Coastal Hazard Risk Management and Adaptation Plan

City of Busselton
Geographe Bay

October 2022

Contents

ACKNOWLEDGEMENT OF COUNTRY

The City of Busselton acknowledges the Traditional Custodians, the Wadandi Bilbulmun People, on whose land we are living and pay our respects to their Elders, past, present and emerging.

This project is funded, in part, by the West Australian Planning Commission through the Coastal Management Plan Assistance Programme

1

Introduction

1.0 Introduction

The majority of development in the City of Busselton is focused on the north-facing, sandy coastline of Geographe Bay and in the nodal settlements of Yallingup, Eagle Bay, Bunker Bay and Smiths Beach. The coast (including vegetation/habitat, foreshore reserves and wetlands and estuaries) is highly valued by our community. It underpins the City's identity, prosperity and lifestyle, and accommodates a variety of recreation, conservation, residential, commercial and tourist uses.

Narrow coastal setbacks and low relief topography make the Geographe Bay sandy coastline sensitive to changing environmental conditions, including storm events and seasonal cycles, and has always been subject to the impacts of coastal hazards, such as erosion and inundation. It is expected that this vulnerability will increase in the future due to the projected combined effects of climate change and sea level rise, as well as an expectation of increased development density in some coastal areas.

This Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) provides a long-term view of coastal hazards for the City, and recommends pathways to adapt to future oceanic and coastal conditions. The CHRMAP aims to ensure that the City is strategically well-placed to contend with those hazards as and when they arise.

The CHRMAP process is designed to be ongoing, with regular updates associated with the emergence and collection of new information to be incorporated into more detailed planning and periodic review. Development of the CHRMAP has followed the requirements of the Western Australian Planning Commission (WAPC) *State Planning Policy No. 2.6 State Coastal Planning Policy* (SPP2.6) and supporting guideline documents.

Community consultation has contributed to the development of the CHRMAP through a Community Coastal Values Survey, a four month formal advertising period, public information sessions, public and agency submissions and engagement with the Geographe Bay Coastal Action Group. The CHRMAP also responds to the following key theme and strategic priority of the City of Busselton *Strategic Community Plan 2021 - 2031*:

Key Theme 1 - Environment

- **Strategic Priority 1.4** – Respond to the impacts of climate change on the City's coastlines through informed, long term planning and action.

A coastal hazard assessment was undertaken to determine the potential extent of coastal erosion over a 100-year planning timeframe. A risk and vulnerability assessment was then applied, with results highlighting the most vulnerable areas and assets along the City's coastline, for which a more detailed investigation and evaluation of adaptation options was undertaken.

The majority of residential and commercial development along the City's coastline is generally situated on land that is less than three metres above sea level. The CHRMAP acknowledges the challenges associated with managing risks in a dynamic coastal environment, together with the need to balance environmental, social and economic values to ensure the long-term sustainable use, monitoring and management of the City's unique coastline.

1.0 Introduction

1.1 Purpose

The purpose of the CHRMAP is to identify the current and projected extent of risk to private assets, public infrastructure and environmental/social/cultural values from coastal hazards, including those arising from projected sea level rise. The CHRMAP also aims to provide a meaningful framework for responding to those hazards, including financial modelling for recommended adaptation pathways over a 100-year timeframe.

1.2 Objectives

The CHRMAP was prepared with the following overarching objectives in mind:

i. To ensure that the location and development of coastal facilities takes into account projected coastal processes, landform stability, erosion hazards, climate change/sea level rise and biophysical criteria.

ii. To guide the identification of appropriate areas for the sustainable use of the coast for housing, tourism, recreation, ocean access, commercial and other activities.

iii. To provide for sustainable public coastal foreshore reserves and access to those reserves.

iv. To protect, conserve and enhance coastal zone values, particularly in areas of landscape, biodiversity and ecosystem integrity, and indigenous and other cultural significance.

1.3 Study area

The Study Area includes the north-facing sandy coast from the City's municipal boundary at Forrest Beach, Wonnerup to Curtis Bay, Dunsborough (approximately 37km in length) as well as the coast at the Smiths Beach, Yallingup, Bunker Bay and Eagle Bay settlements. The remainder of the City's west coast, which is mostly within the Leeuwin-Naturaliste National Park, is not in the Study Area, although the findings of the CHRMAP will be shared with the Department of Biodiversity, Conservation and Attractions (DBCA) and could be referenced as part of that Department's future planning and management arrangements.

The Study Area has been divided into 21 'Management Units', each defining sections of the coastline sharing similar characteristics. These Management Units have also been identified based on:

- coastal erosion hazard assessments.
- a sediment cell framework developed by the Department of Transport.
- existing coastal infrastructure (such as groynes, drains and seawalls).
- the distribution and types of assets vulnerable to coastal erosion hazards.
- variation in the width of beach and foreshore areas.

The Management Units provide a mechanism for evaluating risk management options, adaptation pathways and future monitoring and management. The Management Units are listed with a description of their characteristics in Table 1.

Table 1 **Management Units**

Management Unit No.	Management Unit Name	Boundaries	Description
MU 01	Smiths Beach	***South:*** start of rocky headland ***North:*** start of secondary headland	The southern portion of a west facing Bay and includes the Gunyulgup Brook mouth. The continuous public foreshore reserve is currently Unallocated Crown Land (UCL) and its northern end is contiguous with the Leeuwin-Naturaliste National Park. There are no current coastal protection structures.
MU 02	Yallingup	***South***: start of rocky headland ***North:*** start of northern rock platform	The southern portion of a west-facing sandy beach with rock platforms. Continuous public foreshore reserve partly within the Leeuwin-Naturaliste National Park with the remainder vested in the City. There are no current coastal protection structures.
MU 03	Bunker Bay	***West:*** rocky headland ***East:*** rocky headland	North-facing sandy bay in the lee of a rock headland. Limited public foreshore reserve and facilities. Flows from Lake Jingi breach the dune barrier and discharge into the ocean. There are no current coastal protection structures.
MU 04	Eagle Bay	***West:*** rock outcrop ***East:*** rock outcrop	Northwest-facing sandy bay in the lee of a rock headland. Includes a series of rock outcrops and the mouth of Jingarmup Brook. Continuous public foreshore reserve contiguous with Meelup Regional Park. There are no current coastal protection structures.
MU 05	Old Dunsborough	***North:*** boundary to Meelup Regional Park ***South***: Beach Road (Tertiary sediment cell boundary)	East-facing mixed sandy/rocky coastline including Point Daking and Point Dalling. Continuous public foreshore reserve but often very narrow. There are no current coastal protection structures.
MU 06	Dunsborough Townsite	***North:*** Beach Road (Tertiary sediment cell boundary) ***South:*** Elmore Road	Northeast-facing sandy beach in the lee of rocky headlands. Includes the Dunn Bay Bar and the mouths of the Dandatup and Dugalup Brooks. Continuous public foreshore reserve (including vegetation and habitat). Coastal protection structures: buried geotextile sand container (GSC) seawall installed in 2012.
MU 07	Quindalup	***West:*** Elmore Road ***East:*** Station Gully Drain	Northeast-facing sandy beach that includes the point of land fall for the Dunn Bay Bar. Continuous public foreshore reserve (with significant vegetation & habitat values). Toby Inlet runs generally parallel to the coast and discharges to the west of Station Gully Drain. Coastal protection structures: stone revetment (1973), timber groynes (1982) and Quindalup Sea Rescue trial groyne (2013).
MU 08A	Marybrook West	***West:*** Station Gully Drain ***East:*** Western boundary of Lot 66 (No. 552) Caves Road, Marybrook and Lennox River Drain	Northeast-facing wide sandy beach and foreshore reserve, with the Marybrook Drain outlet. Includes the 'Deadwater' which is the easternmost section of Toby Inlet that is dissected by the Station Gully Drain. The existing foreshore reserve is not entirely in public ownership.
MU 08B	Marybrook/Siesta Park Central	***West:*** Western boundary of Lot 66 (No. 552) Caves Road, Marybrook ***East:*** Siesta Park Holiday Resort western boundary	North-facing sandy beach with the Lennox River Drain outlet. There is no continuous, useable public foreshore reserve. Coastal protection structures: Siesta Park jetty groyne (1950s) and east Lennox timber groyne field (1960s). There are some private coastal protection structures.
MU 09A	Siesta Park Holiday Resort	***West:*** Western boundary of Lots 105 (No. 388) and 106 (No. 367) Caves Road, Siesta Park ***East:*** Eastern boundary of Lot 106 (No. 367) Caves Road, Siesta Park	North-facing beach with a foreshore reserve that becomes wider towards the eastern section of the management unit.

Management Unit No.	Management Unit Name	Boundaries	Description
MU 09B	Siesta Park East	***West:*** Lennox River Drain ***East:*** Locke Swamp Drain	North-facing wide beach and foreshore reserve that has been influenced by the construction of the Siesta Park groyne. The existing foreshore reserve is not entirely in public ownership.
MU 10	Locke Estate	***West:*** Locke Swamp Drain ***East:*** Buayanyup River Drain	North-facing beach backed by leasehold land and, further inland, the Locke Nature Reserve. Camp lease sites on the seaward side of Caves Road. Coastal protection structures: Buayanyup River Drain training wall (1985), groyne field (1988-1992 & 2014/15), Locke Estate seawall (1985-1992/2014).
MU 11	Abbey	***West:*** Buayanyup River Drain ***East:*** Holgate Road Groyne (Secondary sediment cell boundary)	North-facing sandy beach with a continuous narrow public foreshore reserve (including vegetation and habitat). Coastal protection structures: boat ramp headland (1978, refurbished 2011 & 2013), groyne field (1990s, 2011 & 2012/13), Abbey West groyne (2012/13).
MU 12	Broadwater	***West:*** Holgate Road Groyne (Secondary sediment cell boundary) ***East:*** Dolphin Road	North-facing sandy beach with a wide continuous public foreshore reserve (including vegetation and habitat). Landfall for the Abbey sand bar. Coastal protection structures: two trial groynes (2011).
MU 13	Busselton West (A)	***West:*** Dolphin Road ***East:*** Vasse River Diversion Drain	North-facing sandy beach with a narrow continuous public foreshore reserve. Coastal protection structures: seawalls (1970s), groynes (1990-1995 & 2016) and Vasse River Diversion Drain outlet training wall (1983).
MU 14	Busselton West (B)	***West:*** Vasse River Diversion Drain ***East:*** Gale Street	Northwest-facing sandy beach with a generally narrow, continuous public foreshore reserve. Coastal protection structures: King Street carpark buried geotextile sand container seawall (2013).
MU 15	Busselton Central	***West:*** Gale Street ***East:*** Ford Road	Northwest-facing sandy beach with a continuous public foreshore reserve that widens to the east. Includes the Busselton Foreshore Precinct and significant heritage assets. Coastal protection structures: Busselton Jetty GSC groynes (2008), seawalls (refurbished 2011, 2015 & 2017), Scout Road groynes (2013).
MU 16	Busselton East	***West:*** Ford Road ***East:*** Freycinet Drive	Northwest-facing beach with continuous public foreshore reserve. Wide beach and foreshore reserve. Land fall for the Busselton Jetty sand bar. No current coastal protection structures.
MU 17	Port Geographe	***West:*** Freycinet Drive ***East:*** Port Geographe breakwater	Port Geographe Marina and canal development. Public foreshore reserve from the inner marina entry wall extending along the seawall. Coastal protection structures: Port Geographe seawall and west breakwater.
MU 18	Wonnerup	***West:*** Port Geographe breakwater ***East:*** Wonnerup Inlet	Northwest-facing sandy beach and low lying coastal barrier backed by the Vasse-Wonnerup Estuary. Includes the mouth of the Wonnerup Inlet. Continuous public foreshore reserve. Coastal protection structures: Wonnerup groyne field (2004-2006), buried seawall and Baudin Reserve GSC groynes (2017). Flood protection structures: Vasse Estuary storm surge barrier.
MU 19	Forrest Beach	***West:*** Wonnerup Inlet ***East:*** LGA boundary with Shire of Capel	Northwest-facing sandy beach and coastal barrier backed by the Vasse-Wonnerup Estuary. Includes the 'Deadwater' wetland and a continuous public foreshore reserve. No current coastal protection structures. Flood protection structures: Wonnerup Estuary storm surge barrier.

Each Management Unit is delineated on an aerial photo, with coastal erosion hazard lines superimposed, in section 7.4 Recommendations of the CHRMAP.

1.4 Coastal management

Prior to the development of the CHRMAP, the City has undertaken, or been otherwise directly involved in, a number of projects and initiatives that have assisted in setting the future direction for the effective management of our coastline, including:

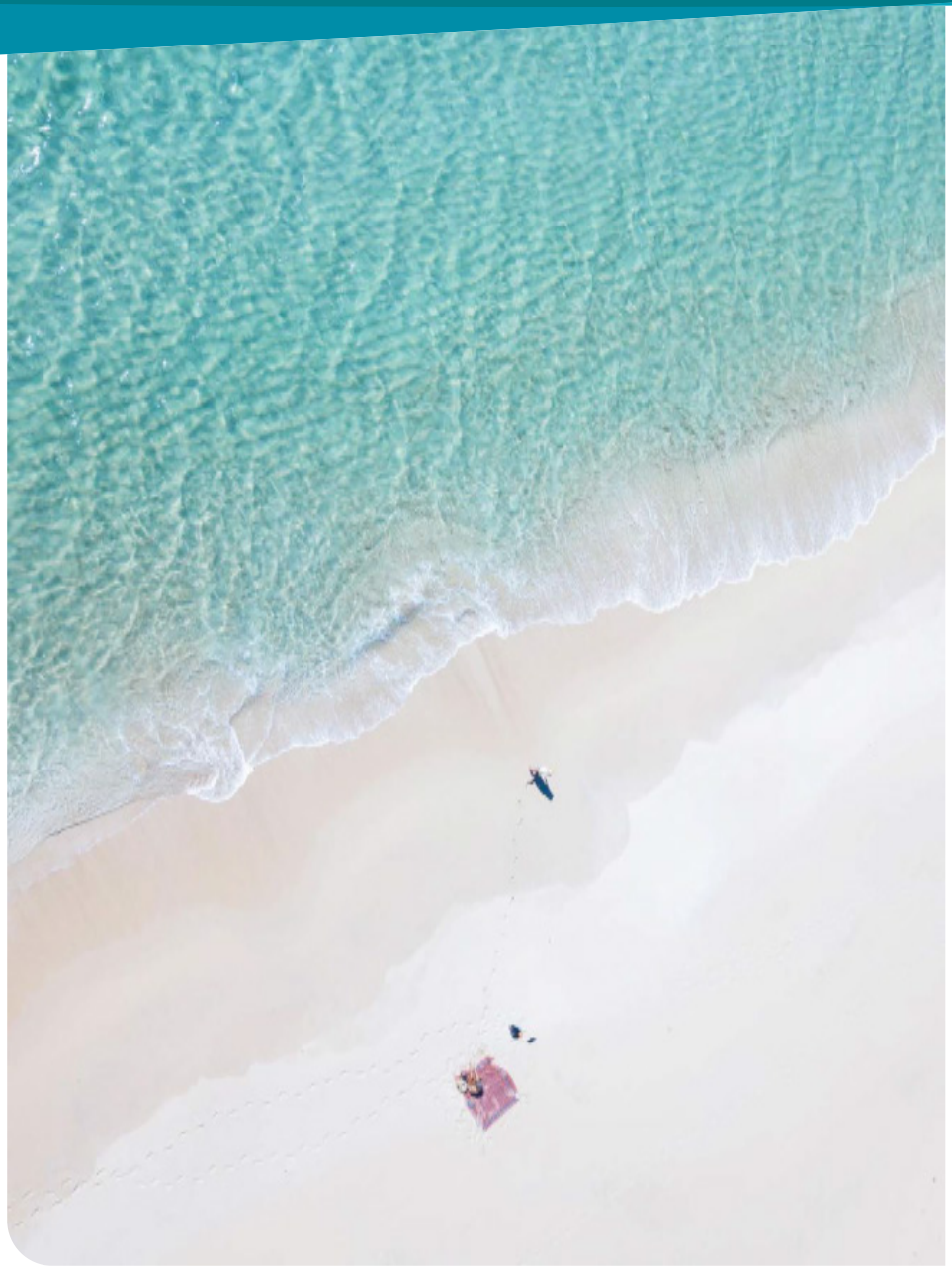
i. Formation of the Peron-Naturaliste Partnership (PNP), which is a collaboration of the nine coastal local authorities between Point Peron (in the City of Rockingham) and Cape Naturaliste (in the City of Busselton) providing regional direction and leadership in terms of coastal monitoring and management, particularly through the:

   - Coastal Adaptation Pathways project that delivered an economic analysis of adaptation options at a 'whole of region' scale, and a demonstration of coastal adaptation pathways and options at a scale relevant to partner local governments (ACIL Tasman/Damara 2012).
   - Coastal Community Adaptation Awareness Plan project (2013) that engaged with the City of Busselton community regarding coastal adaptation challenges and options, with the aim that 'lessons learned' could be applied for similar engagement elsewhere within the PNP region and beyond (ACCARNSI 2013).

ii. A number of coastal erosion studies to model the potential impacts of sea level rise on the Geographe Bay coastline, with the most recent of these (Damara 2012) reflecting the direction of the WAPC that coastal planning be undertaken on the basis of a predicted 0.9 metre sea level rise over a time period of 100-years. The Damara study produced interim coastal modelling maps that provided an interpretation of development planning setbacks for coastal erosion under a set of possible climate change scenarios. These are publicly available on the City's website.

iii. A Coastal Vulnerability Assessment for four settlements either side of Cape Naturaliste: Smiths Beach, Yallingup, Bunker Bay and Eagle Bay (Damara 2017).

iv. A rolling *Coastal Management Programme 10 Year Plan (2020-2030)* for the Geographe Bay coastline that provides the basis for a 'whole of coast' approach to managing coastal erosion, through the definition of six coastal management areas based on tertiary sediment cells and local management practices (Shore Coastal 2020). The CMP also sets out planned and costed coastal protection maintenance works, beach width monitoring, investigations (such as sediment and coastal inlet dynamics, coastal stratigraphy, numerical modelling of coastal flooding and review of sand and rock sources) and coastal adaptation works. The CMP has a time horizon, however, that is less than what is needed for long-term coastal adaptation planning. The focus of the CMP is also on reserves and public assets, with little consideration of private land and assets. A previous five-year CMP (2014-2018) has already been implemented.



v. The transition of the City's 'Beach Protection Reserve' to a 'Coastal and Climate Adaptation Reserve' to enable the direct allocation of funds towards the preparation of a short term (<25 years) coastal protection plan/long-term coastal adaptation strategy (i.e. the CHRMAP) to be reflected in an integrated way into the City's local planning scheme, as well as the City's long-term infrastructure and financial plans.

vi. Two legal implications related projects to assist coastal local government authorities to identify, manage and mitigate legal risks in an environment of changing climate policy.

vii. A WALGA-led project to obtain qualified legal advice and opinion to assist coastal local government authorities with respect to matters associated with coastal hazard planning issues relating to sea level rise.

