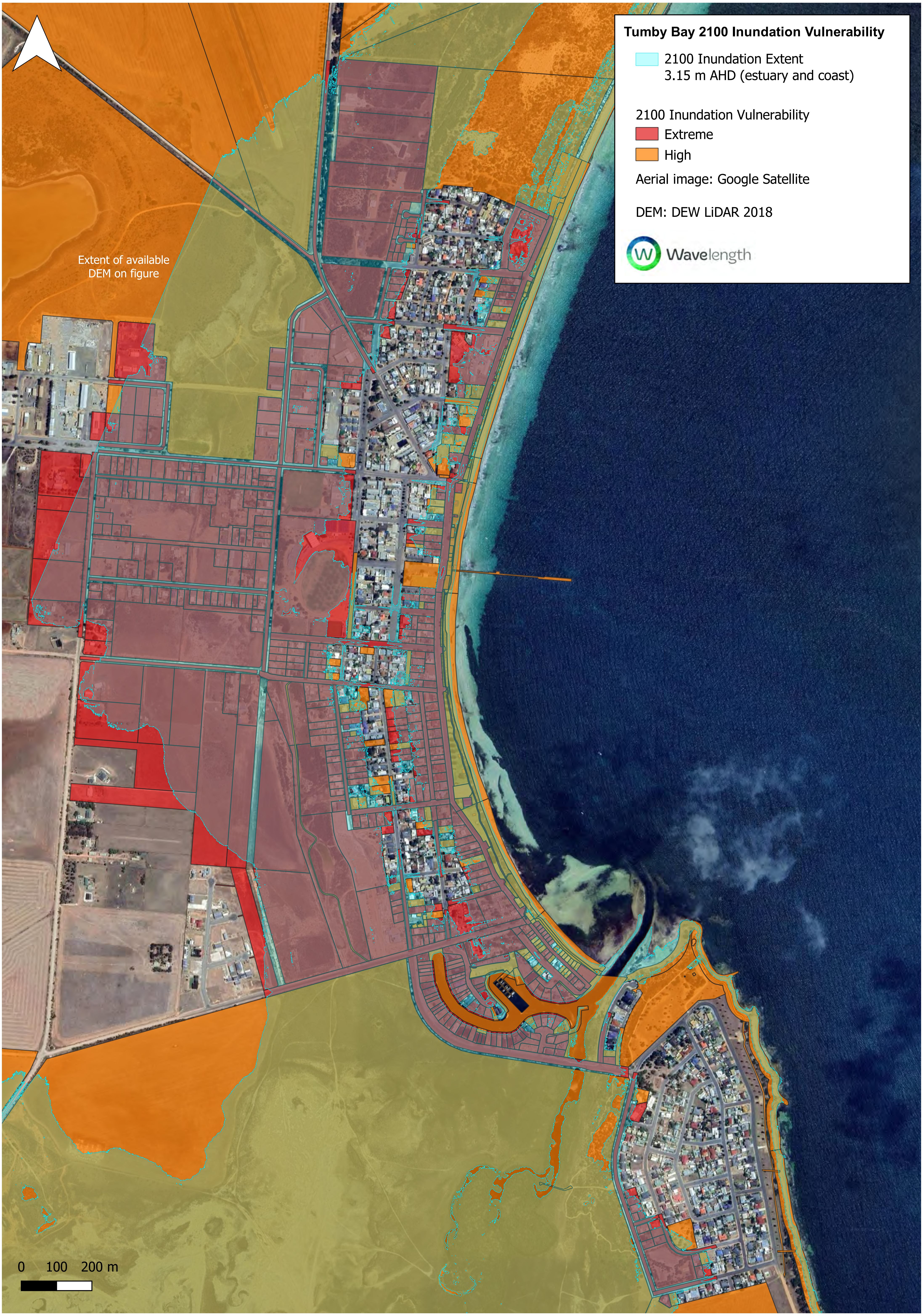
Extent of available
DEM on figure
0
750
1,500 m
Tumby Bay 2023 Inundation Vulnerability
2023 Inundation Extent
2.15 m AHD (estuary)
2.65 m AHD (coast incl. 0.5 m run-up)
2023 Inundation Vulnerability
Extreme
High
Aerial image: Google Satellite
DEM: DEW LiDAR 2018
Wavelength


Tumby Bay 2023 Inundation Vulnerability
2023 Inundation Extent
2.15 m AHD (estuary)
2.65 m AHD (coast incl. 0.5 m run-up)
2023 Inundation Vulnerability
Extreme
High
Aerial image: Google Satellite
DEM: DEW LiDAR 2018
Wavelength
Extent of available DEM on figure
0 100 200 m


Extent of available DEM on figure
0
750
1,500 m
Tumby Bay 2050 Inundation Vulnerability
2050 Inundation Extent
2.45 m AHD (estuary)
2.95 m AHD (coast incl. 0.5 m run-up)
2050 Inundation Vulnerability
Extreme
High
Aerial image: Google Satellite
DEM: DEW LiDAR 2018
Wavelength


Tumby Bay 2050 Inundation Vulnerability
2050 Inundation Extent
2.45 m AHD (estuary)
2.95 m AHD (coast incl. 0.5 m run-up)
2050 Inundation Vulnerability
Extreme
High
Aerial image: Google Satellite
DEM: DEW LiDAR 2018
Wavelength
Extent of available DEM on figure
0 100 200 m

Extent of available DEM on figure
Tumby Bay 2100 Inundation Vulnerability
2100 Inundation Extent
3.15 m AHD (estuary and coast)
2100 Inundation Vulnerability
Extreme
High
Aerial image: Google Satellite
DEM: DEW LiDAR 2018
Wavelength
0
750
1,500 m


Tumby Bay 2100 Inundation Vulnerability
2100 Inundation Extent
3.15 m AHD (estuary and coast)
2100 Inundation Vulnerability
Extreme
High
Aerial image: Google Satellite
DEM: DEW LiDAR 2018
Wavelength
Extent of available
DEM on figure
0
100
200 m

Tumby Bay 2023 Erosion Vulnerability
2023 Erosion Hazard Line
2023 Erosion Vulnerability
Extreme
High
Aerial Image: Google Satellite
Wavelength
Segment 1
Segment 2
Segment 3
Segment 4
Segment 5
Segment 6
0
100
200 m

Segment 6
Segment 7
Rocky Coastline
Segment 8
Segment 9
Segment 10
Segment 11
0 100 200 m
Tumby Bay 2023 Erosion Vulnerability
2023 Erosion Hazard Line
2023 Erosion Vulnerability
Extreme
High
Aerial image: Google Satellite
Wavelength


Tumby Bay 2050 Erosion Vulnerability
2050 Erosion Hazard Line
2050 Erosion Vulnerability
Extreme
High
Aerial Image: Google Satellite
Wavelength
Segment 1
Segment 2
Segment 3
Segment 4
Segment 5
Segment 6
0
100
200 m


Segment 6
Segment 7
Rocky Coastline
Segment 8
Segment 9
Segment 10
Segment 11
Tumby Bay 2050 Erosion Vulnerability
2050 Erosion Hazard Line
2050 Erosion Vulnerability
Extreme
High
Aerial image: Google Satellite
Wavelength
0
100
200 m

Tumby Bay 2100 Erosion Vulnerability
2100 Erosion Hazard Line
2100 Erosion Vulnerability
Extreme
High
Aerial Image: Google Satellite
Wavelength
Segment 1
Segment 2
Segment 3
Segment 4
Segment 5
Segment 6
0
100
200 m