1.5 Assets and values

For the purpose of the CHRMAP 'assets' include:

- Natural features such as beaches, dunes and native vegetation.
- Land, in both public and private ownership.
- Buildings and other structures.
- Infrastructure for provision of drainage, water, sewerage, electricity, communications and gas.
- Roads, car parks and dual use paths/beach access stairs and ramps.
- Structures such as jetties, boat ramps, seawalls and groynes.

The 'value' of an asset can be tangible or intangible, financial or non-financial. Examples of non-tangible assets include ecological functions and coastal views/amenity. The value of an asset also includes consideration of risks and liabilities, and can be deemed positive or negative at different stages of the asset's life. Values in the context of the CHRMAP further encompass the broader economic, social (including heritage) and environmental values of the Study Area.

2

Existing environment

2.1 Climate

The South West of Western Australia has a Mediterranean climate with hot, dry summers and cool, wet winters. Mean maximum temperatures vary from 28.5˚C in summer to 16˚C in winter. The mean annual rainfall in Busselton is approximately 800mm, with most falling from May through to October.

2.2 Geology and landform

The Geographe Bay coastline is comprised of low-relief topography and parallel estuaries and wetlands, with openings to the ocean via a man-made drainage network and natural streams or inlets/estuary mouths. The coastal dunes are limited in height largely due to offshore prevailing winds, with many landforms in the coastal zone situated less than three metres above sea level.

The coastline around and to the south of Cape Naturaliste is characterised by steeper relief topography with distinct bays and/or beaches separated by rocky headlands. Coastal dunes there are higher, ranging from around five metres above sea level at Eagle Bay and Bunker Bay to over 20m at Yallingup.

2.3 Hydrology

A number of ephemeral waterways are present in the Geographe Bay catchment. The Lower Vasse, Lower Sabina, Abba and Ludlow rivers feed into the Vasse-Wonnerup Estuary, which discharges into the ocean via the Wonnerup Inlet. A network of man-made drains (including diverted rivers) constructed in the 1920's to ameliorate flooding of agricultural land and urban areas also intersect with the Geographe Bay coastline and discharge into the ocean.

Natural outlets to Geographe Bay occur at the Wonnerup Inlet, Toby Inlet, Dugalup Brook (Dunsborough), Dandatup Brook (Dunsborough), Jingarmup Brook (Eagle Bay), Lake Jingi (Bunker Bay), Gunyulgup Brook (Smiths Beach) and several other brooks/creeks on the City's west coast. Storm surge barriers located on the exit channels of the Vasse-Wonnerup Estuary (originally installed over 100 years ago) control tidal seawater intrusion and winter outflow of freshwater (WAPC 2005).

Groundwater systems in Geographe Bay catchment include:

- **The Superficial Aquifer:** the near-surface unconfined aquifer that is mostly recharged by rainfall and has a general northerly flow towards the coast.
- **The Leederville Aquifer:** underlies the Superficial Aquifer and varies in thickness from 50m to 500m. This confined aquifer flows generally north and discharges into Geographe Bay and provides potable water supplies to Busselton, Dunsborough and Yallingup. Sea level rise and a drying climate are likely to increase the risk of seawater intrusion into freshwater aquifers and wetlands. The Department of Water and Environmental Regulation has commenced a project to investigate the seawater interface with groundwater along the coast between Dunsborough and Bunbury, through the establishment of a network of new groundwater monitoring bores.
- **The Yarragadee Aquifer:** the oldest and deepest confined aquifer underlying the Superficial and Leederville Aquifers. It ranges in thickness from 600m to 1,600m and also flows towards Geographe Bay and provides potable water to Busselton, Dunsborough and Yallingup.

2.4 Coastal processes

The City's weather is influenced by extra-tropical high pressure ridges and mid-latitude low pressure troughs. Under high pressure conditions, winds have a typical pattern of easterlies in the morning and south-westerlies in the afternoons. Potentially damaging wind speeds/gusts are associated with low pressure conditions, higher storm frequency, proximity and intensity during the winter months.

Geographe Bay is micro-tidal, with an average daily range of approximately 0.6m and a lowest to highest astronomic range of 1.20m. Sea level variability due to storm surge and high tides can produce a range of more than 2m. Extreme water levels were experienced during Tropical Cyclone Alby (1978) and following the Sumatra tsunamis in 2004 (Damara 2011). The diffraction of wave direction and swell energy around Cape Naturaliste, combined with a northerly aspect, provides Geographe Bay with more protection from westerly and south-westerly storm events. Northerly and north-westerly storms, however, can create high wave events along the Geographe Bay coastline.

While tides cause small and predictable changes in sea level, storm surge can result in short-term sea level rise associated with strong winds and barometric pressure changes. In particular, strong winds can generate steep waves which can erode higher sections of beach which are not typically vulnerable. The level of beach impact can be substantial, particularly if storm events coincide with a high tide. Overall, the impact on beach profile is dependent on the magnitude, intensity and duration of the associated storm system and tidal cycle (diurnal, spring-neap or bi-annual) at the time of the event.

2.5 Historic shoreline changes

Historical aerial photography dating back to November 1941 has been used to map the movement of the coastline of Geographe Bay and to identify areas of accretion and erosion. Generally, the Geographe Bay coastline has been accreting over that time period, however localised variations show that, in an unmanaged state, the coastline can be highly mobile, with most of the shoreline experiencing, at the decadal-scale, periods of both significant net accretion and significant net erosion over the last 70 years.

These changes are natural responses to storm erosion and recovery, and are influenced locally by the installation of coastal protection structures, the construction of a regional drainage network (drains that bisect the coast and influence the trapping and release of sediment) and movement of the large, active sandbars within Geographe Bay itself. The prevailing swell and alongshore tidal and wave currents generate sand feeds, resulting in wider beaches near the tips of sandbars. The largest sandbars have an eastward migratory trend and can influence shoreline beach widths.

3

Why does the City need a CHRMAP?

3.0 Why does the City need a CHRMAP?

Mean sea level has risen globally since the 19th century and this is predicted to continue at an increasing rate through the 21st century, significantly altering the WA coastline over the coming decades. Changes to mean sea level over the past century have been observed for the coastline adjacent to the Perth Metropolitan Area. In accordance with SPP2.6, the City is required to address a projected sea level rise of 0.9m over the next 100 years which will have significant impacts on the City's coastal areas in the future.

Because the coastline is mobile and dynamic and has been affected by coastal processes historically, both the City and private landowners have periodically taken steps to manage those affects. It is not a question of if or when the City's coast may be affected by coastal erosion hazards, but the extent to which those affects will continue (and accelerate) over time. Unless strategic actions are taken to protect the coast, not only will private land and development be affected, but so will public beaches, foreshore reserves, environmental assets (vegetation/habitat and wetlands/estuaries), cultural assets and public infrastructure such as roads. Irrespective of whether the projected 0.9m mean sea level rise eventuates (or is exceeded), the coastline within the Study Area requires a well-considered and ongoing strategic management approach.

It is worthwhile thinking about this issue in comparison with the way one thinks about insurance. A person may insure their house for fire, even though it may be overwhelmingly unlikely that the house will ever be damaged or destroyed by fire. A judgement is made about the likelihood and consequences of an adverse event relative to the costs of insurance, even while still hoping and taking care to ensure that the adverse event does not actually occur.

In considering the potential effects of coastal processes generally, coupled with sea level rise, the likelihood of an adverse event is high (and has occurred both historically and very recently), the consequences are very significant and the cost of 'insurance' is relatively low, when compared to the likelihood and consequences of the potential harm. The cost is, however, still substantial, and likely to be well beyond the reasonable financial capacity of local government to generate and manage effectively.

Long-term projected increases in mean sea level have the potential to exacerbate existing coastal processes. As such, all levels of government are putting measures in place to try and ensure that communities understand the risks to values and assets along the coastline, and appreciate the importance of being in a position to be able to adapt to these over time.

While the scientific community has established that human-induced climate change is occurring, uncertainty remains about the magnitude and extent of the likely future impacts from these changes. Despite such uncertainty, early consideration of coastal erosion hazards, and the adaptation and management of appropriate planning responses, is essential to ensure economic, environmental and social objectives can be achieved.

National and international coastal planning practices are increasingly adopting a risk management approach to deal with the potential adverse impacts of coastal erosion hazards. These help ensure that such hazards are appropriately factored into strategic decision-making processes for sustainable land use and development in the coastal zone.

3.1 Community and stakeholder engagement

Community input is the cornerstone of an effective CHRMAP process, helping the City to better understand how people use and value the coast, and how the coastline should be best monitored and managed. Early community engagement (prior to formal consultation on the CHRMAP) began in 2018 with a Community Coastal Values Survey and community information sessions in 2019. Formal consultation once a Draft CHRMAP had been adopted by the Council then occurred in 2021. A broader summary of the consultation and engagement undertaken as part of the CHRMAP process is set out below.

3.1.1 Community coastal values survey

The City commissioned Research Solutions to undertake a community survey to determine what people value most about the coastline in the Study Area (Research Solutions, 2018). The methodology and results of the survey can be viewed on the City's website. The survey

sample itself was divided into coastal and inland residents and property owners. An important objective behind this approach was to deliver a random and representative sample of the community, including those members of the community who may not typically participate in such consultation due to their residing away from the coastline and Study Area.

The survey intended to:

i. Establish how the coastline is used, and then compare this with the values people espouse for the coastline.

ii. Establish key values and what people feel should be protected and preserved from likely future erosion.

iii. Establish whether the community understands the changes that are already occurring along the coastline and the level of awareness of the City's current actions to monitor and manage coastal erosion.

iv. Explore who the community feels should be responsible for meeting the costs of reducing and/or mitigating the impacts of coastal erosion.

The survey found that the north-facing beaches in the City are strongly valued by the community, with over half of those surveyed feeling that uninterrupted stretches of sandy beach are a vital part of the character and social wellbeing of Busselton.

The most important coastal value cited was 'handing the coastal area onto our children and grandchildren in the same or better state than it is now'. Other important values were:

- Knowing that there are places on the coast that feel 'natural'.
- Natural vegetation/habitat on foreshore and beach areas.
- Uninterrupted stretches of sandy beach to walk and recreate along.
- Heritage: historical features such as the Pioneer Cemetery or the Busselton Jetty.
- Safe swimming beaches.

The survey also established that a significant proportion of the community use local beaches in the Study Area. Over 53% of respondents mentioned walking/jogging on the beach or foreshore at least once a week. Of those, 42% of respondents living in the western part of the City preferred remotely located beaches (this increased to 54% of respondents who lived in the eastern part of the City). Of all respondents, 22% cited using both the Busselton 'town beach' or Old Dunsborough beach and more remote beach areas for walking and/or jogging.

There was a high level of awareness of natural changes in the coastline over the year preceding the community survey (62%), and 60% of respondents were aware that the City had taken action to stop or reduce impacts from coastal erosion over the previous five years (e.g. the construction of groynes and seawalls, or the implementation of beach nourishment and revegetation).

On the question of who should be responsible to meet the costs associated with the prevention or mitigation of likely coastal erosion impacts, 41% of respondents felt that the State taxpayer should bear the majority of such necessary costs, with the balance to be borne by all ratepayers in the City (29%) and private landowners/businesses more directly affected (30%).

The results of the community coastal values survey have been used to inform the multi-criteria analysis (MCA) of adaptation options for the CHRMAP, as well as a financial model (where all scenarios assume protection and preservation of a continuous beach and foreshore, wherever possible, as the preferred end result).

3.1.2 Community information sessions

In March 2019, the City held community information sessions in both Dunsborough and Busselton regarding the development of a CHRMAP for the City's coastline. Information disseminated during those sessions included the findings of the community coastal values survey, the State government's position on coastal management and projected sea level rise, the coastal areas within the City considered to be the most vulnerable to potential coastal erosion hazards in future decades, and options for monitoring and managing the effects of sea level rise and coastal hazards.

3.1.3 Strategic Community Plan 2021 - 2031

In June 2020, the City undertook a 'community scorecard survey' to support a review of the Strategic Community Plan and to assist with identifying community priorities. The survey asked respondents to rank local projects and issues, from the most important to the least important.

Of those respondents, 46% ranked the management and protection from coastal erosion of the City's coastline as the most important.

3.1.4 Steering group

The City engaged with relevant government and external stakeholders in the preparation of the CHRMAP through a representative Steering Group. The City will also continue to liaise with relevant agencies as required, in order to best ensure that coastal hazard management and strategic adaptation planning is coordinated and implemented within the municipality and across the region. The Steering Group was comprised of representation from:

- Department of Transport
- Department of Planning, Lands and Heritage
- Department of Water and Environmental Regulation
- Department of Biodiversity, Conservation and Attractions
- Water Corporation
- GeoCatch catchment management group based in Busselton

3.1.5 Advertising of the CHRMAP

The CHRMAP was advertised for four months between 21 May and 28 September 2021. The strategic direction and recommendations outlined in the CHRMAP attracted a significant level of community interest during the consultation period. Of the 62 public submissions received, nearly half (29) indicated general support for the CHRMAP and/or recommended response(s) to managing risk from coastal hazards. Most of the rest of the submissions were from Siesta Park/Marybrook landowners, and expressed concerns about the approach proposed for that part of the coast.

The initial consultation period was 21 May – 23 July 2021 during which time a number of staffed displays, presentations (both online and in person), community information sessions and other forms of communication and engagement in regard to the project were coordinated and conducted by the City, as follows –

- Media release and regular social media updates, including the Mayor's Message
- Weekly newspaper notices ('City Connect')
- Two Bay to Bay articles (the City's digital newsletter)
- Correspondence to community groups and industry associations
- Direct mail out to landowners in Marybrook and Siesta Park
- Static information displays in the City of Busselton Administration Building and the Naturaliste Community Centre
- Staffed information displays at the Busselton Central and Dunsborough Centrepoint shopping centres
- Two community information sessions (City of Busselton Administration Building on 27 May 2021 with 21 attendees and John Edwards Pavilion, Dunsborough with 19 attendees) – powerpoint presentation providing overview of the CHRMAP process, findings of the Community Coastal Values Survey, potential legal/liability implications, methods of advocacy, existing coastal management and protection works by City, application of SPP2.6 and adaptation hierarchy, CHRMAP recommendations and Q&A
- Four online information sessions

Following significant levels of interest and concern expressed to the City by landowners in Marybrook and Siesta Park, the consultation period was extended to 26 August 2021. A community information session specifically for these landowners was convened by the City on 5 August, with approximately 50 persons attending. The format was an overview of the CHRMAP process and then a focus on the Marybrook Siesta Park coast (presenting various data, historical trends, images and mapping) along with specific recommendations for the two management units and how/why these differed from the recommendations for most of the coast.

An outcome of this community information session was agreement to further extend the consultation period to 28 September 2021 to allow for another more science-based session with expert information and advice on the more specialised matters of coastal science, coastal management and engineering and to address related questions/concerns by landowners. That reflected the numerous questions on climate change, sea level rise and coastal mechanics. Co-presenters at the follow up session were specialist coastal consultants Dr Matt Eliot (presentation on climate and coastal science) and Stuart Barr (presentation on coastal protection – engineering and infrastructure – with an emphasis on the City's 10 year coastal management programme).

General points raised in submissions were (summarised) –

1. Broad recognition of risks associated with coastal hazards and the need to determine how those risks might be managed as a matter of priority.
2. Development of the CHRMAP was viewed as a positive step in response to this important issue for the City.
3. Protect was favoured over managed retreat – less cost to ratepayers and less impact on environmental values.
4. Support to protect and retain a useable beach and foreshore.
5. Support for shared funding, including State contributions, but those at most risk/direct beneficiary should contribute more.
6. Support for minimum finished floor levels for habitable floor space to mitigate future flooding risk.
7. Climate change/sea level rise scepticism, hazard modelling too conservative/out of date, inherent uncertainty over 100 years.
8. Concerns about consultation with Marybrook and Siesta Park landowners.
9. Support for the emergency management response for Marybrook and Siesta Park management units.
10. Concerns about impacts of new groynes on the beach in front of properties.

The recommendations of the advertised CHRMAP of most concern during consultation related to MU08 Marybrook and MU09 Siesta Park management units, and in particular –

1. **Boundaries of MU08 Marybrook and MU09 Siesta Park management units** – a more nuanced approach to boundary selection was suggested to reflect the variation in beach and foreshore reserve widths (and therefore the level of risk to assets to 2040).
2. **Distribution of costs and benefits** – concerns about the option for long term managed retreat and possible implications for property values, development/capital improvements, insurance premiums and ability to sell properties, as well as coastal environment/habitat values.
3. **Finished floor levels** - 3.8m AHD for habitable floor space – some support as well as concern about possible financial implications for future development and/or redevelopment.
4. **Planning controls: ceding of land/development approval for all development/ time limited development approvals/prohibit private coastal protection structures** – similar response to point 2 above.
5. **Infill subdivision/development density** – some support, but further guidance/ explanation on 'infill' subdivision and development was sought.