Segment 6
Segment 7
Rocky Coastline
Segment 8
Segment 9
Segment 10
Segment 11
Tumby Bay 2100 Erosion Vulnerability
2100 Erosion Hazard Line
2100 Erosion Vulnerability
Extreme
High
Aerial image: Google Satellite
Wavelength
0 100 200 m

Appendix D: Feasible Adaptation Pathway Costs

DCTB - Tumby Bay CAS
Townsite Beaches - Segments 1 to 6
Short to medium term erosion and inundation risk
Prepared B Smith 29/01/2024

Year		Rock Seawall with Levee	Vertical Seawall with Levee	Nourishment with Dunes	Move Back with Dune Strengthening (Managed Retreat) - No buildings replaced	Move Back with Dune Strengthening (Managed Retreat) - Buildings and assets replaced	Value of assets at risk by 2050 – Council Assets (exc existing seawalls and beach access)	Value of assets at risk by 2050 – Private Properties (inc Ritz Café and Yacht Club)	Value of assets at risk by 2050 – Roads and Footpaths
0	**2024**	$ 2,688,000	$ 6,336,000	$ 816,000	$ 10,845,083	$ 10,841,938			
1	**2025**	$ -	$ -	$ 816,000	$ -	$ -			
2	**2026**	$ -	$ -	$ 816,000	$ -	$ -			
3	**2027**	$ -	$ -	$ 816,000	$ -	$ -			
4	**2028**	$ 6,320,000	$ 15,440,000	$ 2,728,500	$ -	$ -			
5	**2029**	$ -	$ -	$ 2,728,500	$ -	$ -			
6	**2030**	$ -	$ -	$ 2,728,500	$ 199,750	$ 5,048,670			
7	**2031**	$ 5,124,000	$ 12,078,000	$ 6,297,000	$ -	$ -			
8	**2032**	$ 5,208,000	$ 12,276,000	$ 7,086,000	$ 2,625,000	$ 2,625,000			
9	**2033**	$ -	$ -	$ 5,865,000	$ -	$ -			
10	**2034**	$ -	$ -	$ 5,865,000	$ -	$ -			
11	**2035**	$ 588,000	$ 2,003,600	$ 6,043,500	$ 11,382,639	$ 11,382,639			
12	**2036**	$ 192,000	$ -	$ 6,043,500	$ -	$ -			
13	**2037**	$ -	$ -	$ 6,043,500	$ -	$ -	$ 1,301,400	$ 35,506,600	$ 886,801
14	**2038**	$ 480,000	$ 1,544,000	$ 6,043,500	$ -	$ -			
15	**2039**	$ -	$ -	$ 6,043,500	$ -	$ -			
16	**2040**	$ -	$ -	$ 6,043,500	$ -	$ -			
17	**2041**	$ 366,000	$ 1,177,300	$ 6,043,500	$ -	$ -			
18	**2042**	$ 372,000	$ 1,196,600	$ 6,043,500	$ 187,500	$ 187,500			
19	**2043**	$ -	$ -	$ 6,043,500	$ -	$ -			
20	**2044**	$ -	$ -	$ 6,043,500	$ -	$ -			
21	**2045**	$ 762,000	$ 855,100	$ 10,630,500	$ 8,901,250	$ 9,713,750			
22	**2046**	$ -	$ -	$ 6,043,500	$ -	$ -			
23	**2047**	$ -	$ -	$ 6,043,500	$ -	$ -			
24	**2048**	$ -	$ -	$ 6,043,500	$ -	$ -			
25	**2049**	$ -	$ -	$ 6,043,500	$ -	$ -			
26	**2050**	$ -	$ -	$ 6,043,500	$ -	$ -			
Total		**$ 22,100,000**	**$ 52,906,600**	**$ 137,845,500**	**$ 34,141,221**	**$ 39,799,496**	**$ 37,694,801**		

DCTB - Tumby Bay CAS
Townsite Beaches (Segments 1 to 6) - Short to medium term erosion and inundation risk
P7&P10 - Rock Seawall with Levee Costs
Prepared B Smith 29/1/2024

Item	Rate (per m)
Rock Seawall	$ 7,900
Repairs	$ 600
Levee	$ 500
Demolish Seawall	$ 500

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)	Existing Seawall Failure	New Seawall	Levee
1	800		2028	2045
2	70	2035	2035	2045
3	320	2024	2024	2045
4	610		2031	2031
5	370		2032	2032
6	250	2030	2032	2045
Total	**2420**			

		P7 + P10 - Rock Seawall with Levee												
		Segment 1		**Segment 2**		**Segment 3**		**Segment 4**		**Segment 5**		**Segment 6**		**Total**
Year		**Capital**	**Maintenance**	**Capital**	**Maintenance**	**Capital**	**Maintenance**	**Capital**	**Maintenance**	**Capital**	**Maintenance**	**Capital**	**Maintenance**	
0	**2024**					$ 2,688,000								**$ 2,688,000**
1	**2025**													**$ -**
2	**2026**													**$ -**
3	**2027**													**$ -**
4	**2028**	$ 6,320,000												**$ 6,320,000**
5	**2029**													**$ -**
6	**2030**													**$ -**
7	**2031**							$ 5,124,000						**$ 5,124,000**
8	**2032**									$ 3,108,000		$ 2,100,000		**$ 5,208,000**
9	**2033**													**$ -**
10	**2034**													**$ -**
11	**2035**			$ 588,000										**$ 588,000**
12	**2036**						$ 192,000							**$ 192,000**
13	**2037**													**$ -**
14	**2038**		$ 480,000											**$ 480,000**
15	**2039**													**$ -**
16	**2040**													**$ -**
17	**2041**								$ 366,000					**$ 366,000**
18	**2042**										$ 222,000		$ 150,000	**$ 372,000**
19	**2043**													**$ -**
20	**2044**													**$ -**
21	**2045**	$ 400,000		$ 35,000	$ 42,000	$ 160,000						$ 125,000		**$ 762,000**
22	**2046**													**$ -**
23	**2047**													**$ -**
24	**2048**													**$ -**
25	**2049**													**$ -**
26	**2050**													**$ -**
Total		**$ 6,720,000**	**$ 480,000**	**$ 623,000**	**$ 42,000**	**$ 2,848,000**	**$ 192,000**	**$ 5,124,000**	**$ 366,000**	**$ 3,108,000**	**$ 222,000**	**$ 2,225,000**	**$ 150,000**	**$ 22,100,000**

$ 22,100,000

DCTB - Tumby Bay CAS
Townsite Beaches (Segments 1 to 6) - Short to medium term erosion and inundation risk
P8&P10 - Vertical Seawall with Levee Costs
Prepared B Smith 29/1/2024

Item	Rate (per m)
Vertical Seawa	$ 19,300
Repairs	$ 1,930
Levee	$ 500
Demolition	$ 500

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)	Existing Seawall Failure	New Seawall	Levee
1	800		2028	
2	70	2035	2035	
3	320	2024	2024	
4	610		2031	2031
5	370		2032	2032
6	250	2030	2032	
Total	2420			