6. **Integrated approach to erosion protection** - some support (recognising the current piecemeal approach) as well as concerns about how/where this might be considered and funding arrangements.
7. **Funding** - Specified Area Rate to fully fund protection to 2040 – some support, but concerns about how and where it might be applied.
8. **Use of beach, access and foreshore areas** – the Marybrook/Siesta Park coast is used by, and accessible to, the general public and is an asset to the broader community.
9. **Shortening Siesta Park groyne** – concern about this option being foreshadowed in the CHRMAP.

Consultation after advertising the CHRMAP

Following advertising, a site meeting was held in Marybrook/Siesta Park with landowners, Councillors and City staff in November 2021. Subsequently, the Geographe Bay Coastal Action Group (GBCAG) was formed, representing approximately 60 landowners in the MB/SP area. A working group comprised of five members acting as a committee on behalf of GBCAG, two Councillors and City staff was convened to discuss matters arising from the advertised CHRMAP. The working group met on four occasions to discuss potential changes to the advertised CHRMAP.

A public information session was held on 12 May 2022 for Marybrook and Siesta Park landowners on the potential changes to the advertised CHRMAP, with broad support indicated for those changes. A further meeting was held with the GBCAG as an opportunity to provide final comments and/or seek clarification following the public information session. Potential changes to CHRMAP recommendations were also provided to the GBCAG for final comments. The CHRMAP Steering Group was consulted on potential changes and received broad support.

Separate consultation occurred with the landowners of the Siesta Park Holiday Resort on the proposal for the landholding north of Caves Road to form its own management unit (MU09a).

In response to the substantive issues raised during advertising and consultation afterwards, a number of changes to the general and management unit specific adaptation pathways (as contained in the advertised CHRMAP), have been incorporated into this CHRMAP. The scope of changes and their rationale is set out in section 7.4 of the CHRMAP.

The GBCAG has indicated an intention to remain active as a community group representing the landowners of Siesta Park and Marybrook into the future and to be involved and consulted on the implementation of the CHRMAP, including coastal protection and future planning policies/scheme amendments that may affect landowners in this area.

Implementation of some of the recommendations of the CHRMAP are likely to require amendments to the local planning scheme and development of local planning policy. There are statutory requirements to advertise and consult with the community as part of the development of those planning actions, and consultation with GBCAG will occur as part of those processes.

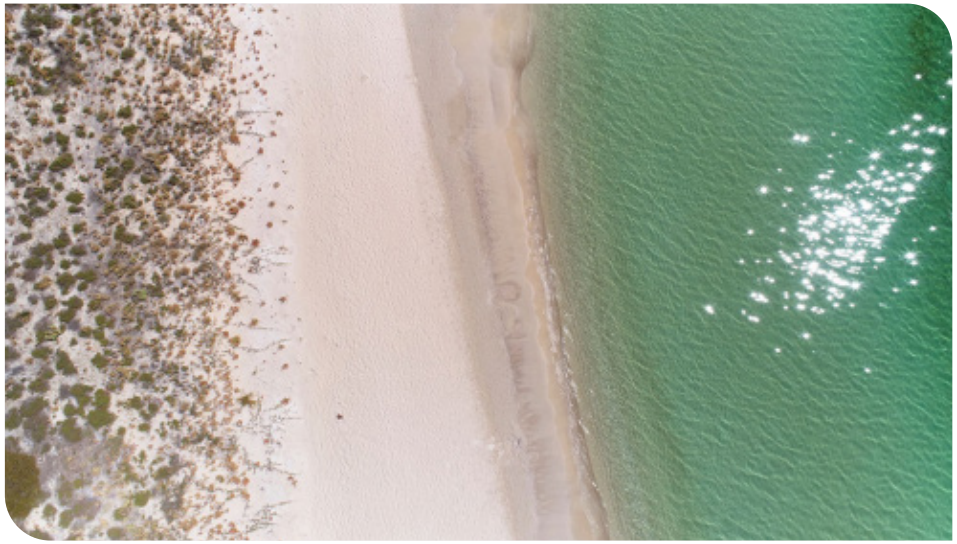
4

What are coastal hazards and how are they identified?

4.1 Coastal hazards

The coast is a relatively narrow dynamic zone characterised by complex interactions between oceanic, terrestrial and atmospheric processes. Ocean temperature, waves, tides, ocean currents and wind all contribute energy to form and shape the coast. These interactions result in natural changes to the coast over a range of timescales, including -

- long-term changes to the coastline as a result of global climatic change and geological processes, including the 120m rise in sea level recorded since the last glacial maximum around 20,000 years ago.
- ongoing processes of coastal sediment transportation, including the supply of sediment from rivers, coastal erosion or offshore sources transported by ocean currents, waves and wind.
- short-term effects of extreme events such as the landfall of a tropical cyclone.



Coastal erosion is a natural process that occurs when winds, waves and coastal currents act to shift sediments away from the shoreline, often during storm events. Typically, erosion occurs during the winter months, with recovery and build up (accretion) during the summer months. In most locations, this is a short-term process and beaches gradually regain sediment. In some places and at times, significant erosion or accretion can occur, however sea level rise is expected to increase net erosion.

Coastal inundation results from the interaction of a number of elements. During a storm, strong onshore winds can increase water levels close to the coast and low atmospheric pressure raises the level of the ocean. A storm surge can interact with other drivers, including coincident high tides, riverine and drain flooding, to increase the severity of inundation.

4.2 Coastal hazard modelling

Coastal hazards are modelled as per the parameters outlined in SPP2.6, which stipulate allowances to be made for erosion as follows:

- **(S1 Erosion) allowance** for the current risk of erosion.
- **(S2 Erosion) allowance** for historic shoreline movement trends.
- **(S3 Erosion) allowance** for erosion caused by future sea level rise.

For sandy coastlines, the allowance should also include a 0.2m per year allowance for 'uncertainty'. An allowance for inundation should be based on:

- **(S4 Inundation) allowance** for the current risk of storm surge inundation.

Coastal hazard assessments that informed the CHRMAP adopted planning timeframes of 2040, 2070 and 2115. SPP2.6 requires planning authorities to consider the potential impact of coastal processes over a 100 year period (i.e. if a decision was being made in 2023, the impact of coastal processes should be considered through to 2123). The planning timeframe of 2123 reflects the preparation of the CHRMAP over the past several years since the hazard modelling

was completed and the additional eight years at the end of the planning period. The difference is not considered significant and the CHRMAP will undergo review during all those planning timeframes. In accordance with SPP2.6, therefore, the hazard modelling applied in the CHRMAP considers a sea level rise of 0.9m by 2123.

A significant number of coastal studies have already been undertaken in the City but it is considered preferential for the CHRMAP to be based on hazard mapping conforming to the requirements of SPP2.6, in order to ensure the CHRMAP's overall general compliance with current planning and regulatory requirements.

Practical recommendations on the selection and application of coastal hazard lines for inclusion in the CHRMAP are summarised below. The detailed technical methodology used to inform the preparation of the CHRMAP can be viewed in Part 1 of the CHRMAP Technical Assessment Report (Advisian, 2020a). The coastal hazard lines described below can be viewed on the Management Unit aerial photographs provided in section 7.4 Recommendations of the CHRMAP.

4.2.1 Erosion – Geographe Bay (Old Dunsborough to Forrest Beach)

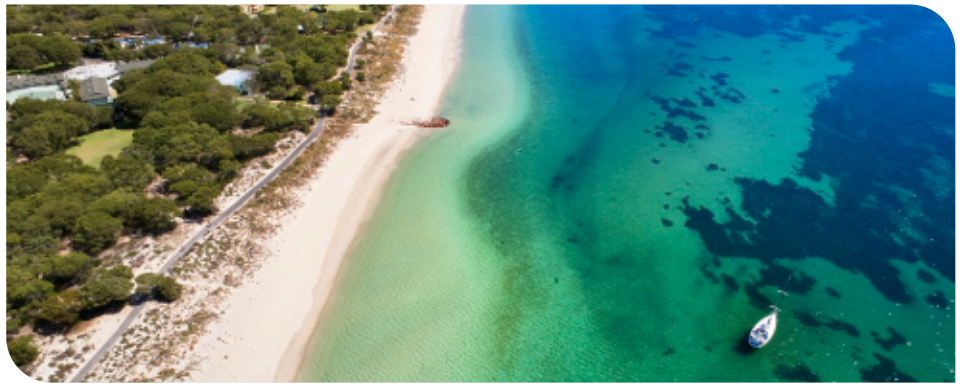
Damara WA (2012) developed hazard lines for the likelihood of coastal erosion for 2040, 2070 and 2115 for: 0.15m (low), 0.4m (medium) and 0.9m (high) sea level rise projections, respectively. The hazard lines were extrapolated west to the boundary of the Meelup Regional Park to incorporate Old Dunsborough. This is because existing coastal hazard studies have not included this section of the coast and the CHRMAP contains recommendations to further investigate coastal hazard risk for the Old Dunsborough Management Unit. The S1 erosion values in Damara WA (2011) are utilised in this CHRMAP to evaluate the present day risk to assets, which is in accordance with the requirements of SPP2.6.

Existing coastal protection structures were not factored into the modelling for coastal erosion for the various planning timeframes. That is because it cannot necessarily be assumed that those structures will be maintained or replaced in perpetuity, and no current structures have been designed with a 100-year design life.

Whilst the coastal erosion hazard lines for Geographe Bay are possibly conservative, they are considered appropriate for the development of the CHRMAP (Advisian, 2020a).

4.2.2 Erosion – Smiths Beach, Yallingup, Bunker Bay and Eagle Bay (Cape settlements)

Damara WA (2017) erosion hazard maps are generally consistent with SPP2.6, other than not including a 'present day' or short-term (2030) hazard scenario. For the purposes of the CHRMAP the 'Type 1 Application' erosion hazard lines are used for the years 2040, 2070 and 2115. This application uses an estimate for S1 based on beach variability and a 100:1 ratio of coastal response to sea level rise for S3. Progressive erosion allowances for S2 over 100 years are included for Smiths Beach and Yallingup. No S2 allowance is made for Bunker Bay or Eagle Bay due to active sediment supply. Hazard lines provided for 2040, 2070 and 2115 are for sea level rise of 0.15m, 0.4m and 0.9m respectively.



4.2.3 Inundation – Geographe Bay (Old Dunsborough to Forrest Beach)

SPP2.6 recommends the management of inundation risk up to a 1 in 500 year ARI event. However, due to the small number of extreme events in the recorded datasets, it is very difficult to accurately quantify the expected water levels during a 1 in 500 year event.

A present day 1 in 500 year ARI event was originally considered comparable to the actual recorded peak water levels during Tropical Cyclone (TC) Alby in 1978 (1.76m AHD in Geographe Bay). However, this peak level is now considered well below more recent estimates of a 1 in 500 year ARI, with current scientific assessments categorising TC Alby as having been around a 1 in 200 year storm event. A study commissioned by the Department of Transport (Seashore Engineering, 2018) identifies 2.9m AHD as a deliberately conservative, upper range estimate of a 1 in 500 year ARI event in Busselton, which would give a 100 year water level in the order of 3.8m AHD, allowing for 0.9m sea level rise.

A 2.9m AHD water level would result in the majority of the Study Area being impacted by inundation, both directly from storm surge and breaches in the dunes, and flooding of existing drainage channels (Advisian, 2020a). There is also the added complexity of the potential combined impacts of flooding due to a rising groundwater table and rainfall surface run-off.

In liaison with the Department of Transport, a targeted inundation study was prepared for the proposed Newport Geographe development at Port Geographe (Baird, 2020). The study makes recommendations for the 1 in 500 ARI coastal water level for the site in accordance with SPP2.6. The study also refers to TC Alby on a design storm basis for determining a recommended finished floor level of 3.4m AHD to protect urban development against 1 in 500 ARI water levels for buildings along the canal waterways for the planning year of 2120. That equates to a level of 2.5m AHD with present day mean sea level. There is not seen to be a reason why those levels would be higher elsewhere in Geographe Bay.

For the purpose of assessing the risk of inundation in the development of short-term management actions, and longer-term adaptation pathways, the CHRMAP assumes that:

- **In the short-term (0-10 years)** all areas below 2.5m AHD are at risk from inundation (this represents the majority of land within the Study Area).
- **In the longer-term (up to 100 years)** all areas within the Study Area below 3.4 m AHD are at risk from inundation.

These assumptions allow for the broader evaluation of management actions across each Management Unit. It is also noteworthy, however, that the CHRMAP contains Recommendation 4(c), which is as follows –

> **4. That the City undertake or support, subject to appropriate assistance from the State and/or Federal Government, the following associated but additional work:**
>
> (c) Given the identified pathways for coastal erosion hazard management in the CHRMAP, further coastal inundation hazard modelling including for both Geographe Bay and west coast settlements (Yallingup and Smiths Beach).

The City has also secured $500,000 in Federal Government funding to implement that recommendation, and at the time of writing is developing the detailed scope for the project.

4.2.4 Inundation - Smiths Beach, Yallingup, Bunker Bay and Eagle Bay (Cape settlements)

The physical characteristics of the City's west coast are different to those of generally sandy zone around Geographe Bay. Coastal inundation along the Cape Naturaliste coastline comprises two distinct components (Damara, 2017)

- For exposed west coast beaches, such as Yallingup and the middle/northern sections of Smiths Beach, coastal inundation caused by wave run-up results from the combined effects of high ocean water levels and onshore wind. This has caused significant dune erosion or 'scarping' in the past. Areas exposed to wave run-up hazard have been included in areas identified as likely to be affected by coastal erosion.
- For low-lying areas of beaches that are more sheltered from wave action (sections of Bunker Bay, Eagle Bay and Smiths Beach in the lee of rocky headlands), localised coastal inundation is caused by ocean water levels and outfall locations associated with drainage/creek lines.

Detailed inundation hazard mapping has not been undertaken as part of the CHRMAP for Smiths Beach, Yallingup, Bunker Bay and Eagle Bay. The need to do so will be considered alongside implementation of Recommendation 4(c), as outlined above.

4.2.5 Evaluating the combined risk of erosion and inundation

Within the Geographe Bay portion of the Study Area (generally north-facing, low-lying sandy beaches) there is a pronounced risk of both erosion and inundation. Although SPP2.6 requires the evaluation of these hazards independently, it is believed the effective assessment of adaptation options will require a more integrated approach. In particular the selection of coastal erosion adaptation options can have a direct influence on options for the management of coastal inundation. For example, a decision to either protect or alternatively retreat from a foreshore reserve could directly affect the City's ability to protect or mitigate against inundation.

However, given both the immediate and long-lasting risks from (and outcomes of) coastal erosion, the priority of the CHRMAP has been centred on the evaluation and determination of adaptation options for coastal erosion. These recommended adaptation options for coastal erosion risk will anyway assist in mitigating inundation hazard.

4.3 How are the risks assessed?

To provide a transparent and logical basis for determining adaptation planning priorities, a risk assessment was undertaken that aligned with the City of Busselton Risk Management Framework (2017).

Risk was assessed in relation to the –

- Likelihood of a hazard occurring.
- Consequences of the hazard if it was to actually occur.
- Capacity for the management of assets to adapt and address coastal hazards.

The risk assessment has assumed that existing coastal protection structures will not function beyond their current design life. For the purpose of estimating 'worst case scenario' coastal hazards, therefore, it is assumed that no other adaptation intervention will occur. For the steeper, rockier coastline at Old Dunsborough, and further west, there is uncertainty about the local geology and associated erosion hazard mapping. For the purposes of risk assessment and multi-criteria analysis, it is assumed that the estimation of risk is accurate (assuming no introduced coastal erosion controls). As a consequence, the CHRMAP includes a recommendation for an additional study to investigate geomorphological influences on coastal erosion risk, for Old Dunsborough, Eagle Bay, Bunker Bay Yallingup and Smiths Beach.

4.4 What could be affected?

Over the 100-year planning timeframe referenced in the preparation of the CHRMAP, the whole of the coast along Geographe Bay is considered vulnerable to coastal erosion. The severity and extent of potential impacts are also predicted to increase progressively. The risk of coastal inundation along the Geographe Bay coastline is also significant because it is so low-lying. The complexity and levels of risk also increases with the interaction between sea level rise, storm surge, peak tides and flooding associated with rainfall run-off from rivers, wetlands/estuaries, agricultural drains and drainage lines more generally.

The coastline at Smiths Beach, Yallingup, Bunker Bay and Eagle Bay is also at risk from coastal hazards but these risks can be considered and addressed separately from those along Geographe Bay, due to the more 'contained' influencing elements (e.g. geomorphic 'controls' such as rocky headlands separating sandy beaches, steeper topography and prevailing wave, swell direction and energy).

The total present day value of existing assets potentially at risk from coastal hazards in the Study Area to 2123 is estimated to exceed $5 billion. This figure includes private residential and commercial properties (valued at approximately $4.9 billion) and City of Busselton and State-owned utility assets (valued at approximately $513 million).

Public infrastructure assets in the study area include -

- **Foreshore areas**
  (including furniture/BBQs/play equipment/irrigation infrastructure/fencing).
- **Carparks.**
- **Dual use paths.**
- **Jetties and boat ramps.**
- **Buildings.**
- **Coastal protection structures.**
- **Roads and bridges.**
- **Utilities**
  (infrastructure for flood protection, stormwater, sewerage, water, power, gas and communications)

There are also highly valuable and significant assets that are inherently difficult to determine a dollar figure for, such as the Ramsar wetlands in the Vasse-Wonnerup Estuary, recognised habitat areas for the critically endangered Western Ringtail Possum, wetlands, groundwater aquifers (seawater intrusion) and sites of both Aboriginal and European historical, spiritual and cultural significance.

The impacts from coastal erosion are typically much more threatening than those of coastal inundation (noting that inundation is different to flooding in the context of the CHRMAP). For example, if a carpark is temporarily inundated with sea water during a storm event, the water will eventually subside and may not result in significant structural damage. If a carpark is undermined during a storm event, however, such erosion is likely to require repair or complete replacement.

In terms of vulnerability, therefore, coastal erosion hazards generally create the highest risk in the short-term, due to their greater capacity to significantly damage assets. The risk of coastal inundation, however, increases substantially over future planning timeframes and extends across large areas of low-lying land in and adjoining the Study Area and, in some cases, a significant distance further inland.

5

What are the management options and related considerations for coastal hazards?

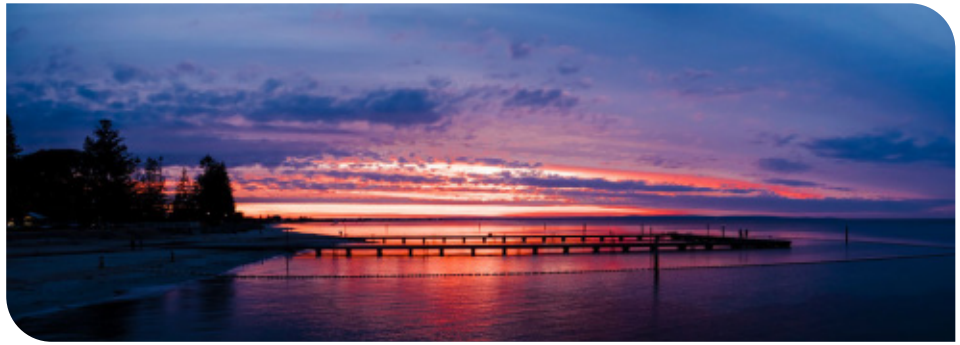
5.1 Key concepts

5.1.1 Equity

Equity is a concept central to the purpose of the CHRMAP process. The City's coastline is considered by the community to represent a highly valuable public asset, as well as by a range of stakeholders including individual property owners in coastal areas, ratepayers, taxpayers in general, and environmental/non-human stakeholders.

Responsibility for coastal planning in WA currently lies with both State and local governments and there is a need to ensure that decision-making properly considers equity in terms of:

- Access – e.g. if the foreshore reserve erodes to the point where private houses end up directly fronting the beach, this would restrict or even entirely prevent public access to those areas. The coastline and coastal foreshore reserves represent public assets that should, wherever possible, be protected and preserved future generations to enjoy.
- Enjoyment – e.g. if a seawall is constructed a person may still be able to enjoy the coastal environment by fishing from those rocks, however, the loss of a sandy beach would remove the potential enjoyment of that coastal environment by someone who simply wants to walk along that beach or swim from that beach.



- Beneficiaries - e.g. the construction of coastal protection structures, such as groynes, may create 'beneficiaries' (those who are subsequently protected from hazards), yet potentially disadvantage others. Such protection structures may exacerbate erosion further along the coast by diverting or limiting sediment transport and availability for maintaining and replenishing beaches some distance away from the protected area. Protection structures can also result in significant impacts to coastal ecosystems well beyond the location in which the structures are actually built.
- Intergenerational equity – e.g. in planning for a 100-year timeframe, how will decisions made now affect future generations? Continuing to allow development near the coastline without effective adaptation planning in relation to recognised and/or likely hazards has the clear potential to result in increased risk and expense for future generations.

In light of the above, it is critical that planning and management of coastal hazards is as transparent, effective, strategic and equitable as possible.

5.1.2 Coastal foreshore reservation

The coastal foreshore provides beach access and public spaces for recreation and conservation. It is also a tourist attraction and provides habitat for native flora and fauna. Importantly, it can also provide a buffer to protect built assets, such as buildings and infrastructure, from coastal hazards. As evidenced by the coastal values survey, a significant proportion of our community use the local beaches and foreshore areas.

SPP2.6 Schedule One provides guidance for calculating the width of a coastal foreshore reserve required to accommodate coastal processes. This is intended to ensure that, at the end of the planning timeframe, an attractive, accessible and usable coastal foreshore reserve is still present for recreation and/or conservation and is not, instead, exposed to and degraded by the adverse impacts of erosion and inundation. Additional and future development will need to be situated an appropriate distance from the coastal shoreline and foreshore reserve(s) and the City is already actively engaged in monitoring and managing the coastline in the Study Area to best ensure the

retention of these important recreational and environmental resources until the findings and recommendations of the CHRMAP can be properly implemented.

Notwithstanding the above, Schedule One, Clause 7 – Variations, outlines specific instances where certain types of development may need to occur within an area identified to be potentially impacted by coastal hazards within the 100-year planning timeframe. Consideration of development should occur within the context of a CHRMAP and may include, amongst other things, public recreation facilities with a finite lifespan, coastally dependent and easily relocatable buildings and surf lifesaving clubs.

5.1.3 Rights and responsibilities

There is no present law requiring any level of government to provide for the protection of private property from natural hazards, nor compensation when private land is undermined or lost to the sea. There are, however, several laws that permit the intervention of governments to enforce demolition if private property becomes dangerous or uninhabitable. The removal of buildings can also be ordered if those constitute an identified public risk. In the event of coastal erosion causing a privately-owned residential (or other) asset to 'fall into the sea', and the property itself to 'disappear below the high water mark', such losses are to be borne entirely by that owner.

The current legal situation in WA determines, however, that property Title remains even where the land is entirely lost to coastal processes. Nonetheless, the CHRMAP process ultimately intends to minimise risks and maximise opportunities for the sustainable beneficial use of the coast from an economic, social and environmental perspective. For more information on rights and responsibilities, refer to the State Government's WA Coastal Zone Strategy 2017.

5.2 Adaptation hierarchy

There are four broad categories of potential risk management options for responding to coastal hazard risks for any given section of coastline. The hierarchy of options in SPP2.6 is described as follows:

5.2.1 Avoid

Avoid any further residential or commercial development within areas identified as vulnerable to the impacts of coastal hazards. Avoid is seen as the 'preferred strategy' but is generally only applicable to undeveloped areas of the coast where intensification of development in hazardous areas might otherwise reasonably be proposed. This option is underpinned by the implementation of planning controls which should prevent inappropriate use of land in areas identified as potentially at risk from coastal hazards.

Pros	Cons
Ensures that property and infrastructure will not require costly management in the future.	Not an option for much of the City's coastline, where development already exists in areas recognised as being vulnerable to coastal hazards.

5.2.2 Planned or managed retreat

This option provides for the progressive removal of assets ahead of risk becoming manifest from coastal hazards. This would be a significant and problematic undertaking and could potentially involve acquisition of vulnerable private property and the removal and relocation of public infrastructure in order to preserve beach and coastal foreshore assets, public access, recreation, conservation and coastal foreshore management.

Planned or managed retreat for existing development involves relocating or sacrificing infrastructure, both public assets and private property, when the effects of erosion and coastal recession reach agreed trigger points.

Managed retreat is identified as the generally preferred adaptation pathway under SPP2.6. The Planned or Managed Retreat Guidelines (DPLH, 2019) outline mechanisms for securing the

transfer of land from private ownership to the public realm under this approach. Although the State Government generally recommends managed retreat, it has not explained how it proposes to fund such an option at this stage. While there is currently no obligation at any level of government to compensate landholders for the detrimental effects of coastal hazards and sea level rise, there is a pronounced and evident obligation for government to act in accordance with the accepted best interests of a particular community. The community coastal values survey in the City of Busselton strongly supported the retention, wherever possible, of a continuous beach and foreshore, and to achieve this under a managed retreat management option, private properties would need to be purchased, often compulsorily.

This option could be facilitated in a number of ways, including:

- Leaving assets unprotected and repairing or removing them only when they are directly threatened or otherwise affected (e.g. minor park infrastructure).
- Removing or relocating assets before they are directly affected (e.g. larger-scale assets and infrastructure, including commercial/private property and roads).
- Not acting to retreat until other certain trigger points have been reached (e.g. shoreline recedes to a defined point).
- The application of pre-emptive planning controls, such as delineating a Special Control Area over vulnerable areas.
- Reserving land in the local planning scheme to expand existing foreshore reserves, including the acquisition of land through either voluntary or compulsory means.

It is important to note that without the acquisition of private property to expand the foreshore reserve, a managed retreat option may result in a loss of public access to foreshore areas and a loss of amenity as houses become uninhabitable.

Pros	Cons
• Removing assets from hazardous areas eliminates the need to fund ongoing protection. • From an intergenerational equity perspective, failing to retreat when needed could be seen to disadvantage future generations, who would effectively be paying to rectify land mismanagement attributable to previous generations.	• Well-defined trigger levels based on long term datasets are critical to ensure that management responses are entirely appropriate and conducted in a timely way. For example, an arbitrary trigger might be that managed retreat will be implemented once more than 40m of a shoreline/beach is lost. However, if 80m of beach was lost in one storm, it would obviously not allow sufficient time to implement a contingency response. • There is currently no funding mechanism proposed by the State or Federal governments to assist with the estimated likely costs of managed retreat, making it prohibitively expensive for local government to even consider. • Much of the most desirable property would no longer attract investment due to loss of income, economic productivity and investment confidence. • Unless private properties are acquired in a timely way, useable beaches and foreshore reserves will be lost to the broader community. • With the progressive removal of significant infrastructure such as roads, there will be a need to maintain safe and efficient public access to property, including private property. • A managed retreat strategy would result in the blighting and gradual dysfunction of existing residential areas as homes and infrastructure are progressively removed over time.

5.2.3 Accommodate

Accommodate options aim to re-design existing infrastructure to mitigate potential impacts as they occur, and allow for land uses of a lower risk profile (e.g. of a temporary) nature. This option is rarely applicable to areas at risk of coastal erosion but is suitable to some areas prone to coastal inundation, where assets can be elevated to maintain useability in an otherwise hazardous area. The ability for substantial built assets to be redesigned to accommodate coastal erosion hazards, however, is generally far more limited.

Emergency response plans and controls are also considered as a measure to accommodate coastal hazards. This would involve the implementation of plans for assets and areas that are at risk from hazards, with agreed triggers and procedures in place for before, during and after events. It would also identify and designate roles and responsibilities, along with management measures such as signage and barriers to prevent access.

Pros	Cons
Relatively simple to implement through planning controls in undeveloped areas.	• Is not effective for existing developed areas within the City. • Is not effective for areas impacted by coastal erosion. • Retrofitting existing structures to accommodate inundation risk would be challenging and costly. • Where substantial inundation hazard levels are expected, the accommodate option may adversely impact on the character and amenity of the area.

5.2.4 Protect

Protect options will seek to hold the coast (maintain foreshore reserves, public access and safety, property and infrastructure) as best as feasibly possible over a specific timescale. Protect options would include:

- Beach nourishment
- Dune stabilisation
- Groynes
- Vegetated/landscaped bund
- Exposed seawall or revetment
- Buried seawall
- Detached breakwaters

Coastal protection works may be categorised as either 'soft' or 'hard'.

5.2.4.1 Soft protection

Beach nourishment involves placing sand on beaches or dunes following significant erosion events to create an additional buffer to mitigate future storm events. Sand nourishment is regularly undertaken by the City along the Geographe Bay coastline to manage beach erosion. This is an important coastal risk management solution that can be the primary response at some beaches, and at other sites subject to more persistent erosion, provides an interim response prior to the construction of more permanent protective works. Sand nourishment is also undertaken at the time of protective capital works to minimise 'downdrift effects'. The feasibility of this option is influenced and often constrained, however, by the availability of suitable sand supplies. Where suitable land-based sources are not readily available, or are located a considerable distance away, transportation costs can be significantly increased. The coastline within the Study Area is at the edge of the Ngari Capes Marine Park (State) which itself is adjoined by the Geographe Marine Park (Commonwealth). The latter protects ecologically important seagrass meadows, which contribute to natural sediment supply. Offshore sand supply from local sources would, therefore, not be permitted.

Dune stabilisation and management involves an ongoing program for revegetation and rehabilitation of the dune system, including fencing, and is usually undertaken in tandem with other protection works.

Pros	Cons
• Lower up front cost compared to other management options. • Does not require significant infrastructure. • Can delay the need for hard protection structures or managed retreat. • Locally stabilises the beach and foreshore reserve. • Can assist with retaining beach amenity and aesthetics. • Maintains access and enjoyment of the beach.	• Only offers interim temporary protection, and may not be a feasible long term option. • Significant and progressively escalating ongoing cost. • Uncertainty of suitable, cost-effective sand supplies to meet future demand.

5.2.4.2 Hard protection

This option involves the construction of engineered structures to protect the coast and/or landward assets from the effects of coastal hazards. There are more than 50 coastal protection structures already in place along the Geographe Bay foreshore. Types of structures include low profile rock groynes, exposed and buried seawalls, timber groynes and granite training walls for regional drain ocean outlets. More recently, geotextile sand container groynes and revetments have been constructed adjacent to the Busselton Jetty. This protection approach has been feasible to date due to an ongoing net supply of sand from west to east along Geographe Bay over recent decades.

It should be noted that no protection option is considered permanent, and all have associated expenses to implement, maintain, remove and potentially replace. Hard protection options also have the potential to divert coastal erosion hazards, increasing risk for adjacent areas or assets and potentially creating public liabilities for those responsible for the construction of these structures. Seawalls can be either exposed or buried structures built in front of identified assets along the coast.

FIGURE 1

Existing Busselton Foreshore Seawall
EXPOSED GRANITE

FIGURE 2

Existing Dunsborough Foreshore Reserve

EXISTING BURIED GEOFABRIC SAND CONTAINER SEAWALL

> **Figure 1** illustrates a 'cutaway' section of the existing coastal protection structures at the Busselton Foreshore, to the west of the Busselton Jetty. This section includes the granite seawall and geotextile sand container groynes, supplemented with sand nourishment as needed.

> **Figure 2** illustrates a 'cutaway' section of the existing coastal protection structure at the Dunsborough Foreshore. In 2012, the rock seawall and carpark was replaced by a buried seawall (constructed from geotextile sand containers), which lies at the seaward edge of the foreshore and is overlain with sand and planted with coastal vegetation.

The rate of erosion in front of an exposed seawall can increase due to wave refraction, resulting in the loss of a useable beach over time. Beach nourishment is therefore usually required to further assist with maintaining beach and shoreline attributes.

The potential to degrade beach amenity is likely to lower the deemed acceptability of exposed seawalls to the broader community, unless these can also perform the dual function of protecting assets and/or broader areas from intermittent coastal inundation. Therefore, exposed seawalls are not considered to be a best option for areas that are solely at risk from coastal erosion. A buried seawall is rock or geotextile sand container protection buried under the beach or foreshore reserve. It can be covered with sand, vegetated and landscaped to form an attractive and unintrusive protective bund.

> **Figures 3** and **Figure 4** illustrate 'cutaway' sections of a buried seawall, constructed from geotextile sand containers, overlain with sand to create a 'bund' or artificial dune and landscaped with coastal vegetation within a wide foreshore reserve and a narrow foreshore reserve respectively. Groynes and beach nourishment would most likely be required to further assist with maintaining the beach and foreshore.

Groynes are structures constructed of timber, rock or geotextile and are situated perpendicular to a beach. Usually constructed in groups, groynes restrict or stop longshore sand movement and stabilise beaches locally. This form of stabilisation is usually supplemented with beach nourishment as localised erosion down-drift can often occur.

A detached breakwater is a structure, normally made of rock or geotextile and constructed parallel to the coastline. Detached breakwaters reduce wave-induced longshore currents/sand transport and stabilise beaches locally.