		P8 + P10 - Vertical Seawall with Levee												
		Segment 1		Segment 2		Segment 3		Segment 4		Segment 5		Segment 6		Total
Year		Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	
0	2024					$ 6,336,000								$ 6,336,000
1	2025													$ -
2	2026													$ -
3	2027													$ -
4	2028	$ 15,440,000												$ 15,440,000
5	2029													$ -
6	2030													$ -
7	2031							##########						$ 12,078,000
8	2032									$ 7,326,000		$ 4,950,000		$ 12,276,000
9	2033													$ -
10	2034													$ -
11	2035			$ 1,386,000			$ 617,600							$ 2,003,600
12	2036													$ -
13	2037													$ -
14	2038		$ 1,544,000											$ 1,544,000
15	2039													$ -
16	2040													$ -
17	2041								$ 1,177,300					$ 1,177,300
18	2042										$ 714,100		$ 482,500	$ 1,196,600
19	2043													$ -
20	2044													$ -
21	2045	$ 400,000		$ 35,000	$ 135,100	$ 160,000						$ 125,000		$ 855,100
22	2046													$ -
23	2047													$ -
24	2048													$ -
25	2049													$ -
26	2050													$ -
Total		$ 15,840,000	$ 1,544,000	$ 1,421,000	$ 135,100	$ 6,496,000	$ 617,600	##########	$ 1,177,300	$ 7,326,000	$ 714,100	$ 5,075,000	$ 482,500	$ 52,906,600

$ 52,906,600

DCTB - Tumby Bay CAS
Townsite Beaches (Segments 1 to 6) - Short to medium term erosion and inundation risk
P2 - Annual Nourishment with Dune Strengthening
Prepared B Smith 29/1/2024

Item	Rate ($ per m)
Nourishment	$ 2,550
Dune	$ 3,300

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)	Existing Seawall Failure	Nourishment	Dune
1	750		2028	2045
2	70	2035	2035	2045
3	320	2024	2024	2045
4	610		2031	2031
5	370		2032	2032
6	250	2030	2032	2045
Total	**2370**			

		P2 - Annual Nourishment with Dune Strengthening												
		Segment 1		**Segment 2**		**Segment 3**		**Segment 4**		**Segment 5**		**Segment 6**		**Total**
Year		**Nourishment**	**Dunes**	**Nourishment**	**Dunes**	**Nourishment**	**Dunes**	**Nourishment**	**Dunes**	**Nourishment**	**Dunes**	**Nourishment**	**Dunes**	
0	**2024**					$ 816,000								**$ 816,000**
1	**2025**					$ 816,000								**$ 816,000**
2	**2026**					$ 816,000								**$ 816,000**
3	**2027**					$ 816,000								**$ 816,000**
4	**2028**	$ 1,912,500				$ 816,000								**$ 2,728,500**
5	**2029**	$ 1,912,500				$ 816,000								**$ 2,728,500**
6	**2030**	$ 1,912,500				$ 816,000								**$ 2,728,500**
7	**2031**	$ 1,912,500				$ 816,000		$ 1,555,500	$ 2,013,000					**$ 6,297,000**
8	**2032**	$ 1,912,500				$ 816,000		$ 1,555,500		$ 943,500	$ 1,221,000	$ 637,500		**$ 7,086,000**
9	**2033**	$ 1,912,500				$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 5,865,000**
10	**2034**	$ 1,912,500				$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 5,865,000**
11	**2035**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
12	**2036**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
13	**2037**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
14	**2038**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
15	**2039**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
16	**2040**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
17	**2041**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
18	**2042**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
19	**2043**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
20	**2044**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
21	**2045**	$ 1,912,500	$ 2,475,000	$ 178,500	$ 231,000	$ 816,000	$ 1,056,000	$ 1,555,500		$ 943,500		$ 637,500	$ 825,000	**$ 10,630,500**
22	**2046**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
23	**2047**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
24	**2048**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
25	**2049**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
26	**2050**	$ 1,912,500		$ 178,500		$ 816,000		$ 1,555,500		$ 943,500		$ 637,500		**$ 6,043,500**
Total		**$ 43,987,500**	**$ 2,475,000**	**$ 2,856,000**	**$ 231,000**	**$22,032,000**	**$ 1,056,000**	**$31,110,000**	**$ 2,013,000**	**$17,926,500**	**$ 1,221,000**	**$12,112,500**	**$ 825,000**	**$ 137,845,500**

$ 137,845,500

DCTB - Tumby Bay CAS
Townsite Beaches (Segments 1 to 6) - Short to medium term erosion and inundation risk
PMR2 - Move Back with Dune Strengthening (Managed Retreat) - No buildings replaced
Prepared B Smith 29/1/2024

Item	Rate
Demolish beach access	$ 10,000
Remove footpath/roa	$ 7
New Beach Access	$ 50,000
New Dune	$ 3,300
New Footpath/raod	$ 81
Demolish Seawall	$ 500

-Refer individual sheets for rates

Area Footpath	4438
Area Road	6455

Implementation Plan

Segment	Length (m)	Existing Seawall Failure
1	750	
2	70	2035
3	320	2030
4	610	
5	370	
6	250	2030
Total	2370	

		PMR2 - Move Back w Dune Strengthening (Managed Retreat) - no buildings replaced																					
		Segment 1			Segment 2			Segment 3			Segment 4			Segment 5			Segment 6 - Seawall and levee		All segments			Contingency (20%)	Design (5%)	Total
Year		Demolish Assets & Buildings	New beach access	Dunes	Demolish Assets & Buildings	New beach access	Dunes	Demolish Assets & Buildings	New beach access	Dunes	Demolish Assets & Buildings	New beach access	Dunes	Demolish Assets & Buildings	New beach access	Dunes	Capital	Maintenance	Remove Utilities & Reticulation	Demolish Footpath and Reinstate	Demolish Road (Assume 1 lane) & road works			
0	2024	$ 62,900	$ 250,000	$ 2,475,000	$ 66,000	$ 50,000	$ 231,000	$ 30,000	$ 150,000	$ 1,056,000	$ 20,000	$ 100,000	$ 2,013,000	$ 10,000	$ 50,000	$ 1,221,000	$ -	$ -	$ 500,000	$ 391,166		$ 1,735,213	$ 433,803	**$ 10,845,083**
1	2025																$ -	$ -				$ -	$ -	**$ -**
2	2026																$ -	$ -				$ -	$ -	**$ -**
3	2027																$ -	$ -				$ -	$ -	**$ -**
4	2028																$ -	$ -				$ -	$ -	**$ -**
5	2029																$ -	$ -				$ -	$ -	**$ -**
6	2030	$ 12,800			$ 19,000			$ 92,900			$ 30,500			$ 4,600			$ -	$ -				$ 31,960	$ 7,990	**$ 199,750**
7	2031																$ -	$ -				$ -	$ -	**$ -**
8	2032																$ 2,100,000	$ -				$ 420,000	$ 105,000	**$ 2,625,000**
9	2033																$ -	$ -				$ -	$ -	**$ -**
10	2034																$ -	$ -				$ -	$ -	**$ -**
11	2035		$ 300,000	$ 2,475,000		$ 50,000	$ 231,000		$ 150,000	$ 1,056,000		$ 100,000	$ 2,013,000		$ 50,000	$ 1,221,000	$ -	$ -	$ 500,000	$ 391,166	$ 568,945	$ 1,821,222	$ 455,306	**$ 11,382,639**
12	2036																$ -	$ -				$ -	$ -	**$ -**
13	2037																$ -	$ -				$ -	$ -	**$ -**
14	2038																$ -	$ -				$ -	$ -	**$ -**
15	2039																$ -	$ -				$ -	$ -	**$ -**
16	2040																$ -	$ -				$ -	$ -	**$ -**
17	2041																$ -	$ -				$ -	$ -	**$ -**
18	2042																$ -	$ 150,000				$ 30,000	$ 7,500	**$ 187,500**
19	2043																$ -	$ -				$ -	$ -	**$ -**
20	2044																$ -	$ -				$ -	$ -	**$ -**
21	2045			$ 2,475,000			$ 231,000			$ 1,056,000			$ 2,013,000			$ 1,221,000	$ 125,000	$ -				$ 1,424,200	$ 356,050	**$ 8,901,250**
22	2046																$ -	$ -				$ -	$ -	**$ -**
23	2047																$ -	$ -				$ -	$ -	**$ -**
24	2048																$ -	$ -				$ -	$ -	**$ -**
25	2049																$ -	$ -				$ -	$ -	**$ -**
26	2050																$ -	$ -				$ -	$ -	**$ -**
Total		**$ 75,700**	**$ 550,000**	**$ 7,425,000**	**$ 85,000**	**$ 100,000**	**$ 693,000**	**$ 122,900**	**$ 300,000**	**$ 3,168,000**	**$ 50,500**	**$ 200,000**	**$ 6,039,000**	**$ 14,600**	**$ 100,000**	**$ 3,663,000**	**$ 2,225,000**	**$ 150,000**	**$ 1,000,000**	**$ 782,332**	**$ 568,945**	**$ 5,462,595**	**$ 1,365,649**	**$ 34,141,221**

$ 34,141,221

DCTB - Tumby Bay CAS
Townsite Beaches (Segments 1 to 6) - Short to medium term erosion and inundation risk
PMR2 - Move Back with Dune Strengthening (Managed Retreat) - Buildings and assets replaced further landward
Prepared B Smith 29/1/2024

Item	Rate
Demolish beach access	$ 10,000
Remove footpath/road	$ 7
New Beach Access	$ 50,000
New Dune	$ 3,300
New Footpath/raod	$ 81
Demolish Seawall	$ 500

-Refer individual sheets for rates

Area Footpath	4438
Area Road	6455

Relocate Services 20%

Implementation Plan

Segment	Length (m)	Existing Seawall Failure
1	750	
2	70	2035
3	320	2030
4	610	
5	370	
6	250	2030
Total	2370	

PMR2 - Move Back w Dune Strengthening (Managed Retreat) - Buildings and assets replaced further landward

Year		Segment 1				Segment 2				Segment 3			
		Demolish Assets & Buildings	Replace Building (same value) plus services	New beach access	Dunes	Demolish Assets & Buildings	Replace Building (same value) plus services	New beach access	Dunes	Demolish Assets & Buildings	Replace Building (same value) plus services	New beach access	Dunes
0	2024	$ 62,900		$ 250,000	$ 2,475,000	$ 66,000		$ 50,000	$ 231,000	$ 30,000		$ 150,000	$ 1,056,000
1	2025												
2	2026												
3	2027												
4	2028												
5	2029												
6	2030	$ 12,800	$ 40,800			$ 19,000	$ 132,000			$ 92,900	$ 2,299,200		
7	2031												
8	2032												
9	2033												
10	2034												
11	2035			$ 300,000	$ 2,475,000			$ 50,000	$ 231,000			$ 150,000	$ 1,056,000
12	2036												
13	2037												
14	2038												
15	2039												
16	2040												
17	2041												
18	2042												
19	2043												
20	2044												
21	2045			$ 300,000	$ 2,475,000			$ 50,000	$ 231,000			$ 150,000	$ 1,056,000
22	2046												
23	2047												
24	2048												
25	2049												
26	2050												
Total		$ 75,700	$ 40,800	$ 850,000	$ 7,425,000	$ 85,000	$ 132,000	$ 150,000	$ 693,000	$ 122,900	$ 2,299,200	$ 450,000	$ 3,168,000

Year		Segment 4				Segment 5				Segment 6 - Seawall		All segments			Contingency	Design (5%)	Total
		Demolish Assets & Buildings	Replace Building (same value) plus services	New beach access	Dunes	Demolish Assets & Buildings	Replace Building (same value) plus services	New beach access	Dunes	Capital	Maintenance	Remove Utilities & Reticulation	Demolish Footpath and Reinstate	Demolish Road (Assume 1 lane) & road works			
0	2024	$ 20,000		$ 100,000	$ 2,013,000	$ 10,000		$ 50,000	$ 1,221,000	$ -	$ -	$ 500,000	$ 391,166		$ 1,735,213	$ 430,658	$ 10,841,938
1	2025									$ -	$ -				$ -	$ -	$ -
2	2026									$ -	$ -				$ -	$ -	$ -
3	2027									$ -	$ -				$ -	$ -	$ -
4	2028									$ -	$ -				$ -	$ -	$ -
5	2029									$ -	$ -				$ -	$ -	$ -
6	2030	$ 30,500	$ 1,341,600			$ 4,600	$ 67,680			$ -	$ -				$ 808,216	$ 199,374	$ 5,048,670
7	2031									$ -	$ -				$ -	$ -	$ -
8	2032									$ 2,100,000	$ -				$ 420,000	$ 105,000	$ 2,625,000
9	2033									$ -	$ -				$ -	$ -	$ -
10	2034									$ -	$ -				$ -	$ -	$ -
11	2035			$ 100,000	$ 2,013,000			$ 50,000	$ 1,221,000	$ -	$ -	$ 500,000	$ 391,166	$ 568,945	$ 1,821,222	$ 455,306	$ 11,382,639
12	2036									$ -	$ -				$ -	$ -	$ -
13	2037									$ -	$ -				$ -	$ -	$ -
14	2038									$ -	$ -				$ -	$ -	$ -
15	2039									$ -	$ -				$ -	$ -	$ -
16	2040									$ -	$ -				$ -	$ -	$ -
17	2041									$ -	$ -				$ -	$ -	$ -
18	2042									$ -	$ 150,000				$ 30,000	$ 7,500	$ 187,500
19	2043									$ -	$ -				$ -	$ -	$ -
20	2044									$ -	$ -				$ -	$ -	$ -
21	2045			$ 100,000	$ 2,013,000			$ 50,000	$ 1,221,000	$ 125,000	$ -				$ 1,554,200	$ 388,550	$ 9,713,750
22	2046									$ -	$ -				$ -	$ -	$ -
23	2047									$ -	$ -				$ -	$ -	$ -
24	2048									$ -	$ -				$ -	$ -	$ -
25	2049									$ -	$ -				$ -	$ -	$ -
26	2050									$ -	$ -				$ -	$ -	$ -
Total		$ 50,500	$ 1,341,600	$ 300,000	$ 6,039,000	$ 14,600	$ 67,680	$ 150,000	$ 3,663,000	$ 2,225,000	$ 150,000	$ 1,000,000	$ 782,332	$ 568,945	$ 6,368,851	$ 1,586,388	$ 39,799,496

$ 39,799,496

DCTB - Tumby Bay CAS
Townsite Beaches (Segments 1 to 6) - Long term (2100) erosion and inundation risk
P7&P10 - Rock Seawall with Levee Costs
Prepared B Smith 29/1/2024

Item	Rate (per m)
Rock Seawall	$ 9,700
Repairs	$ 800

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)
1	800
2	70
3	320
4	610
5	370
6	250
Total	2420