FIGURE 3

Wide Foreshore Reserve
GEOFABRIC SAND CONTAINERS

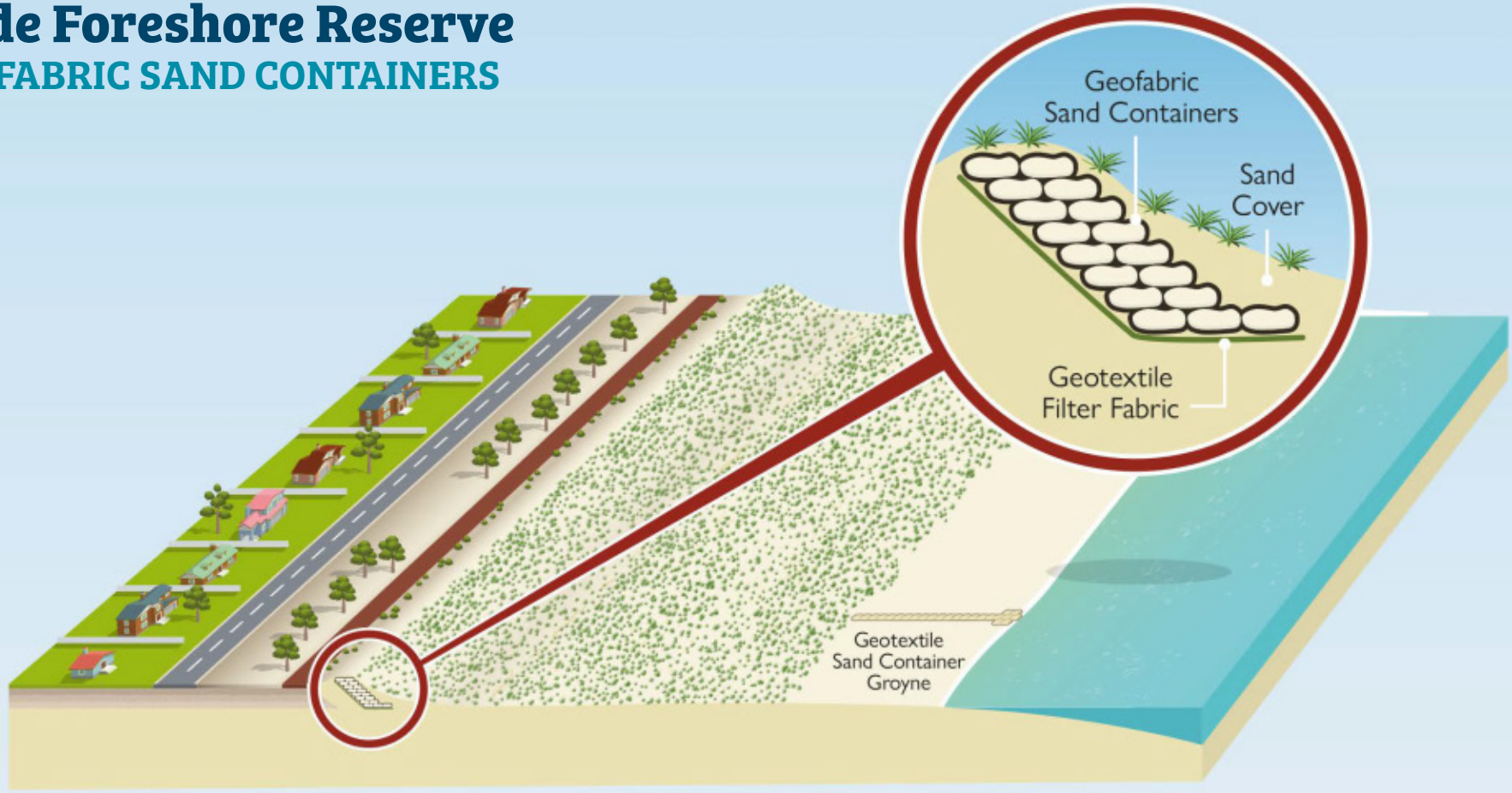
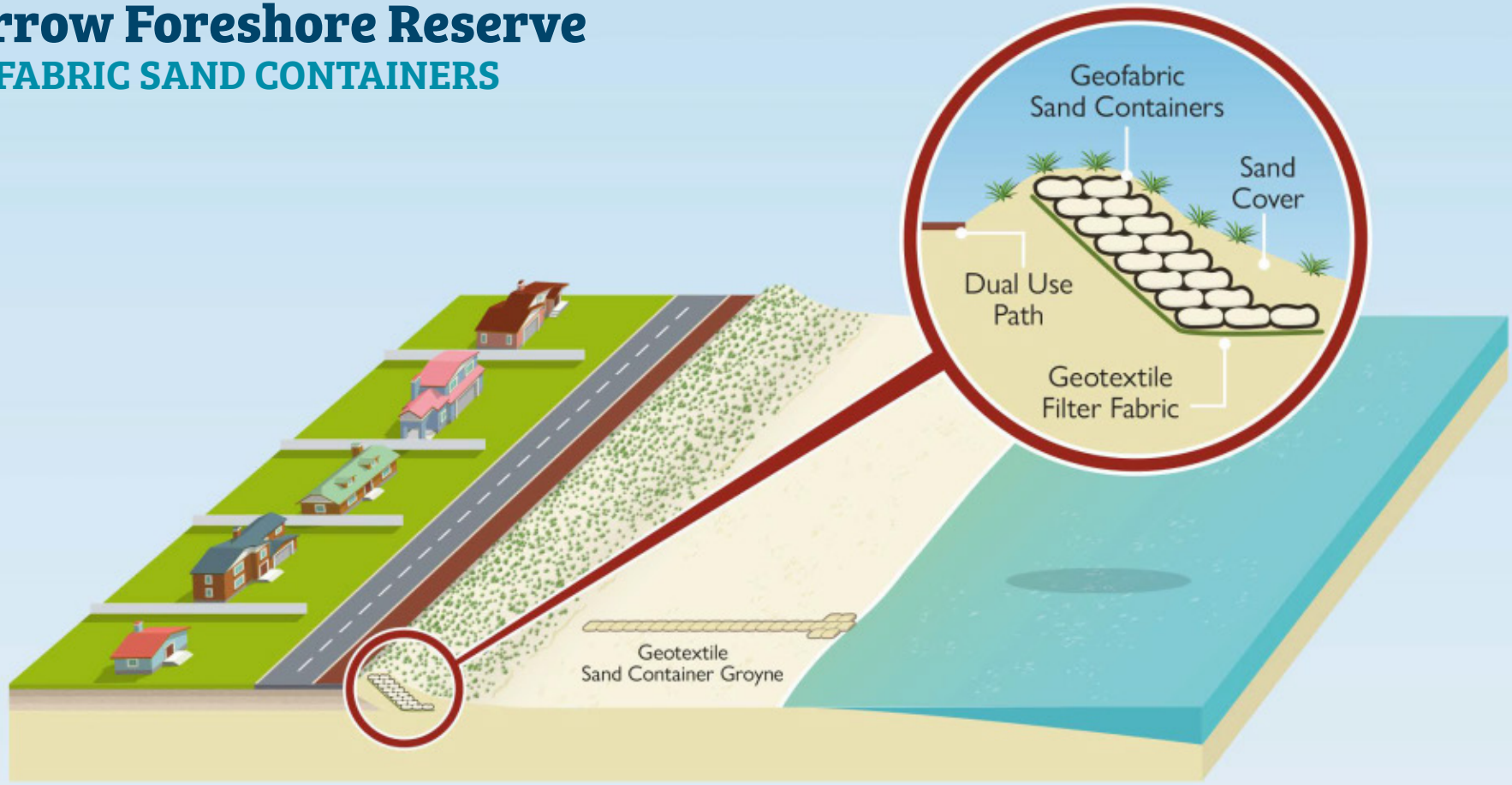


FIGURE 4

Narrow Foreshore Reserve

GEOFABRIC SAND CONTAINERS



Pros	Cons
Exposed seawall	
• Provides interim protection against coastal hazards for the assets and private properties behind the seawall. • Locally stabilises beach and foreshore reserve areas.	• Hard protection structures generally divert erosion issues elsewhere, such as to beaches either side of, and directly in front of, a seawall. • Require a significant up-front capital cost and long-term maintenance. • May eventually result in complete loss of a beach. • Over time, may require beach stabilisation through sand nourishment. This may not be sustainable in the long term due to cost and limited sand supply relative to increasing demand.
Buried seawall	
• Unobtrusive and can be landscaped with vegetation and managed to resemble a natural dune. • Provides interim protection against coastal hazards for landward assets. • Locally stabilises the beach and foreshore reserve. • Would not impede longshore sand movement. • Can be reinstated relatively quickly if eroded by a storm event.	• May result in down-drift erosion if exposed during a storm event. • May require supplementary beach nourishment, particularly after a storm event. • May be difficult to implement where the beach and foreshore reserve are narrow and/or lot boundaries extend to the high water mark.

Pros	Cons
Groynes	
• Sand trapped on the up-drift side of groynes may act as a buffer to absorb storm erosion. • Correctly designed, groynes can allow both longshore sand movement and sediment retention. • Locally stabilises the beach and foreshore reserve. • Most effective where there is predominant longshore sand movement.	• Usually requires supplementary beach nourishment. • May result in down-drift erosion if poorly designed.
Detached breakwater	
• Locally stabilises the beach and foreshore reserve. • Shelter the beach from waves and reduces longshore currents and sand movement. • Over time a tombolo, or sand connection between the breakwater and the beach, can form.	• The Geographe Bay coastline is adjacent to the Ngari Capes Marine Park which contains ecologically important seagrass beds. Construction of detached breakwaters within the Marine Park may not be feasible, or permitted. • Provide limited protection against sudden, short-term events such as a severe storm. • Usually requires supplementary beach nourishment. • Can change the nature and appearance of a coastline.

5.3 Multi-criteria analysis

Risk management options have been considered for each Management Unit. As recommended in the *CHRMAP Guidelines* (WAPC, 2014a) a multi-criteria analysis (MCA) has been used as a preliminary step to identify potentially suitable risk management options for each Management Unit, as well to identify those that are considered to be 'fatally flawed' (and can therefore be objectively discounted).

The MCA was guided by assessment of the following criteria:

i. Acceptability criteria

> **Social impact** (property & infrastructure)

Loss or damage to private property or privately operated leasehold land, reticulated services, roads etc.

> **Social impact** (community use)

Ability to use a beach and foreshore/public recreational infrastructure (e.g. dual use path).

- **Environmental impact**

Possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage assets.

ii. Feasibility criteria

> **Effectiveness in risk reduction**

How effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective.

> **Practicability**

Can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?).

> **Reversibility/adaptability**

Can it be reversed or adapted.

iii. Financial criteria

> **Cost** (implementation)

Cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs).

> **Ongoing cost** (maintenance)

Cost to keep maintaining a risk management option.

> **Ongoing cost** (lost revenue)

How much revenue (specifically rates) would be lost due to a particular risk management option.

The risk management options were scored based on assessment against each of the above criteria, with a score of 1 having the least impact and 4 having the highest impact:

- Socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost.
- Minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost.
- Significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost.
- Unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.

Additionally, each criteria was weighted, which was necessary because not all criteria could be considered to have equal relevance of importance dependent on the attributes of each Management Unit.

The MCA outcomes for coastal erosion hazard are based on the following assumptions for the risk management options:

Avoid – fatally flawed where hazard lines intersect infrastructure and/or property (i.e. cannot avoid because assets/development already exists).

Managed Retreat – assumes that all existing protection structures are removed, no new structures are installed, and the coast is allowed to naturally retreat. A Managed Retreat response would require property acquisition (compulsorily, if necessary) and planning controls to prevent further development in the interim period. Other risk management options could include a 'Special Control Area' requirement in the local planning scheme and notifications on Title. A key consideration would be maintaining public access to a safe and useable beach and foreshore reserve.

Accommodate – fatally flawed where hazard lines intersect infrastructure and/or property. In some areas, Accommodate for inundation could be considered in conjunction with Protect (but this option has not been specifically assessed as part of the current CHRMAP process). As a 'stand-alone' option it is considered to be fatally flawed, like Avoid, where hazard lines intersect property and/or infrastructure).

Protect – to maintain a useable beach & foreshore using beach nourishment, or a combination of coastal protection structures and beach nourishment. Nourishment alone will not effectively address inundation hazard to any significant degree.

The MCA recognised the importance of retaining coastal amenity (useable beach and foreshore) as a key outcome of the community coastal values survey. Refer to Appendix A of the CHRMAP for the MCA results tables. Based on the MCA, the risk management options considered most appropriate for each of the Management Units are summarised in Table 2.

Note - MCA outcomes are the same for the division of MU08 and MU09 into four management Units. Refer to section 7.3 Marybrook and Siesta Park.

Table 2 **Summary of MCA of coastal erosion hazard management options**

Management Unit	2040	2070	2120
MU 01 Smiths Beach	P	P	P
MU 02 Yallingup	P M	P	P
MU 03 Bunker Bay	P M	P	P
MU 04 Eagle Bay	P	P	P
MU 05 Old Dunsborough	P	P	P
MU 06 Dunsborough Townsite*	P	P	P
MU 07 Quindalup	P	P	P
MU 08 Marybrook	P	P	P
MU 09 Siesta Park*	P	P	P
MU 10 Locke Estate*	P	P	P
MU 11 Abbey*	P	P	P
MU 12 Broadwater*	P	P	P
MU 13 Busselton West (A)*	P	P	P
MU 14 Busselton West (B)*	P	P	P
MU 15 Busselton Central*	P	P	P
MU 16 Busselton East	P	P	P
MU 17 Port Geographe*	P	P	P
MU 18 Wonnerup*	P	P	P
MU 19 Forrest Beach	P M	P	P

* *Management Unit already has City of Busselton or Department of Transport managed protection but not for the whole planning period, and not necessarily for the whole of the Management Unit*

The following tables identify key assets recognised within each Management Unit and provide a snapshot of MCA considerations:

MU 01 Smiths Beach

Assets	*Beach, continuous public foreshore reserve (including dunes & vegetation), recreational facilities/carparks/beach access, tourist accommodation/facilities, Smiths Beach Road, utilities*
X	• Existing assets in hazard areas preclude this option.
M	• Continuous public foreshore reserve (including vegetation/habitat) and beach access increasingly constrained by existing land tenure. • Opportunities to locate new facilities and/or relocate existing recreational and public assets increasingly constrained. • Progressive removal of Smiths Beach Road/car parking/utilities. • Removal of existing tourist accommodation and associated facilities. Opportunities to relocate and/or build new accommodation units within already developed Tourist zoned land constrained.
P	• Retain continuous public foreshore reserve and beach access. • Retain opportunities to locate additional public recreational assets such as a surf lifesaving club facility. • Retain road access, foreshore carparks and utilities. • Retain tourist accommodation and associated facilities.

MU 02 Yallingup

Assets	*Beach, continuous foreshore reserve, beach access, carparks, public ablutions, playground, Yallingup Beach Road/other local roads, tourist accommodation/ commercial/residential properties, utilities*
X	• Existing assets in hazard areas preclude this option.
M	• Continuous public foreshore reserve (including vegetation/habitat contiguous with the Leeuwin Naturaliste National Park) and beach access increasingly constrained by land tenure. • Opportunities to locate new facilities and/or relocate existing recreational and public assets increasingly constrained. • Progressive removal of Yallingup Beach Road, Dawson Drive and other local roads and options for relocation/alternative routes constrained by surrounding land tenure, existing development and environmental considerations. • Removal of existing tourist accommodation (especially Yallingup Beach Holiday Park) and associated facilities. Opportunities to relocate and/or build new accommodation units within already developed Tourist zoned land increasingly constrained. • Removal of residential properties.
P	• Retain continuous public foreshore reserve and beach access. • Retain opportunities to locate additional/or upgrade existing public recreational assets. • Retain road access, foreshore carparks and utilities. • Retain tourist accommodation and associated facilities. • Retain residential properties.

MU 03 Bunker Bay

Assets *Beach, continuous foreshore reserve, beach access, carpark, public ablutions, tourist/commercial/residential properties, utilities, Lake Jingi*

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve (including vegetation/habitat) and beach access increasingly constrained by adjoining land tenure.
- Opportunities to locate new facilities and/or relocate existing recreational and public assets increasingly constrained.
- Removal of existing tourist accommodation and associated facilities. Opportunities to relocate and/or build new accommodation units within already developed Tourist zoned land constrained.
- Removal of residential properties.
- Environmental and possibly Aboriginal cultural heritage implications for Lake Jingi.

P

- Preserve continuous public foreshore reserve and beach access.
- Retain foreshore carpark and associated facilities/utilities.
- Retain tourist accommodation and associated facilities.
- Retain residential properties.
- Retain Lake Jingi.

MU 04 Eagle Bay

Assets *Beach, continuous foreshore reserve (including vegetation/habitat), beach access and foreshore carparks, Eagle Bay-Meelup Road and other local roads, community centre and fire station, residential properties, utilities*

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve (including vegetation and habitat contiguous with Meelup Regional Park) and beach access increasingly constrained.
- Opportunities to locate new facilities and/or relocate existing recreational and public assets increasingly constrained.
- Removal of residential properties.

P

- Retain continuous public foreshore reserve and beach access.
- Retain foreshore carparks and associated facilities/utilities.
- Retain residential properties.

MU 05 Old Dunsborough

Assets *Beach, continuous foreshore reserve (including dual use path), beach access, boat ramp/jetty, foreshore carparks and public ablutions, Hurford Street and Bay View Crescent, residential properties, utilities*

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve and beach access increasingly constrained.
- Opportunities to locate new facilities and/or relocate existing recreational and public assets increasingly constrained.
- Removal of residential properties.

P

- Retain continuous public foreshore reserve and beach access.
- Retain foreshore carparks and associated facilities/utilities.
- Retain residential properties.

MU 06 Dunsborough Town Site

Assets *Beach, continuous foreshore reserve (including dual use path), beach access and foreshore carparks, public ablutions, Geographe Bay Road and other local roads, tourist accommodation/commercial/residential properties, utilities*

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve (including vegetation/habitat) and beach access increasingly constrained.
- Opportunities to locate new facilities and/or relocate existing recreational and public assets increasingly constrained.
- Removal of tourist accommodation and associated facilities.
- Removal of residential properties.

P

- Retain continuous public foreshore reserve and beach access.
- Retain Geographe Bay Road and other local roads/utilities.
- Retain foreshore carparks and associated facilities.
- Retain residential properties.

MU 07 Quindalup Beach

Assets	*Beach, continuous foreshore reserve (including vegetation/habitat), beach access and foreshore carparks, Toby Inlet, Dunsborough Bay Yacht Club, Naturaliste Volunteer Marine Rescue/jetty, public ablutions, Geographe Bay Road/Caves Road and other local roads, tourist accommodation, residential properties, utilities*
X	• Existing assets in hazard areas preclude this option.
M	• Continuous public foreshore reserve and beach access increasingly constrained. • Implications for vegetation and habitat values. • Opportunities to locate new facilities and/or relocate existing recreational and public assets increasingly constrained. • Removal of tourist accommodation and associated facilities. • Removal of residential properties. • Implications for Toby Inlet and management of the inlet/ocean mouth in terms of inland flood risk if left unmanaged. • Potential environmental issues associated with seawater intrusion into groundwater and wetlands.
P	• Retain continuous public foreshore reserve (including important vegetation and habitat values) and beach access. • Retain Geographe Bay Road and other local roads/utilities. • Retain foreshore carparks and associated facilities. • Retain opportunities to locate new recreational facilities and public assets. • Retain residential properties. • Management of Toby Inlet mouth and Station Gully Drain outlet would require investigation. • Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 08A Marybrook West

Assets	*Beach, foreshore reserve (including dual use path between Caves Road & Birl Elbow), tourist accommodation, residential properties, Caves Road/bridges and other local roads, utilities*
X	• Existing assets in hazard areas preclude this option.
M	• Public foreshore reserve and beach access increasingly constrained. • Implications for vegetation and habitat values within the foreshore reserve and south of Caves Road. • Removal of tourist accommodation and associated facilities. • Removal of residential properties. • Implications for the management of agricultural drain outlets in terms of inland flood risk, if left unmanaged. • Potential environmental issues associated with seawater intrusion into groundwater and wetlands.
P	• Retain public foreshore reserve (including vegetation/habitat values), dual use path and beach access. • Retain Caves Road and other local roads/utilities. • Retain residential properties. • Management of agricultural drain outlets would need further investigation in conjunction with a Protect strategy. • Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 08B Marybrook/Siesta Park Central

Assets *Beach, partial foreshore reserve, residential properties, utilities*

X

- Existing assets in hazard areas preclude this option.