		P7 + P10 - Rock Seawall with Levee												
		Segment 1		Segment 2		Segment 3		Segment 4		Segment 5		Segment 6		Total
Year		Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	
27	2050					$ 3,104,000								$ 3,104,000
28	2051													$ -
29	2052													$ -
30	2053													$ -
31	2054	$ 7,760,000												$ 7,760,000
32	2055													$ -
33	2056													$ -
34	2057							$ 5,917,000						$ 5,917,000
35	2058									$ 3,589,000		$ 2,425,000		$ 6,014,000
36	2059													$ -
37	2060													$ -
38	2061			$ 679,000										$ 679,000
39	2062						$ 256,000							$ 256,000
40	2063													$ -
41	2064		$ 640,000											$ 640,000
42	2065													$ -
43	2066													$ -
44	2067								$ 488,000					$ 488,000
45	2068										$ 296,000		$ 200,000	$ 496,000
46	2069													$ -
47	2070													$ -
48	2071				$ 56,000									$ 56,000
49	2072						$ 256,000							$ 256,000
50	2073													$ -
51	2074		$ 640,000											$ 640,000
52	2075													$ -
53	2076													$ -
54	2077								$ 488,000					$ 488,000
55	2078										$ 296,000		$ 200,000	$ 496,000
56	2079													$ -
57	2080													$ -
58	2081				$ 17,500									$ 17,500
59	2082						$ 256,000							$ 256,000
60	2083													$ -
61	2084		$ 640,000											$ 640,000
62	2085													$ -
63	2086													$ -
64	2087								$ 488,000					$ 488,000
65	2088										$ 296,000		$ 200,000	$ 496,000
66	2089													$ -
67	2090													$ -
68	2091				$ 2,170									$ 2,170
69	2092						$ 256,000							$ 256,000
70	2093													$ -
71	2094		$ 640,000											$ 640,000
72	2095													$ -
73	2096													$ -
74	2097								$ 488,000					$ 488,000
75	2098										$ 296,000		$ 200,000	$ 496,000
76	2099													$ -
77	2100													$ -
Total		$ 7,760,000	$ 2,560,000	$ 679,000	$ 75,670	$ 3,104,000	$ 1,024,000	$ 5,917,000	$ 1,952,000	$ 3,589,000	$ 1,184,000	$ 2,425,000	$ 800,000	$ 31,069,670

$ 31,069,670

DCTB - Tumby Bay CAS
Townsite Beaches (Segments 1 to 6) - Long term (2100) erosion and inundation risk
P7&P10 - Rock Seawall with Levee Costs
Prepared B Smith 29/1/2024

Item	Rate (per m)
Rock Seawall	$ 8,400
1m levee	$ 1,300
Repairs	$ 1,930

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)
1	800
2	70
3	320
4	610
5	370
6	250
Total	**2420**

		P7 + P10 - Rock Seawall with Levee												
		Segment 1		Segment 2		Segment 3		Segment 4		Segment 5		Segment 6		Total
Year		Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	Capital	Maintenance	
27	2050					$ 3,104,000								$ 3,104,000
28	2051													$ -
29	2052													$ -
30	2053													$ -
31	2054	$ 7,760,000												$ 7,760,000
32	2055													$ -
33	2056													$ -
34	2057							$ 5,917,000						$ 5,917,000
35	2058									$ 3,589,000		$ 2,425,000		$ 6,014,000
36	2059													$ -
37	2060													$ -
38	2061			$ 679,000										$ 679,000
39	2062						$ 617,600							$ 617,600
40	2063													$ -
41	2064		$ 1,544,000											$ 1,544,000
42	2065													$ -
43	2066													$ -
44	2067								$ 1,177,300					$ 1,177,300
45	2068										$ 714,100		$ 482,500	$ 1,196,600
46	2069													$ -
47	2070													$ -
48	2071				$ 135,100									$ 135,100
49	2072						$ 617,600							$ 617,600
50	2073													$ -
51	2074		$ 1,544,000											$ 1,544,000
52	2075													$ -
53	2076													$ -
54	2077								$ 1,177,300					$ 1,177,300
55	2078										$ 714,100		$ 482,500	$ 1,196,600
56	2079													$ -
57	2080													$ -
58	2081				$ 17,500									$ 17,500
59	2082						$ 617,600							$ 617,600
60	2083													$ -
61	2084		$ 1,544,000											$ 1,544,000
62	2085													$ -
63	2086													$ -
64	2087								$ 1,177,300					$ 1,177,300
65	2088										$ 714,100		$ 482,500	$ 1,196,600
66	2089													$ -
67	2090													$ -
68	2091				$ 2,170									$ 2,170
69	2092						$ 617,600							$ 617,600
70	2093													$ -
71	2094		$ 1,544,000											$ 1,544,000
72	2095													$ -
73	2096													$ -
74	2097								$ 1,177,300					$ 1,177,300
75	2098										$ 714,100		$ 482,500	$ 1,196,600
76	2099													$ -
77	2100													$ -
Total		$ 7,760,000	$ 6,176,000	$ 679,000	$ 154,770	$ 3,104,000	$ 2,470,400	$ 5,917,000	$ 4,709,200	$ 3,589,000	$ 2,856,400	$ 2,425,000	$ 1,930,000	$ 41,770,770

$ 41,770,770

DCTB - Tumby Bay CAS
Southern Beaches - Segments 8 & 9
Short to medium term erosion risk
Prepared B Smith 29/01/2024

Year		Rock Seawall	Vertical Seawall	Nourishment	Move Back (Managed Retreat) - No buildings replaced	Move Back (Managed Retreat) - Buildings and assets replaced
0	2024	$ -	$ -	$ -	$ 91,825	$ 91,825
1	2025	$ -	$ -	$ -	$ -	$ -
2	2026	$ -	$ -	$ -	$ -	$ -
3	2027	$ -	$ -	$ -	$ -	$ -
4	2028	$ -	$ -	$ -	$ -	$ -
5	2029	$ -	$ -	$ -	$ -	$ -
6	2030	$ 2,840,000	$ 6,830,000	$ 892,500	$ 231,338	$ 556,338
7	2031	$ -	$ -	$ 892,500	$ -	$ -
8	2032	$ -	$ -	$ 892,500	$ -	$ -
9	2033	$ -	$ -	$ 892,500	$ -	$ -
10	2034	$ -	$ -	$ 892,500	$ -	$ -
11	2035	$ -	$ -	$ 892,500	$ -	$ -
12	2036	$ -	$ -	$ 892,500	$ -	$ -
13	2037	$ -	$ -	$ 892,500	$ -	$ -
14	2038	$ -	$ -	$ 892,500	$ -	$ -
15	2039	$ -	$ -	$ 892,500	$ -	$ -
16	2040	$ 210,000	$ 675,500	$ 892,500	$ -	$ -
17	2041	$ -	$ -	$ 892,500	$ -	$ -
18	2042	$ -	$ -	$ 892,500	$ -	$ -
19	2043	$ -	$ -	$ 892,500	$ -	$ -
20	2044	$ -	$ -	$ 892,500	$ -	$ -
21	2045	$ -	$ -	$ 892,500	$ -	$ -
22	2046	$ -	$ -	$ 892,500	$ -	$ -
23	2047	$ -	$ -	$ 892,500	$ -	$ -
24	2048	$ -	$ -	$ 892,500	$ -	$ -
25	2049	$ -	$ -	$ 892,500	$ -	$ -
26	2050	$ 210,000	$ 675,500	$ 892,500	$ -	$ -
Total		**$ 3,260,000**	**$ 8,181,000**	**$ 18,742,500**	**$ 323,163**	**$ 648,163**

DCTB - Tumby Bay CAS
Southern Beaches - Segments 8 & 9
Short to medium term erosion risk
P7 - Rock Seawall Costs
Prepared B Smith 29/01/2024

Item	Rate (per m)
Rock Seawall	$ 7,900
Repairs	$ 600
Levee	$ 500
Demolish Seawall	$ 500

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)	Existing Seawall Failure	New Seawall
8	200		2030
9	150		2030
Total	350		