M

- Removal of residential properties.
- Implications for the management of agricultural drain outlets in terms of inland flood risk, if left unmanaged.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain partial public foreshore reserve.
- Retain residential properties.
- Management of agricultural drain outlets would need further investigation in conjunction with a Protect strategy.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 09A Siesta Park Holiday Resort

Assets *Beach, foreshore reserve, tourist accommodation*

X

- Existing assets in hazard areas preclude this option.

M

- Foreshore reserve increasingly constrained.
- Removal of tourist accommodation and associated facilities.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain existing foreshore reserve.
- Retain tourist accommodation and associated facilities.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 09B Siesta Park East

Assets *Beach, foreshore reserve (including vegetation/habitat), residential properties, dual use path, Caves Road/local road, utilities*

X

- Existing assets in hazard areas preclude this option.

M

- Foreshore reserve increasingly constrained.
- Removal of residential properties.
- Implications for vegetation and habitat values south of Caves Road.
- Implications for the management of agricultural drain outlets in terms of inland flood risk, if left unmanaged.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain existing foreshore reserve.
- Retain Caves Road and associated infrastructure/utilities.
- Retain residential properties.
- Management of agricultural drain outlets would need further investigation.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 10 Locke Estate

Assets *Beach, continuous public foreshore reserve, leasehold holiday accommodation, Caves Road, utilities, Locke Nature Reserve*

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve increasingly constrained.
- Implications for the environmental values of Locke Nature Reserve.
- Removal of holiday accommodation and associated facilities.
- Implications for the management of agricultural drain outlets in terms of inland flood risk, if left unmanaged.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain continuous public foreshore reserve.
- Retain Caves Road and associated infrastructure/utilities.
- Retain holiday accommodation and associated facilities.
- Management of agricultural drain outlets would need further investigation.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 11 Abbey

Assets

Beach, continuous public foreshore reserve (including vegetation and habitat/ dual use path), boat ramp/jetty/carpark, public ablutions, tourist accommodation (resorts & infrastructure), residential and commercial properties, local shopping centre, aged care facility, Bussell Highway, Caves Road and Geographe Bay Road/ other local roads, Buayanyup River Drain, utilities

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve increasingly constrained.
- Removal of recreational assets.
- Removal of tourist accommodation and associated facilities.
- Removal of residential properties and aged care facility.
- Removal of local shopping centre.
- Implications for the management of agricultural drain outlets in terms of inland flood risk, if left unmanaged.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain continuous public foreshore reserve and existing recreational facilities.
- Retain tourist accommodation and associated facilities, residential properties, aged care facility and the local shopping centre.
- Retain Bussell Highway, Caves Road, Geographe Bay Road and other local roads and utilities.
- Management of agricultural drain outlets will need further investigation in conjunction with a Protect strategy.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 12 Broadwater

Assets

Beach, continuous wide public foreshore reserve (including vegetation and habitat/ dual use path), boat ramp/carpark, public ablutions, tourist accommodation (resorts & infrastructure), residential properties, Bussell Highway/Geographe Bay Road/other local roads, utilities

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve increasingly constrained.
- Removal of recreational assets.
- Implications for vegetation and habitat values.
- Removal of tourist accommodation and associated facilities.
- Removal of residential properties.
- Progressive removal of Bussell Highway, Geographe Bay Road and other local roads/utilities and options for relocation/alternative routes constrained.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain continuous public foreshore reserve, vegetation/habitat and existing recreational facilities.
- Retain tourist accommodation and associated facilities.
- Retain residential properties.
- Retain Bussell Highway, Geographe Bay Road and other local roads and utilities.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 13 Busselton West (A)

Assets	*Beach, continuous but narrow public foreshore reserve (including dual use path), vegetation and habitat, tourist accommodation (resorts & infrastructure), residential and commercial properties, primary school, hospital, local centre, Bussell Highway/Geographe Bay Road/other local roads, utilities, Vasse River Diversion Drain*
X	• Existing assets in hazard areas preclude this option.
M	• Continuous public foreshore reserve increasingly constrained. • Removal of recreational assets. • Removal of tourist accommodation and associated facilities. • Removal of residential properties. • Progressive removal of Bussell Highway, Geographe Bay Road and other local roads/utilities and options for relocation/alternative routes constrained. • Implications for the management of the Vasse diversion Drain outlet in terms of inland flood risk, if left unmanaged. • Potential environmental issues associated with seawater intrusion into groundwater and wetlands.
P	• Retain continuous public foreshore reserve. • Retain tourist accommodation and associated facilities. • Retain residential and commercial properties. • Retain hospital, primary school and local centre. • Retain Bussell Highway, Geographe Bay Road and other local roads and utilities. • Management of Vasse Diversion Drain outlet will need further investigation in conjunction with a Protect strategy. • Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 14 Busselton West (B)

Assets	*Beach, continuous but narrow public foreshore reserve, Geographe Bay Yacht Club/ boat ramp, fitness club, foreshore carpark and public ablutions, residential and commercial properties, Bussell Highway/Geographe Bay Road/other local roads and utilities*
X	• Existing assets in hazard areas preclude this option.
M	• Continuous public foreshore reserve increasingly constrained. • Removal of recreational assets. • Removal of residential properties. • Progressive removal of Bussell Highway, Geographe Bay Road and other local roads/utilities and options for relocation/alternative routes constrained. • Potential environmental issues associated with seawater intrusion into groundwater and wetlands.
P	• Retain continuous public foreshore reserve. • Retain residential and commercial properties. • Retain Bussell Highway, Geographe Bay Road and other local roads and utilities. • Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 15 Busselton Central

Assets	*Beach, continuous public foreshore reserve, recreational/sporting/tourist/visitor infrastructure and commercial properties within the Busselton Foreshore Precinct, Busselton Jetty, Busselton Volunteer Marine Rescue/boat ramp, Pioneer Cemetery, heritage buildings, Busselton City Centre commercial and residential properties, tourist accommodation, Churchill Park, vegetation and habitat for the Western Ringtail Possum, Geographe Bay Road/other local roads, utilities*
X	• Existing assets in hazard areas preclude this option.
M	• Continuous public foreshore reserve increasingly constrained. • Removal of recreational/sporting/tourist/visitor infrastructure and commercial properties within the Busselton Foreshore Precinct. • Removal of heritage and recreational assets. • Removal of residential, tourist and commercial properties within, and adjacent to, the Busselton City Centre. • Retain Geographe Bay Road/foreshore carparks and other local roads/utilities. • Implications for the management of the Vasse Diversion Drain outlet in terms of inland flood risk, if left unmanaged. • Potential environmental issues associated with seawater intrusion into groundwater and wetlands.
P	• Retain continuous public foreshore reserve. • Retain recreational/tourist/visitor infrastructure and commercial properties within the Busselton Foreshore Precinct. • Retain heritage and recreational assets. • Retain residential, tourist and commercial properties within, and adjacent to, the Busselton City Centre. • Retain Geographe Bay Road and other local roads/utilities. • Management of Vasse Diversion Drain outlet will need further investigation in conjunction with a Protect strategy. • Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 16 Busselton East

Assets	*Beach, continuous wide public foreshore reserve (including dual use path), Geographe Bay residential properties, tourist accommodation, vegetation and habitat for the Western Ringtail Possum, primary school, local centre, Geographe Bay Road/other local roads, utilities*
X	• Existing assets in hazard areas preclude this option.
M	• Continuous public foreshore reserve increasingly constrained. • Removal of residential, tourist and commercial properties. • Progressive removal of Geographe Bay Road, Marine Terrace and other local roads/utilities. • Implications for vegetation and habitat linkages for the Western Ringtail Possum. • Potential environmental issues associated with seawater intrusion into groundwater and wetlands.
P	• Retain continuous public foreshore reserve. • Retain recreational assets. • Retain residential, tourist and commercial properties. • Retain Geographe Bay Beach Road and other local roads/utilities. • Retain vegetation and habitat linkages for the Western Ringtail Possum. • Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 17 Port Geographe

Assets *Beach (within breakaters), public foreshore reserve (including dual use path), marina/boat ramp, residential properties, tourist accommodation, commercial properties, Layman Road/other local roads, utilities*

X

- Existing assets in hazard areas preclude this option.

M

- Public foreshore reserve increasingly constrained.
- Removal of residential, tourist and commercial properties.
- Progressive removal of marina infrastructure.
- Progressive removal of Layman Road and other local roads/utilities.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain public foreshore reserve and recreational assets.
- Retain residential, tourist and commercial properties.
- Retain viable marina infrastructure.
- Retain Layman Road and other local roads/utilities.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 18 Wonnerup

Assets *Beach, continuous public foreshore reserve, residential properties, Layman Road/ other local roads, utilities, Vasse-Wonnerup Estuary, flood barrier, vegetation and habitat for Western Ringtail Possum*

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve increasingly constrained.
- Removal of residential, tourist and commercial properties.
- Progressive removal of Layman Road and other local roads/utilities.
- Environmental implications for Vasse-Wonnerup Estuary transforming over time from a freshwater estuary to a saltwater inlet.
- Implications for the management of the Vasse-Wonnerup Estuary inlet in terms of inland flood risk, if left unmanaged.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain continuous public foreshore reserve.
- Retain recreational assets.
- Retain residential, tourist and commercial properties.
- Retain Layman Road and other local roads/utilities.
- Retain environmental values of Vasse-Wonnerup Estuary.
- Ongoing management of Vasse-Wonnerup Estuary inlet will need further investigation in conjunction with a Protect strategy.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

MU 19 Forrest Beach

Assets *Beach, continuous public foreshore reserve, residential properties, Forrest Beach Road, utilities, Vasse-Wonnerup Estuary, flood barrier, vegetation and habitat for Western Ringtail Possum*

X

- Existing assets in hazard areas preclude this option.

M

- Continuous public foreshore reserve increasingly constrained.
- Removal of residential properties.
- Progressive removal of Forrest Beach Road and utilities.
- Potential environmental implications for Vasse-Wonnerup. Estuary transforming over time from a freshwater estuary to a saltwater inlet.
- Implications for the management of the Vasse-Wonnerup Estuary inlet in terms of inland flood risk, if left unmanaged.
- Potential environmental issues associated with seawater intrusion into groundwater and wetlands.

P

- Retain continuous public foreshore reserve.
- Retain residential properties.
- Retain Forrest Beach Road and utilities.
- Potentially retain environmental values of the Vasse-Wonnerup Estuary.
- Management of Vasse-Wonnerup Estuary inlet will need further investigation in conjunction with a Protect strategy.
- Retain vegetation and habitat areas and linkages for the Western Ringtail Possum.
- Environmental issues associated with seawater intrusion into groundwater and wetlands may require monitoring and/or investigation within planning timeframes.

5.4 Triggers

Adaptation pathways comprise a sequence of risk management options and tipping points triggered by the impact of coastal hazards over defined planning timeframes. The approach taken in the preparation of the CHRMAP seeks to establish a degree of flexibility in keeping options open and to avoid 'path dependency'. There has also been an intention to apply an appropriate sequence of actions in the short term, followed by a longer term pathway.

Triggers for the implementation of risk management options are events or situations that occur as a direct result of natural coastal processes (e.g. a severe storm combined with a high tide that causes significant coastal erosion). Trigger points are identified to flag predetermined levels of change where decisions on agreed risk management measures must be implemented in order to reduce risk to acceptable levels. This CHRMAP will set the direction and timeframes for acceptable risk management. Appropriate triggers will be assessed and determined, on an ongoing basis, through the City's rolling *Coastal Management Programme 10 Year Plan* (2020 – 2030).

6

Financial considerations

6.0 Financial considerations

Potential financial implications for the City arising from decisions made about coastal adaptation are likely to be very significant and would generally fall into one of four categories:

1. Costs associated with researching and understanding the relevant issues, and determining future direction (e.g. the detailed assessment of coastal hazards and the preparation of the CHRMAP).
2. Costs associated with current and potential future coastal protection measures (e.g. beach nourishment, maintenance/construction of groynes and/or seawalls, dune stabilisation/ revegetation, regulation of private coastal protection initiatives through the planning system).

3. Costs associated with managed retreat (e.g. enforcement of planning controls if there were areas where that was proposed, relocation/removal of public buildings and infrastructure, land acquisition to create or maintain coastal foreshore reserves and beach amenity).
4. Costs associated with potential claims against the City where land, buildings and/or infrastructure are affected by coastal processes in the future – and where there are potential costs for the City of Busselton associated with both successful and unsuccessful claims.

It should be noted that there are also significant economic costs associated with coastal adaptation decisions which may not have any direct financial implications for the City of Busselton, but which will nevertheless have an impact on investment decisions in both the private and public sector, and hence on the location and overall rate of economic growth (or contraction), and which may influence feelings of community wellbeing more broadly.

Most of the costs that have been borne by the City to date are in the second category above – coastal protection. The total cost to the City of managing coastal hazards over the five years to 2021 exceeded $3 million. The City's endorsed *Coastal Management Programme 10 Year Plan (2020 – 2030)* estimates that expenditure will increase to be in the vicinity of $6 million.

In the 2006/07 financial year the City established a 'Beach Protection Reserve' for the purpose of budgeting and funding measures necessary to protect both beach and land-based assets, as well as specific capital projects designed to help protect the coastline, such as the construction of seawalls. Since its inception, the Beach Protection Reserve has been allocated budgeted yearly funding of 1% of general rates revenue. Council subsequently made a decision to change the name and purpose of the Reserve in the 2015/16 financial year, to a 'Climate Adaptation Reserve' and 'Coastal and Climate Adaptation Reserve' in 2021/22. The changes were to ensure that funds could be effectively utilised for matters other than specific coastal protection works, such as coastal hazard modelling, the preparation of a CHRMAP and other issues associated with climate change, sea level rise and risk management.

6.0 Financial considerations

A significant amount of work has been done to identify what sections of the City's coast may be most vulnerable to coastal hazards, especially erosion, over coming decades and beyond. This has helped to instruct and inform the CHRMAP process. Much of the coastline in the Study Area has been affected by coastal processes historically, and, especially in the last ten years, as they have related to an upsurge in El Nino and (more significantly in terms of the severity of coastal erosion) La Nina events. Both the City and private landowners have been taking active steps to try to manage those impacts. In terms of detailed decision-making on potential adaptation options for the coastline within the Study Area, it is therefore crucial that the City and the community has a better understanding of what those costs are likely to be and how they are, realistically, best able to be met.

6.1 Financial model

A financial model developed as part of the CHRMAP process seeks to identify the potential long-term implications associated with different adaptation strategies (set out below), both generally and for particular sections of the coast, over the 100-year planning timeframe. There are three key scenarios modelled:

1. Protect the whole of the coast in the Study Area through beach nourishment to maintain beach amenity and environmental values (this would address coastal erosion hazard only).
2. Protect the whole of the coast through structures (buried seawall/bund and/or groynes) supplemented by beach nourishment, to maintain beach amenity and environmental values (this would address both coastal erosion and inundation hazard).
3. Managed retreat of the whole of the coast by removal or relocation of public assets and property acquisition at unaffected market value (this would address coastal erosion hazard only).

The model identifies all privately-owned, City-owned and State-/utility owned assets within the mapped 100-year coastal hazard area and assesses likely impacts to those assets at 2040, 2070 and 2115. The model allows for the indexation of costs at 2.5%, except for sand to be used for beach nourishment which, beyond 2023, is indexed at 5% (sand supply and availability is likely to become limited and more costly over time).

Since the financial model was developed there has been a significant acceleration in the rate of inflation, and more uncertainty around future inflation expectations. Whilst that acceleration would increase future costs in nominal dollars, it would not have a significant impact on the key conclusions drawn from the model.

Likely costs include: maintenance of beach and foreshore facilities; ongoing cost of sand replacement; capital for, maintenance and replacement of protection infrastructure; demolition, relocation and/or replacement of public infrastructure; private property (land) acquisition; and private property (premises) demolition.

The model also incorporates financial benefits that would be likely to be delivered by each of the three scenarios. For protection of private and public assets by coastal structures, for example, the public financial benefit would be the value of the avoided loss of public infrastructure and rates revenue. For managed retreat, for example, private financial benefit would be the value of compensation through property acquisition.

The model enables a comparison of costs derived from the application of a single scenario for all, and each, Management Units i.e. protection by beach nourishment, protection by coastal structures or a managed retreat. It also provides cost comparisons to the single scenario by 'tailored' adaptation pathways, whereby risk management options can be applied for individual Management Units at specified intervals over the 100-year planning timeframe.

The model, like all such models, has its limitations, but is considered to provide a reasonable basis for high level direction setting. In terms of some of the limitations of the model, it is incomplete in some respects. For instance, it does not identify:

- costs associated with coastal inundation protection at places like the Port Geographe Marina entry channel.
- the legal and other administrative costs that may be associated with land acquisition as part of retreat scenarios, or costs of land acquisition where property is rated on the basis of unimproved value.

Another limitation reflects the fact that the model is a tool which has been designed to calculate potential costs at decadal time scales. It has not been set up to provide a realistic guide to expenditures in any given year, or over shorter time periods.

The model is not a 'cost-benefit analysis' in the usual sense of that term, as it does not seek to identify the value of non-financial costs or benefits. There are three key reasons for that. Firstly, all of the modelled scenarios, reflecting the outcomes of coastal values work undertaken (see section 3.1 Community and Stakeholder Consultation), assume the retention of a continuous beach and foreshore reserve along the whole of the coast, wherever possible, essentially giving that benefit an infinite value. Secondly, ascribing equivalent dollar values to non-financial costs or benefits is fraught with difficulty. For instance, what is the value of a beach? Is it to be valued on a per-linear metre or a per-square metre basis? How is that value to be derived? There are means of doing so, one of which is a set of techniques sometimes known as 'hedonic pricing', but it is not clear what such an approach would add, when it comes to real world decision-making. Finally, in this particular case, to secure many of the non-financial benefits, financial costs would be involved, and money is required for that. Including non-financial costs and benefits in the model would have meant that it was a less useful tool to isolate and identify what funds may be required and when.

The model does, however, identify that, for most sections of the City's coastline in the Study Area, once reasonable assumptions about property values are made for the purposes of retreat, a protect strategy would be significantly less costly than a retreat strategy. Over the 100-year planning time horizon and on the basis of a 'best estimate' scenario, the cost of retreat is estimated at approximately $8.3B in today's dollars, whereas the least expensive of the protect scenarios modelled is estimated to cost approximately $1.6B in today's dollars. Even that protect scenario represents a very significant cost, equivalent to an average of $16M per annum over the 100 year period. Average annual costs for the next few decades, however, are substantially lower than that, and higher in later decades. It also needs to be noted that, in some Management Units, the relative costs of different scenarios vary somewhat.

Set out below are the estimated long-term (100 year) costs and benefits, in today's dollars, of several different adaptation scenarios, derived from the financial model:

	Financial cost	Public financial benefit	Private financial benefit	Net financial benefit (cost)
1. Tailored (mostly protection for erosion through groynes, seawalls and nourishment, protection for inundation in main urban areas vulnerable to erosion, accommodate elsewhere, with some densification)	$1,601,271,518	$277,762,764	$11,670,524,258	$10,347,015,503
2. Retreat, with some densification and unaffected value land acquisition (requires accommodation for inundation)	$8,297,425,778	$214,787,607	$7,484,391,656	($598,246,515)
3. Retreat, without densification, but with unaffected value land acquisition (requires accommodation for inundation)	$5,605,555,122	$214,787,607	$4,792,521,000	($598,246,515)
4. Retreat, without land acquisition (requires accommodation for inundation)	$813,034,122	$214,787,607 (probably overvalued – model not set up with this option in mind, as it doesn't preserve public beach / foreshore)	Nil	($598,246,515)

It is highly likely those costs will not be able to be met through the City of Busselton's resources alone. It is also unreasonable to expect that would occur. The City of Busselton already allocates 1.0% of total rates revenue to a 'Coastal Adaptation Reserve' each year, drawing on the balance as required to support coastal management. The City of Busselton's Long Term Financial Plan also provides for that to increase to 2.0% of total rates revenue. It is clear, however, that will be insufficient over the longer term, if it is to be the only source of funding for coastal adaptation.

In a practical/physical sense this may be an issue that can be addressed at a local government scale by the City of Busselton. That is not the case, certainly not to the same degree, in the Greater Bunbury, Peel or Perth regions where each local government has a much smaller coastline. It does seem that a more pro-active role will need to be taken by the State in the future, in relation to planning, coordinating and funding coastal adaptation. The State has recently increased the funding it provides to support coastal adaptation work, but it is clear that it is still insufficient to meet current demands, let alone the larger demands expected in the future.

At some stage, that may best be supported by the introduction of a levy or similar by the State that would provide an equitable, sustainable and efficient basis for addressing this significant risk. The Emergency Services Levy (ESL) is one example of where that kind of thing has been implemented, but there are many others from around the country and elsewhere in the world. Whatever funding approach is taken, it may be sensible for it to support both coastal protection, where appropriate, but also managed retreat, in contexts where that may be appropriate. These are not, however, matters that will be simply or easily resolved – and it is likely that whatever approaches are adopted from time to time, the approach will evolve over time.

There are a number of other reasons why the costs of coastal adaptation should not be met by local government ratepayers alone. State government and utilities own very significant assets that are potentially vulnerable to coastal risks and the owners derive income from those assets and would benefit from coastal protection. There are also very significant environmental assets at potential risk, including the Ramsar-listed Vasse-Wonnerup Wetlands (which are internationally important waterbird habitat), and significant habitat for the Critically Endangered Western Ringtail Possum, which is located in coastal areas in both Busselton and Dunsborough.

The financial challenge is also potentially less significant when looked at in the context of the economy of the City of Busselton as a whole, rather than from the perspective of the local government rate-base alone. Projecting what the City's rate-base may be over such a long period of time is obviously very difficult and highly uncertain. But, on the basis of a scenario which assumes continued rate-base growth, and continued economic growth, at rates somewhat lower than what has occurred over recent decades, costs of the tailored scenario calculated through the financial model would be around 9.0% of total rates revenue over the 100 year period, but less than 0.2% of gross regional product (i.e. crudely, for every $100 spent in the City in a year, 20c would need to be spent on coastal management).

It does need to be very strongly emphasised, though, that is merely one, fairly crude scenario, and over such a long period, small adjustments in underlying assumptions can have a very significant impact on those figures. For instance, if growth in the rate-base and economy ceased at the end of the ten year period of the City of Busselton's current (as at 2020) *Long-Term Financial Plan*, but other assumptions remained the same, costs of the tailored scenario calculated through the financial model might be as high as 33.6% of total rates revenue over the 100 year period, and more than 0.6% of gross regional product (i.e. crudely, for every $100 spent in the City in a year, 60c would need to be spent on coastal management).

It is for the reasons set out above that the CHRMAP does not make specific recommendations about long-term funding arrangements. Rather, there is a focus on advocacy and working with partners to resolve those issues over time. The key partner being the State Government, although the Federal Government is also identified in the recommendations.

As well as needing to address these long-term funding issues, it should be noted that the CHRMAP recommendations involve extensive further work to better define the approach and associated costs. Grant funding, or other support from partners may be able to assist with those tasks, but there will be a need for City funds to be allocated to that work as well in coming years. Those costs are not captured in the financial model. Refer to Part 4 Financial Modelling of the CHRMAP Technical Assessment Report (Advisian, 2020a) for detailed further information.

6.2 Funding options

Currently, the City of Busselton places almost 2% per annum of the total rates revenue in its 'Coastal and Climate Adaptation Reserve'. The cost for future coastal management will be considerably greater than the City's current forecast expenditure based on the City's Coastal Management Programme 10 Year Plan (2020–2030). Additional funding will be essential to implement the responses to managing coastal risks arising from climate change and predicted sea level rise recommended by this CHRMAP.

A key principle in considering potential funding options is that the responsibility for paying for coastal adaptation should rest with the beneficiaries of those actions. These include land and asset owners that benefit from protection strategies, and coastal users that benefit from coastal management approaches. Where public funds are used for coastal adaptation works there should be a direct public benefit as a result of that investment. Ongoing cooperation between Local and State government and key asset owners will be required to consider and address these funding issues and responsibilities.

There is no legal obligation on State or Local Governments to either protect public or private assets within coastal hazard areas, or to compensate for any damage or losses incurred to those assets due to coastal hazards. Some options for managing and covering the costs of coastal adaptation options include:

1. Funding from State Government (noting that this source cannot be fully relied upon as there is no certainty around securing such funding and the amount of contribution funding available from a limited funding 'pool' for all relevant local government areas would be significantly less than that required in reality). Such funding is presently provided through grant applications to:
    - Coastal Adaptation and Protection (CAP) grants through the Department of Transport
    - Coastal Management Plan Assistance Programme (CMPAP) through the Western Australian Planning Commission
2. Funding through the City's Rates revenue –
    - Application of a 'Flat Rate' (as is currently the case)
    - Application of 'Specified Area Rates' and/or 'Differential Rating' within the identified coastal hazard risk areas and Management Units.
3. Advocate for State and Federal Government leadership and assistance to support coastal adaptation measures and initiatives, including the bipartisan development of an equitable and sustainable funding framework.

The appropriate funding sources for coastal adaptation options should recognise the likely beneficiaries of the measures proposed to be taken, and the values being protected as a consequence. Direct beneficiaries should directly contribute to coastal management and adaptation costs but as these will almost always be multiple beneficieries, should generally not be required to meet all of the costs on their own. Indirect beneficiaries can more equitably contribute by public funding investment, through rates and taxes, into public funds.

The Community Coastal Values Survey included a question on who should pay for the substantial likely costs of managing/mitigating damage attributable to coastal erosion hazards erosion. The response from 41% of respondents was that the State Government taxpayer should bear the majority of costs, with the balance borne by those private landowners/businesses directly affected (30%) and by all registered ratepayers in the City (29%).

7

Recommendations and adaptation pathways

Given the CHRMAP is required to consider and address potential adaptation pathways across a 100-year planning timeframe (at 2043, 2073 and 2123), recommendations are presented in section 7.3 as:

- Recommendations to guide future coastal adaptation following the formal adoption of the CHRMAP (see Recommendations 1 – 8).
- Recommended coastal adaptation pathways for sequential planning timeframes as at 2043, 2073 and 2123 for each of the 21 identified Management Units (see Recommendation 9).

In conjunction with the recommended adaptation pathways set out in Recommendation 9, an aerial photograph of each Management Unit is shown superimposed with coastal erosion hazard lines derived from Damara WA (2011), Damara WA (2012) and Damara WA (2017).

In viewing the Management Unit coastal erosion hazard maps, it should be noted that:

- The erosion hazard lines are based on a suite of assumptions that have varying degrees of uncertainty, any of which may influence the likelihood of affects being realised at each planning horizon.
- In order to account for the uncertainty associated with dynamic natural environments and the lack of long term datasets, the hazard lines are designed to be 'conservative'.
- They will be revised periodically (as part of formally scheduled CHRMAP reviews) to take into account new information as it emerges.

7.1 Coastal inundation risk and finished floor levels

The CHRMAP, reflecting SPP2.6 requirements and Department of Transport advice, considers and seeks to address the potential impacts of a 3.8m AHD coastal inundation event. Given the geology and topography that does not create significant issues for the settlements either side of Cape Naturaliste (i.e. Smiths Beach, Yallingup, Bunker Bay, Eagle Bay, Old Dunsborough). It does, however, create significant issues along the rest of the City's coast, from the Dunsborough Townsite all the way to the boundary with the Shire of Capel, at Forrest Beach. Fundamentally, there are two potential strategies to address this risk.

The first would be an accommodation strategy, potentially requiring the minimum finished floor level (FFL) for new development to be at or above 3.8m AHD (note that this would principally be for 'habitable' floorspace such as houses, sheds or similar could have lower floor levels). In new/greenfields development areas, that would mean that the floor level for all development would be at or above that level. Most of the vulnerable areas, however, are not new/greenfields development areas. They are older and largely developed areas, so such a requirement would only have a practical impact as and when sites are redeveloped.

Whilst some redevelopment can no doubt be expected to occur over coming decades, in many areas, a significant proportion of existing buildings will still exist in 20, 30 or even 100 years' time. That would mean that, whilst the lifting of floor levels would mitigate the risk to some degree, it would represent a partial solution only, and the largest flooding events could still be expected to have very significant consequences, both during and after any such event. Given the scale and nature of the vulnerable areas, the task of evacuating and accommodating people living in houses with floor levels below the flood level in and of itself would be extremely challenging. The shorter-term cost and amenity impacts of requiring floor levels for new development to be, in some cases, over 2.0 metres above existing ground or floor levels would, however, also be considerable – and probably unacceptable to the community.

For those and other reasons, the CHRMAP instead recommends a medium- to long-term protect strategy for inundation risk for the City's main urban/developed areas. That would entail the construction of a continuous seawall/bund or similar in the foreshore reserve for much of the coast. It would also entail works to prevent seawater entering urban areas via the various 'gaps' along the coast – e.g. drain and inlet entry channels, or the Port Geographe Marina entry. The CHRMAP recommends further investigations into the potential costs and means of managing

the 'gaps', as well as further investigation into coastal inundation risk more broadly (note that the City has recently been awarded a Federal Government grant that will enable those further investigations to commence).

Together, those approaches enabled the advertised CHRMAP to recommend that FFLs in the main urban/developed areas be set at 3.0m AHD, rather than 3.8m AHD. 3.0m AHD was chosen in recognition of the fact that it may take several decades to implement the medium- to long-term protect strategy for inundation risk for the City's main urban/developed areas, and there is still a significant coastal inundation risk in the interim period.

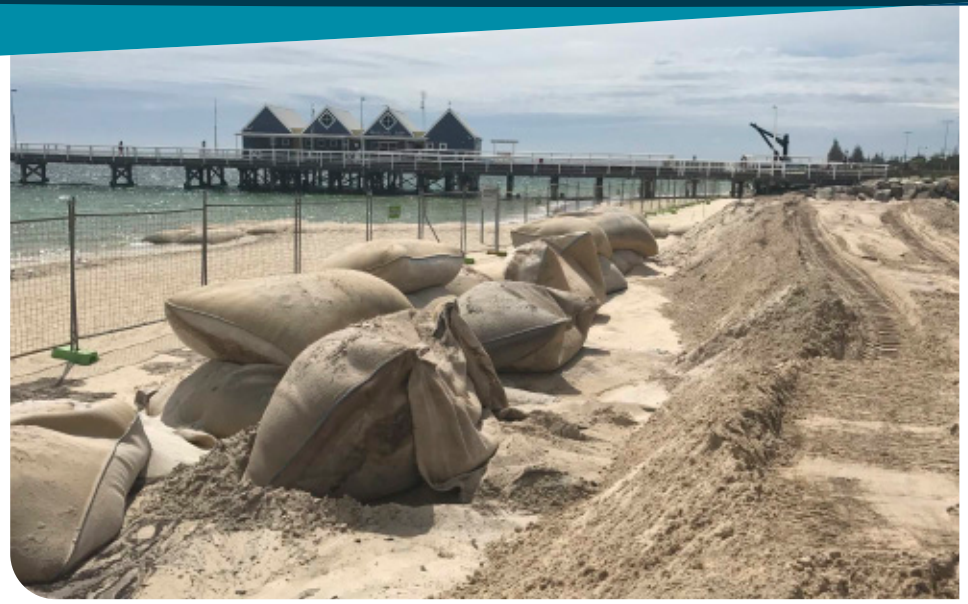
There would be cost and amenity impacts in requiring floor levels for new development to be 3.0m AHD. In some cases, that would still be over 1.0 metre higher than existing ground or floor levels. Two strategies have been identified and are recommended by the CHRMAP to reduce those impacts.

Firstly, consideration has been given to coastal inundation modelling undertaken to support a review of structure planning for Port Geographe. That modelling indicates that the level of a 1 in 500 year coastal storm surge with present day mean sea levels is 2.5m AHD (i.e. 2.5 metres above mean sea level), or 3.4m AHD with mean sea level 0.9 metres higher, rather than 2.9m AHD or 3.8m AHD respectively. That modelling, prepared by Baird Consultants for the developers (Aigle Royal) has been accepted by DoT, and there is not seen to be any reason why the figure would be higher for other parts of the City's coast.

On the basis of that, it is considered that minimum FFLs for new development in areas where a medium- to long-term protect strategy for inundation risk is being proposed could be reduced from the originally proposed 3.0m AHD to 2.7m AHD. The reason that 2.5m AHD is not proposed is because some of the projected 0.9m sea level rise over the next 100 years will occur in the period between now and when the medium- to long-term protect strategy for inundation risk can actually be implemented. Note that the recommended revised recommendations also add the word 'generally', and that the additional modelling being funded by the Federal Government and progressed by the City is also likely to have been completed prior to the City's town planning scheme being amended to actually implement this recommendation of the CHRMAP – and the actual level(s) required could be adjusted based on that modelling.

Secondly, consideration has also been given to allowing some development, especially additions or alterations to existing development, to occur at a somewhat lower level – down to 2.2m AHD. It is proposed that be allowed to occur where development has been built to withstand temporary inundation, with moisture proofing up to a level of at least 2.7m AHD. Whilst in extreme events, such development could still be inundated, residents need to be evacuated and significant damage done to finishes, furniture or appliances, the integrity of the structure would be expected to be maintained.

Further work would be required to determine the specific/requirements for new floorspace below 2.7m AHD, but it is seen as important that option is accommodated. There are some



small areas where a minimum FFL of 2.7m AHD would be around 1.0 metre higher than existing ground or floor levels, and even a 2.2m AHD FFL would be around 0.5 metres above existing ground or floor levels. Even that level would have cost and in some cases amenity impacts, and whilst it is seen as vital that the City does seek to mitigate future flooding risk, that does need to be considered in a broader context, especially in terms of potential cost and amenity impacts.

In the Siesta Park/Marybrook/Locke Estate and Forrest Beach areas, a long-term protect strategy for inundation risk was not proposed in the advertised CHRMAP. Given that, a minimum FFL of 3.8M AHD was recommended. The CHRMAP does not now explicitly 'rule out' a long-term protect strategy, however, neither is a commitment to do so recommended at this stage. A key impact of that is that the minimum FFL for new development should reflect the projected 1 in 500 year coastal storm surge, including an allowance for a 0.9 metre increase in mean sea level. Given material identified above, however, it is now considered that can be 3.4m AHD, rather than 3.8m AHD – although that would also be subject to the additional modelling as also described above. It should also be noted that application of that requirement would require a town planning scheme amendment, which would entail further community and stakeholder engagement.