		P7 - Rock Seawall				
		Segment 8		Segment 9		Total
Year		Capital	Maintenance	Capital	Maintenance	
0	2024					$ -
1	2025					$ -
2	2026					$ -
3	2027					$ -
4	2028					$ -
5	2029					$ -
6	2030	$ 1,580,000		$ 1,260,000		$ 2,840,000
7	2031					$ -
8	2032					$ -
9	2033					$ -
10	2034					$ -
11	2035					$ -
12	2036					$ -
13	2037					$ -
14	2038					$ -
15	2039					$ -
16	2040		$ 120,000		$ 90,000	$ 210,000
17	2041					$ -
18	2042					$ -
19	2043					$ -
20	2044					$ -
21	2045					$ -
22	2046					$ -
23	2047					$ -
24	2048					$ -
25	2049					$ -
26	2050		$ 120,000		$ 90,000	$ 210,000
Total		$ 1,580,000	$ 240,000	$ 1,260,000	$ 180,000	$ 3,260,000

DCTB - Tumby Bay CAS
Southern Beaches - Segments 8 & 9
Short to medium term erosion risk
P8 - Vertical Seawall Costs
Prepared B Smith 29/01/2024

Item	Rate (per m)
Vertical Seawa	$ 19,300
Repairs	$ 1,930
Levee	$ 500
Demolition	$ 500

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)	Existing Seawall Failure	New Seawall
8	200		2030
9	150		2030
Total	350		

		P8 - Vertical seawall				
		Segment 8		Segment 9		Total
Year		Capital	Maintenance	Capital	Maintenance	
0	2024					$ -
1	2025					$ -
2	2026					$ -
3	2027					$ -
4	2028					$ -
5	2029					$ -
6	2030	$ 3,860,000		$ 2,970,000		$ 6,830,000
7	2031					$ -
8	2032					$ -
9	2033					$ -
10	2034					$ -
11	2035					$ -
12	2036					$ -
13	2037					$ -
14	2038					$ -
15	2039					$ -
16	2040		$ 386,000		$ 289,500	$ 675,500
17	2041					$ -
18	2042					$ -
19	2043					$ -
20	2044					$ -
21	2045					$ -
22	2046					$ -
23	2047					$ -
24	2048					$ -
25	2049					$ -
26	2050		$ 386,000		$ 289,500	$ 675,500
Total		$ 3,860,000	$ 772,000	$ 2,970,000	$ 579,000	$ 8,181,000

DCTB - Tumby Bay CAS
Southern Beaches - Segments 8 & 9
Short to medium term erosion risk
P2 - Annual Nourishment
Prepared B Smith 29/01/2024

Item	Rate ($ per m)
Nourishment	$ 2,550
Dune	$ 3,300

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)	Existing Seawall Failure	Nourishment
8	200		2030
9	150		2030
Total	350		

		P2 - Annual Nourishment				
		Segment 8		Segment 9		Total
Year		Nourishment	Dunes	Nourishment	Dunes	
0	2024					$ -
1	2025					$ -
2	2026					$ -
3	2027					$ -
4	2028					$ -
5	2029					$ -
6	2030	$ 510,000		$ 382,500		$ 892,500
7	2031	$ 510,000		$ 382,500		$ 892,500
8	2032	$ 510,000		$ 382,500		$ 892,500
9	2033	$ 510,000		$ 382,500		$ 892,500
10	2034	$ 510,000		$ 382,500		$ 892,500
11	2035	$ 510,000		$ 382,500		$ 892,500
12	2036	$ 510,000		$ 382,500		$ 892,500
13	2037	$ 510,000		$ 382,500		$ 892,500
14	2038	$ 510,000		$ 382,500		$ 892,500
15	2039	$ 510,000		$ 382,500		$ 892,500
16	2040	$ 510,000		$ 382,500		$ 892,500
17	2041	$ 510,000		$ 382,500		$ 892,500
18	2042	$ 510,000		$ 382,500		$ 892,500
19	2043	$ 510,000		$ 382,500		$ 892,500
20	2044	$ 510,000		$ 382,500		$ 892,500
21	2045	$ 510,000		$ 382,500		$ 892,500
22	2046	$ 510,000		$ 382,500		$ 892,500
23	2047	$ 510,000		$ 382,500		$ 892,500
24	2048	$ 510,000		$ 382,500		$ 892,500
25	2049	$ 510,000		$ 382,500		$ 892,500
26	2050	$ 510,000		$ 382,500		$ 892,500
Total		$ 10,710,000	$ -	$ 8,032,500	$ -	$18,742,500

DCTB - Tumby Bay CAS
Southern Beaches - Segments 8 & 9
Short to medium term erosion risk
PMR2 - Move Back (Managed Retreat) - No buildings replaced
Prepared B Smith 29/01/2024

Item	Rate
Demolish beach access	$ 10,000
Remove footpath/road	$ 7
New Beach Access	$ 50,000
New Dune	$ 3,300
New Footpath/raod	$ 81
Demolish Seawall	#REF!

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)
8	200
9	150
Total	**350**

		PMR2 - Move Back w Dune Strengthening (Managed Retreat) - no buildings replaced								
		Segment 8			Segment 9			Contingency (20%)	Design (5%)	Total
Year		Demolish Assets	New beach access	Relocate path	Demolish Assets	New beach access	Remove clubhouse			
0	2024				$ 23,460	$ 50,000		$ 14,692	$ 3,673	**$ 91,825**
1	2025							$ -	$ -	**$ -**
2	2026							$ -	$ -	**$ -**
3	2027							$ -	$ -	**$ -**
4	2028							$ -	$ -	**$ -**
5	2029							$ -	$ -	**$ -**
6	2030	$ 20,000	$ 100,000	$ 44,070			$ 21,000	$ 37,014	$ 9,254	**$ 231,338**
7	2031							$ -	$ -	**$ -**
8	2032							$ -	$ -	**$ -**
9	2033							$ -	$ -	**$ -**
10	2034							$ -	$ -	**$ -**
11	2035							$ -	$ -	**$ -**
12	2036							$ -	$ -	**$ -**
13	2037							$ -	$ -	**$ -**
14	2038							$ -	$ -	**$ -**
15	2039							$ -	$ -	**$ -**
16	2040							$ -	$ -	**$ -**
17	2041							$ -	$ -	**$ -**
18	2042							$ -	$ -	**$ -**
19	2043							$ -	$ -	**$ -**
20	2044							$ -	$ -	**$ -**
21	2045							$ -	$ -	**$ -**
22	2046							$ -	$ -	**$ -**
23	2047							$ -	$ -	**$ -**
24	2048							$ -	$ -	**$ -**
25	2049							$ -	$ -	**$ -**
26	2050							$ -	$ -	**$ -**
Total		**$ 20,000**	**$ 100,000**	**$ 44,070**	**$ 23,460**	**$ 50,000**	**$ 21,000**	**$ 51,706**	**$ 12,927**	**$ 323,163**

$ 323,163

DCTB - Tumby Bay CAS
Southern Beaches - Segments 8 & 9
Short to medium term erosion risk
PMR2 - Move Back (Managed Retreat) - Buildings replaced
Prepared B Smith 29/01/2024

Item	Rate
Demolish beach access	$ 10,000
Remove footpath/roa	$ 7
New Beach Access	$ 50,000
New Dune	$ 3,300
New Footpath/raod	$ 81
Demolish Seawall	#REF!

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)
8	200
9	150
Total	**350**

		PMR2 - Move Back w Dune Strengthening (Managed Retreat) - buildings replaced								
		Segment 8			Segment 9			Contingency (20%)	Design (5%)	Total
Year		Demolish Assets	New beach access	Relocate path	Demolish Assets	New beach access	Remove & Replace Clubhouse			
0	2024				$ 23,460	$ 50,000		$ 14,692	$ 3,673	**$ 91,825**
1	2025							$ -	$ -	**$ -**
2	2026							$ -	$ -	**$ -**
3	2027							$ -	$ -	**$ -**
4	2028							$ -	$ -	**$ -**
5	2029							$ -	$ -	**$ -**
6	2030	$ 20,000	$ 100,000	$ 44,070			$ 281,000	$ 89,014	$ 22,254	**$ 556,338**
7	2031							$ -	$ -	**$ -**
8	2032							$ -	$ -	**$ -**
9	2033							$ -	$ -	**$ -**
10	2034							$ -	$ -	**$ -**
11	2035							$ -	$ -	**$ -**
12	2036							$ -	$ -	**$ -**
13	2037							$ -	$ -	**$ -**
14	2038							$ -	$ -	**$ -**
15	2039							$ -	$ -	**$ -**
16	2040							$ -	$ -	**$ -**
17	2041							$ -	$ -	**$ -**
18	2042							$ -	$ -	**$ -**
19	2043							$ -	$ -	**$ -**
20	2044							$ -	$ -	**$ -**
21	2045							$ -	$ -	**$ -**
22	2046							$ -	$ -	**$ -**
23	2047							$ -	$ -	**$ -**
24	2048							$ -	$ -	**$ -**
25	2049							$ -	$ -	**$ -**
26	2050							$ -	$ -	**$ -**
Total		**$ 20,000**	**$ 100,000**	**$ 44,070**	**$ 23,460**	**$ 50,000**	**$ 281,000**	**$ 103,706**	**$ 25,927**	**$ 648,163**

$ 648,163

DCTB - Tumby Bay CAS
Southern Beaches - Segment 9 Long Term costs
P7 - Rock Seawall
Prepared B Smith 29/1/2024

Item	Rate (per m)
Rock Seawall Upgrade	$ 9,700
New rock seawall	$ 7,900
Repairs	$ 800

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)
9 - new	450
9 - existing	150
Total	**600**

Year		P7 - Rock Seawall Segment 9 Capital	Maintenance	Total
27	2051			$ -
28	2052			$ -
29	2053			$ -
30	2054			$ -
31	2055			$ -
32	2056			$ -
33	2057			$ -
34	2058			$ -
35	2059			$ -
36	2060			$ -
37	2061	$ 1,455,000		$ 1,455,000
38	2062			$ -
39	2063			$ -
40	2064			$ -
41	2065			$ -
42	2066			$ -
43	2067			$ -
44	2068			$ -
45	2069			$ -
46	2070			$ -
47	2071	$ 3,555,000	$ 120,000	$ 3,675,000
48	2072			$ -
49	2073			$ -
50	2074			$ -
51	2075			$ -
52	2076			$ -
53	2077			$ -
54	2078			$ -
55	2079			$ -
56	2080			$ -
57	2081		$ 480,000	$ 480,000
58	2082			$ -
59	2083			$ -
60	2084			$ -
61	2085			$ -
62	2086			$ -
63	2087			$ -
64	2088			$ -
65	2089			$ -
66	2090			$ -
67	2091		$ 480,000	$ 480,000
68	2092			$ -
69	2093			$ -
70	2094			$ -
71	2095			$ -
72	2096			$ -
73	2097			$ -
74	2098			$ -
75	2099			$ -
76	2100		$ 480,000	$ 480,000
Total		$ 5,010,000	$ 1,560,000	$ 6,570,000

DCTB - Tumby Bay CAS
Southern Beaches - Segment 9 Long Term costs
P8 - Vertical Seawall
Prepared B Smith 29/1/2024

Item	Rate (per m)
Vert Seawall Upgrade	$ 8,400
New vert seawall	$ 19,300
Repairs	$ 1,930

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)
9 - new	450
9 - existing	150
Total	**600**

		P8 - Vertical Seawall		
		Segment 9		Total
Year		Capital	Maintenance	
27	2051			$ -
28	2052			$ -
29	2053			$ -
30	2054			$ -
31	2055			$ -
32	2056			$ -
33	2057			$ -
34	2058			$ -
35	2059			$ -
36	2060			$ -
37	2061	$ 1,260,000		$ 1,260,000
38	2062			$ -
39	2063			$ -
40	2064			$ -
41	2065			$ -
42	2066			$ -
43	2067			$ -
44	2068			$ -
45	2069			$ -
46	2070			$ -
47	2071	$ 8,685,000	$ 289,500	$ 8,974,500
48	2072			$ -
49	2073			$ -
50	2074			$ -
51	2075			$ -
52	2076			$ -
53	2077			$ -
54	2078			$ -
55	2079			$ -
56	2080			$ -
57	2081		$ 1,158,000	$ 1,158,000
58	2082			$ -
59	2083			$ -
60	2084			$ -
61	2085			$ -
62	2086			$ -
63	2087			$ -
64	2088			$ -
65	2089			$ -
66	2090			$ -
67	2091		$ 1,158,000	$ 1,158,000
68	2092			$ -
69	2093			$ -
70	2094			$ -
71	2095			$ -
72	2096			$ -
73	2097			$ -
74	2098			$ -
75	2099			$ -
76	2100		$ 1,158,000	$ 1,158,000
Total		$ 9,945,000	$ 3,763,500	$ 13,708,500

DCTB - Tumby Bay CAS
Southern Beaches - Segment 9
Long term erosion risk
PMR2 - Move Back (Managed Retreat) - No buildings replaced
Prepared B Smith 29/01/2024

Item	Rate
Demolish beach access	$ 10,000
Remove footpath/roa	$ 7
New Beach Access	$ 50,000
New Footpath/raod	$ 81

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)
9 - road length	400
9 - carpark entry access	100

		PMR2 - Move Back (Managed Retreat) - no buildings replaced									
		Segment 8 - Retreat TBC with geotechnical results			Segment 9				Contingency (20%)	Design (5%)	Total
Year		Demolish Assets	New beach access	Relocate path	Remove road and carpark	New road and carpark (west side)	New beach access	Remove clubhouse			
27	2051						$ 50,000		$ 10,000	$ 2,500	**$ 62,500**
28	2052								$ -	$ -	**$ -**
29	2053								$ -	$ -	**$ -**
30	2054								$ -	$ -	**$ -**
31	2055								$ -	$ -	**$ -**
32	2056								$ -	$ -	**$ -**
33	2057								$ -	$ -	**$ -**
34	2058								$ -	$ -	**$ -**
35	2059								$ -	$ -	**$ -**
36	2060				$ 26,920	$ 325,641		$ 21,000	$ 74,712	$ 18,678	**$ 466,951**
37	2061								$ -	$ -	**$ -**
38	2062								$ -	$ -	**$ -**
39	2063								$ -	$ -	**$ -**
40	2064								$ -	$ -	**$ -**
41	2065								$ -	$ -	**$ -**
42	2066								$ -	$ -	**$ -**
43	2067								$ -	$ -	**$ -**
44	2068								$ -	$ -	**$ -**
45	2069								$ -	$ -	**$ -**
46	2070								$ -	$ -	**$ -**
47	2071								$ -	$ -	**$ -**
48	2072								$ -	$ -	**$ -**
49	2073								$ -	$ -	**$ -**
50	2074								$ -	$ -	**$ -**
51	2075								$ -	$ -	**$ -**
52	2076								$ -	$ -	**$ -**
53	2077								$ -	$ -	**$ -**
54	2078								$ -	$ -	**$ -**
55	2079								$ -	$ -	**$ -**
56	2080								$ -	$ -	**$ -**
57	2081						$ 50,000		$ 10,000	$ 2,500	**$ 62,500**
58	2082								$ -	$ -	**$ -**
59	2083								$ -	$ -	**$ -**
60	2084								$ -	$ -	**$ -**
61	2085								$ -	$ -	**$ -**
62	2086								$ -	$ -	**$ -**
63	2087								$ -	$ -	**$ -**
64	2088								$ -	$ -	**$ -**
65	2089								$ -	$ -	**$ -**
66	2090							$ 21,000	$ 4,200	$ 1,050	**$ 26,250**
67	2091								$ -	$ -	**$ -**
68	2092								$ -	$ -	**$ -**
69	2093								$ -	$ -	**$ -**
70	2094								$ -	$ -	**$ -**
71	2095								$ -	$ -	**$ -**
72	2096								$ -	$ -	**$ -**
73	2097								$ -	$ -	**$ -**
74	2098								$ -	$ -	**$ -**
75	2099								$ -	$ -	**$ -**
76	2100								$ -	$ -	**$ -**
Total		**$ -**	**$ -**	**$ -**	**$ 26,920**	**$ 325,641**	**$ 100,000**	**$ 42,000**	**$ 98,912**	**$ 24,728**	**$ 618,201**

$ 618,201

DCTB - Tumby Bay CAS
Southern Beaches - Segment 9
Long term erosion risk
PMR2 - Move Back (Managed Retreat) - No buildings replaced
Prepared B Smith 29/01/2024

Item	Rate
Demolish beach access	$ 10,000
Remove footpath/road	$ 7
New Beach Access	$ 50,000
New Footpath/raod	$ 81

-Refer individual sheets for rates

Implementation Plan

Segment	Length (m)
9 - road length	400
9 - carpark entry access	100

		PMR2 - Move Back (Managed Retreat) - no buildings replaced									
		Segment 8 - Retreat TBC with geotechnical results			Segment 9				Contingency (20%)	Design (5%)	Total
Year		Demolish Assets	New beach access	Relocate path	Remove road and carpark	New road and carpark (west side)	New beach access	Remove clubhouse			
27	2051						$ 50,000		$ 10,000	$ 2,500	**$ 62,500**
28	2052								$ -	$ -	**$ -**
29	2053								$ -	$ -	**$ -**
30	2054								$ -	$ -	**$ -**
31	2055								$ -	$ -	**$ -**
32	2056								$ -	$ -	**$ -**
33	2057								$ -	$ -	**$ -**
34	2058								$ -	$ -	**$ -**
35	2059								$ -	$ -	**$ -**
36	2060				$ 26,920	$ 325,641		$ 281,000	$ 126,712	$ 31,678	**$ 791,951**
37	2061								$ -	$ -	**$ -**
38	2062								$ -	$ -	**$ -**
39	2063								$ -	$ -	**$ -**
40	2064								$ -	$ -	**$ -**
41	2065								$ -	$ -	**$ -**
42	2066								$ -	$ -	**$ -**
43	2067								$ -	$ -	**$ -**
44	2068								$ -	$ -	**$ -**
45	2069								$ -	$ -	**$ -**
46	2070								$ -	$ -	**$ -**
47	2071								$ -	$ -	**$ -**
48	2072								$ -	$ -	**$ -**
49	2073								$ -	$ -	**$ -**
50	2074								$ -	$ -	**$ -**
51	2075								$ -	$ -	**$ -**
52	2076								$ -	$ -	**$ -**
53	2077								$ -	$ -	**$ -**
54	2078								$ -	$ -	**$ -**
55	2079								$ -	$ -	**$ -**
56	2080								$ -	$ -	**$ -**
57	2081						$ 50,000		$ 10,000	$ 2,500	**$ 62,500**
58	2082								$ -	$ -	**$ -**
59	2083								$ -	$ -	**$ -**
60	2084								$ -	$ -	**$ -**
61	2085								$ -	$ -	**$ -**
62	2086								$ -	$ -	**$ -**
63	2087								$ -	$ -	**$ -**
64	2088								$ -	$ -	**$ -**
65	2089								$ -	$ -	**$ -**
66	2090							$ 281,000	$ 56,200	$ 14,050	**$ 351,250**
67	2091								$ -	$ -	**$ -**
68	2092								$ -	$ -	**$ -**
69	2093								$ -	$ -	**$ -**
70	2094								$ -	$ -	**$ -**
71	2095								$ -	$ -	**$ -**
72	2096								$ -	$ -	**$ -**
73	2097								$ -	$ -	**$ -**
74	2098								$ -	$ -	**$ -**
75	2099								$ -	$ -	**$ -**
76	2100								$ -	$ -	**$ -**
Total		**$ -**	**$ -**	**$ -**	**$ 26,920**	**$ 325,641**	**$ 100,000**	**$ 562,000**	**$ 202,912**	**$ 50,728**	**$ 1,268,201**

$ 1,268,201

DCTB - Tumby Bay CAS
Estuary Inundation - Segments 1 to 6 (landward of townsite - estuary connection over Mc
Short to medium term inundation risk
Prepared B Smith 15/12/2023

Year		Protect - Modify McCallum St	Value of private properties at intolerable inundation risk by 2050
0	**2024**	$ -	$ 77,296,700
1	**2025**	$ -	
2	**2026**	$ -	
3	**2027**	$ -	
4	**2028**	$ -	
5	**2029**	$ -	
6	**2030**	$ -	
7	**2031**	$ -	
8	**2032**	$ -	
9	**2033**	$ -	
10	**2034**	$ -	
11	**2035**	$ 957,248	
12	**2036**	$ -	
13	**2037**	$ -	
14	**2038**	$ -	
15	**2039**	$ -	
16	**2040**	$ -	
Total		**$ 957,248**	

DCTB - Tumby Bay CAS
Estuary Inundation - Segments 1 to 6 (landward of townsite - estuary connection over McCallum St)
Short to medium term inundation risk
Raise McCallum St
Prepared B Smith 15/12/2023

Item	Rate (per m road) -12m wide
Demolish road	$ 81
Asphalt new road	$ 977
Raise road 0.3m	$ 3,200

Lowest point on McCallum St = 2.25mAHD
100 year ARI SWL estuary = +2.45mAHD
Raise road 0.3m

Implementation Plan

Segment	Length (m)
Resheet Asphalt 10cm	100
Raise 30cm	150
Total	**250**

Year		Protect - Raise McCallum St				
		Segments 1 to 6 (landward of townsite - estuary		Contingency (20%)	Design (10%)	Total
		Resheet Asphalt Center Section	Demolish, raise & asphalt East section			
0	2024			$ -	$ -	$ -
1	2025			$ -	$ -	$ -
2	2026			$ -	$ -	$ -
3	2027			$ -	$ -	$ -
4	2028			$ -	$ -	$ -
5	2029			$ -	$ -	$ -
6	2030			$ -	$ -	$ -
7	2031			$ -	$ -	$ -
8	2032			$ -	$ -	$ -
9	2033			$ -	$ -	$ -
10	2034			$ -	$ -	$ -
11	2035	$ 97,692	$ 638,652	$ 147,269	$ 73,634	**$ 957,248**
12	2036			$ -	$ -	$ -
13	2037			$ -	$ -	$ -
14	2038			$ -	$ -	$ -
15	2039			$ -	$ -	$ -
16	2040			$ -	$ -	$ -
Total		**$ 97,692**	**$ 638,652**	**$ 147,269**	**$ 73,634**	**$ 957,248**