The cost and amenity impacts of that higher minimum FFL in Siesta Park/Marybrook/Locke Estate and Forrest Beach are likely to be less than in significant parts of the main urban/developed areas, as natural ground levels are generally above 2.5m AHD, and through building (rather than planning) controls the City has been recommending (and in most cases applying) a minimum FFL of 3.0m AHD in any case. As such, in many cases, the increase in minimum FFL is only from 3.0m AHD to 3.4m AHD. It is also considered that, on average, the rate of redevelopment in these areas will be a little higher than the average rate elsewhere, enhancing the risk mitigation value of that approach, as a larger proportion of existing development, some of which will be at a lower level, would be demolished and then replaced with new development with a hjgher FFL.

There are several other key reasons why it is not seen as necessary or appropriate to recommend a protect strategy for inundation risk for the Siesta Park/Marybrook/Locke Estate and Forrest Beach areas in the CHRMAP –

1. The total population and value of assets that would be protected per kilometer of coast would be considerably lower, as there are not the extensive urban/residential areas inland from the coast that would benefit from the protection, instead there is a relatively narrow strip of developed land along Caves Road in the case of Siesta Park/Marybrook/Locke Estate, and a small number of somewhat sparsely distributed houses in the case of Forrest Beach;

2. The costs of protection per kilometer of coast would be somewhat higher, as the number of 'gaps' is higher – in the entire approximately 18km length of coast between Abbey and Wonnerup, there are four such gaps (counting the two at either end – the Buayanyup Drain and Vasse-Wonnerup Estuary mouth), whereas in the approximately 7km length of coast between the Locke Estate and Quindalup there are six;

3. As there is not a continuous foreshore reserve in the Siesta Park/Marybrook area, and even where there is in some cases it is quite narrow, without the City acquiring private land, the land on which to build a continuous seawall/bund that would provide that protection is actually not available; and

4. There could be significant amenity issues and challenges maintaining a continuous beach, with continuous seawall/bund in this section of the coast, given the absence of or limited width of the foreshore reserve.

One of the other issues that has been considered in developing the recommendations is the definition of the inland boundaries of areas where different floor level controls may apply. Because so much of the land in the City is flat and low, those areas need to extend quite some distance inland – essentially sufficiently far inland to a point where existing ground levels are at or above the minimum FFLs proposed. If the same minimum FFL was being proposed everywhere, that would be fairly straightforward, as the town planning scheme could simply establish a minimum FFL throughout the whole of the City.

Reflecting the approach to flood risk mitigation proposed, it is envisaged that a general minimum of 2.7m AHD would be introduced, but that in the areas inland from Siesta Park/Marybrook/Locke Estate and Forrest Beach, a minimum of 3.4m AHD would apply, extending south through to key east-west oriented roads (i.e. Vasse-Yallingup Siding Road and Tuart Drive respectively), by which point existing ground levels are above 3.4 AHD. As noted, there would also be allowance for some development to be approved below that level, and the exact levels and boundaries would also be identified following the further modelling work that has been noted above.

7.2 Community use of foreshore reserves

The CHRMAP includes a very high level recommendation for all management units on community use of foreshore reserves. As evidenced by the coastal values survey, a significant proportion of our community use the local beaches and foreshore areas, with stretches of sandy beaches to walk on, natural vegetation and habitat afforded by foreshore and beach areas, safe swimming beaches, and the 'natural' aesthetic of some parts of the coast being very highly valued. Handing the beaches and foreshore areas to future generations in the same or better state than it is now was cited as the most important value.

For Abbey, and most of the rest of the coast, the CHRMAP recommends continued support and consideration of new community infrastructure within the foreshore reserve. The principle also recognises that there is public access and use of the foreshore in Marybrook and Siesta Park and flags that some areas could accommodate community infrastructure at some point in the future, but other parts are too constrained.

The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. The CHRMAP recognises that public assets are protected at the City's cost and therefore those assets should be available and able to be used by the whole community. Protection also provides an opportunity to consider new or expanded infrastructure available for use by the whole community.

7.3 Marybrook and Siesta Park

This section focusses on issues/considerations that are particular to this part of the coast and which principally relate to coastal erosion risk. The coastal adaptation direction set by the CHRMAP for these areas is protection from erosion and accommodation for inundation (as discussed in section 7.1).

This is different to the direction in the advertised CHRMAP, where erosion protection was proposed for the short to medium term only (through to 2070), with the potential for retreat in the long term. That had necessitated a recommendation that any new development approval contain a 'sunset clause', with approvals only being valid until 2070. That recommendation had generated a high and consistent level of concern from affected landowners.

1. Long term retreat

The CHRMAP does not recommend a long-term retreat strategy for this section of the coast. There are two key reasons for that –

- The significant landowner concerns, especially in the context of a situation where there is seen to be a need for the City to work closely with some of the landowners to be able to implement erosion protection in the more vulnerable, central portion of this section of the coast; and
- A very strong sense that retreat would only be politically acceptable if it involved property acquisition by government, and that the only level of government that is likely to do that is the State, meaning that the right approach for the City was to proactively plan to protect the coast from erosion.

2. Distribution of costs and benefits

A number of submissions raised concerns that, through the direction set out in the advertised CHRMAP, landowners in the Siesta Park and Marybrook areas were having costs imposed on them that were greater than other landowners. Costs do, however, also need to be understood in the context of the related benefits. For a variety of reasons, however, changes have been made to the recommendations that would reduce those costs to landowners. Those include –

- No longer applying a sunset clause condition as described above;
- No longer requiring direct contributions to coastal protection from landowners at the eastern and western ends of the Siesta Park/Marybrook area, recognizing that vulnerability in those areas is significantly lower, and protection is not needed in the next 20 years or so – this is addressed in more detail below;
- Within the central section of the Siesta Park/Marybrook area, rather than requiring the entire cost of erosion protection to be met by landowners, proposing that the cost be

split between State or Federal Government, City of Busselton ratepayers as a whole, and direct contributions from landowners – also addressed in more detail below;

- Reducing minimum FFL for new development from 3.8m AHD to 3.4m AHD – as described in section 7.1;
- No longer requiring the ceding of a foreshore reserve where development approval is being granted – again addressed further below; and
- No longer proposing the prohibition of new private coastal protection structures, although some controls on such structures are still proposed (and there are some controls currently too - again, this is also addressed further below).

The result of those changes is that the only landowners from which direct contributions may be sought are those in the central section of the Siesta Park/Marybrook area, where properties often are and in fact have been vulnerable in the past to coastal erosion, and many landowners have chosen to develop private coastal protection structures in the past. Through the integrated approach now recommended, however, it is envisaged that protection can be enhanced and made more consistent, and through economies of scale, at lower overall cost. There is also an opportunity to ensure that the beach is protected and maintained long-term, as well as the land, buildings and other assets.

Wherever possible, the strategic direction is applied via general rather than Management Unit specific recommendations, reflecting the application of consistent principles across the whole of the coast wherever possible. Because the issues are not the same everywhere, though, there are also some differences in approach proposed, reflecting the different characters of different parts of the coast.

3. Boundaries of MU08 Marybrook and MU09 Siesta Park management units

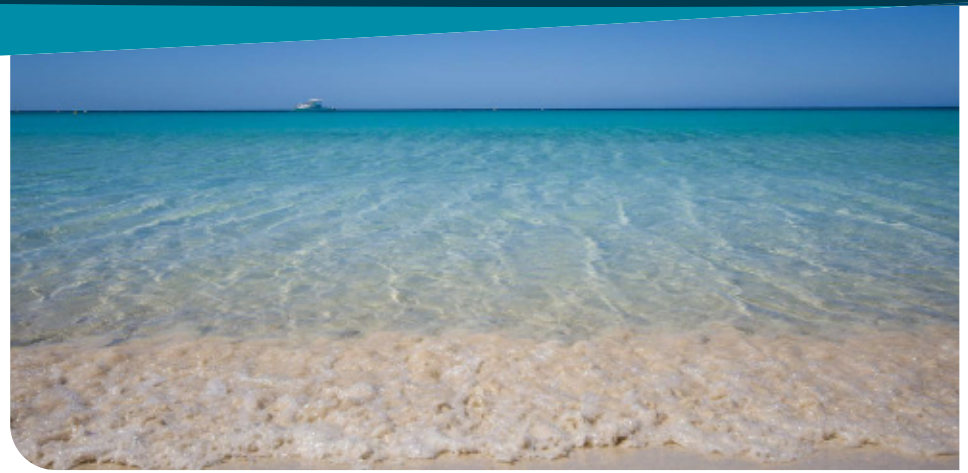
These two Management Units as per the draft CHRMAP are now divided into four -

i. MU08(a) Marybrook West – wide beach and foreshore reserve mostly in public ownership. Coastal erosion risk is similar to MU11 Abbey (unlikely to be at risk before 2040). Larger foreshore area allows consideration at some point in the future for new public infrastructure with a long term protect strategy. Land to the south of Caves Road is not immediately at risk from coastal erosion, and Caves Road itself is a significant State asset.

ii. MU09(b) Siesta Park East – similar characteristics as MU08(a) Marybrook West and includes the Siesta Park groyne and dual use path.

iii. MU08(b) Marybrook/Siesta Park Central – a single row of privately owned beachfront properties with a narrow beach and little or no public foreshore. Landowners have constructed various private coastal protection structures at their own cost. Includes the Lennox River Drain outlet that has contributed to some coastal management issues.

iv. MU09(a) Siesta Park Holiday Resort – land in single ownership with a coastal frontage of approximately 400m which is of sufficient length to implement its own protection strategy.



The Management Units in the advertised CHRMAP were defined on the basis of: coastal erosion hazard assessments; Department of Transport sediment cell framework; existing coastal infrastructure; and the distribution/types of assets vulnerable to coastal hazards. A more nuanced approach reflects variation in beach/foreshore width, the vulnerability of private assets by 2040 and provides for a refinement of recommendations/risk responses along this part of the coast.

4. Planning controls: ceding of land/development approval for all development/time limited development approvals/prohibit private coastal protection structures

The planning response set out for Marybrook and Siesta Park Management Units in the draft CHRMAP included the following planning controls:

- *As a condition of approval for any development or subdivision, ceding of land to ensure there is a foreshore reserve of a minimum width of approximately 20m.*
- *Where development approval is granted, it must always be subject to a 'time limited approval', with development approval lapsing no later than 1 July 2070.*

The CHRMAP does not include these planning controls as long term retreat is not now being recommended.

5. Prohibit private coastal protection structures.

The CHRMAP does not include this planning control that was recommended in the draft CHRMAP. Consideration of private coastal protection works is set out under general recommendation 5 and addressed through potential amendments to the planning framework and progression towards implementation of an integrated approach to coastal protection.

6. Infill subdivision/development density

This principle is already established in the City's Local Planning Strategy Theme 4(i) which seeks to maintain the physical separation of settlements, in particular, through not supporting intensification of development in the Marybrook/Siesta Park area and is removed from the CHRMAP.

7. Integrated approach to erosion protection

An 'integrated approach' refers to the City-led integrated protection strategy for the Marybrook and Siesta Park MUs in the advertised CHRMAP, instead of the current, ad hoc, individual landowner-led approaches. With the changes to the Management Unit boundaries set out in point 1 above, the integrated approach would now only apply to the most vulnerable section being MU08(b) Marybrook/Siesta Park Central, and where many landowners have spent money on coastal protection in the past.

Detailed design and other work will be necessary to advance an integrated approach to coastal protection. If groynes and beach nourishment are seen as sufficient to protect property and assets in Marybrook/Siesta Park Central without necessarily needing a seawall, then there may be capacity to allow individual landowners to construct private seawalls if they wanted an additional level of protection.

For MU08(a) Marybrook West and MU09(b) Siesta Park East, infrastructure, buildings and the foreshore reserve are less vulnerable and an integrated approach is not necessary due to the relatively wide reserve. Erosion control would be through a combination of groynes,

beach nourishment and seawalls as required (same as for Abbey where it is possible to do so, and most of the rest of the coast).

Over the course of the next couple of decades, such an integrated approach will provide much more effective protection than current ad hoc, individual landowner-led approaches, and is likely to do so at lower overall cost – due to economies of scale, and the possibility that seawalls may not be required to the extent that would likely be required if protection was being done on a lot by lot basis.

In relation to MU09(a) Siesta Park Holiday Resort, the City has had discussions with the landowner who is willing to prepare and implement an integrated coastal adaptation strategy ('mini-CHRMAP') for the Management Unit.

The direction for the abovementioned approaches also relates to changes proposed to fund coastal protection works. The City and landowners will also seek State technical and financial assistance to implement coastal protection in these sections of the coast.

8. Use of beach and foreshore reserves

This is a recommendation theme applied to all Management Units in recognition of the value that our community places on using the beaches and foreshore areas and that these areas should be available and able to be used by the whole community. Protection also provides an opportunity to consider new or expanded infrastructure available for use by the whole community.

9. Shortening Siesta Park Groyne

This is not included in the CHRMAP. The maintenance of coastal protection structures is set out in the City's *Coastal Management Programme (2020 – 2030)* and would be subject to coastal monitoring and modelling/investigation of potential adverse updrift and downdrift impacts, as well as community consultation.

7.4 Recommendations

The City of Busselton adopts the following recommendations to guide future coastal adaptation:

RECOMMENDATION 1

That the coastal erosion hazard lines shown on the maps for each of the identified Management Units in Recommendation 9 be adopted as a guide for future planning.

Key Rationale:

The most pervasive hazard for most of the City's coastline in the Study Area, especially over the short to medium term, is coastal erosion. Unless and until direction is set regarding how that hazard is to be addressed, it is difficult to develop clear direction on the other key hazard; coastal inundation. There are also a range of other recommendations that require the identification of an area that may be subject to coastal erosion hazard, if the coast is not protected from that hazard. Given that some sections of the coast already benefit from coastal erosion protection, and especially because those protections do not have a 100 year design life, in adopting coastal erosion hazard lines for those purposes, it is seen as appropriate to assume that existing protections are not in place, even though it is clear that, unless those structures were deliberately removed, they would provide some coastal erosion protection.

RECOMMENDATION 2

That the adaptation pathways for the identified Management Units are generally as set out in Recommendation 9.

Key Rationale:

This identifies the key role that the Management Unit specific recommendations play in setting the overall strategic direction.

RECOMMENDATION 3

That the City:

a. Allocates, through a phased increase from 1% (as applies currently), a minimum of 2.0% of total rates revenue to the 'Coastal Adaptation Reserve', as set out within the City's current 10-year Long Term Financial Plan;

b. Advocates and make application for State and/or Federal Government grants funding to support coastal adaptation measures and initiatives as these become available and necessary;

c. Advocates at State and Federal Government level for the identification and implementation of a sustainable, equitable and efficient framework for the funding of coastal adaptation; and

d. Advocates at State Government level to identify and secure strategic sand supplies for beach nourishment, including a coordinated regional approach to the delivery of such supplies.

Key rationale:

Part (a) reflects a decision that the Council has reflected this in the City's current LongTerm Financial Plan, given the potential risks and costs faced by the City and the community. It is also a demonstration that, whilst the City sees a clear case and need for support from higher levels of government, the City is also prepared to make a significant financial commitment itself.

Parts (b) and (c) reflect the fact that support from higher levels of government will be required, but the City obviously cannot make decisions on their behalf – the focus needs to be on advocacy.

Part (d) reflects the vital importance of sand supplies, and that the issue would be best addressed at a regional or State level.

RECOMMENDATION 4

That the City undertake or support, subject to appropriate assistance from the State and/or Federal Government, the following associated but additional work:

a. A cost-benefit and/or benefit distribution analysis and/or systemic financial and economic system risk analysis of the identified adaptation pathways.

b. Coastal erosion modelling, following specific geotechnical investigations (possibly in partnership with landowners), for the following Management Units:

   i. Smiths Beach;
   ii. Yallingup;
   iii. Bunker Bay;
   iv. Eagle Bay; and
   v. Old Dunsborough.

c. Given the identified pathways for coastal erosion hazard management in the CHRMAP, further coastal inundation hazard modelling including for both Geographe Bay and west coast settlements (Yallingup and Smiths Beach).

d. Preliminary design and costings associated with storm surge events (coastal inundation hazard) protection at:

   i. Toby Inlet mouth.
   ii. The mouths of all agricultural drains.
   iii. The eastern bank of the Buayanyup River Drain.
   iv. Vasse Diversion Drain mouth and Vasse-Wonnerup Estuary storm surge barrier.
   v. Port Geographe Marina entry channel and seawall.
   vi. Vasse-Wonnerup Estuary Channel.
   vii. Layman Road, from a point just to the north of the Vasse-Wonnerup Estuary Channel to a point somewhat to the north of Tuart Drive.
   viii. Urban stormwater outlets.

Key rationale:

Part (a) reflects the fact that in advocating for or otherwise pursuing appropriate funding options, and refining the adopted adaptation pathways, further economic or financial assessments of that kind may be appropriate and useful.

Part (b) recognises that existing coastal erosion hazard assessments in those areas are not informed by detailed geotechnical information, and more detailed assessments would be appropriate to get a better sense of the potential risks.

Part (c) recognises that the response to coastal erosion hazard can have profound impacts on coastal inundation hazard, and that little work has been done to assess inundation hazard on the west coast (although the risk are thought to be relatively low).

Part (d) reflects the fact that there are a number of locations where there needs to be connection between inland waterways/drainage infrastructure and the ocean, and that means of preventing coastal inundation in those locations have not been scoped or costed yet, but do need to be at some stage.

RECOMMENDATION 5

That the City amends the Local Planning Strategy and town planning scheme, and develops local planning policy, as follows -

a. Amend Theme 4, Strategies (f), (g) and (i) of the Local Planning Strategy to identify the adoption of the CHRMAP, and reflect at a high level the strategic direction set out in the CHRMAP;

b. Extension of a modified Coastal Management Special Control Area or other suitable mechanism in the town planning scheme to –

   i. Establish a requirement for development approval for development that is not infill, but which would otherwise not require development approval;

   ii. Support the setting out of advice in local planning policy around –

      I. what types of development could be supported beyond the 'infill line';

      II. how to calculate/determine the location of the infill line; and

      III. guidance relating to private coastal protection works, which may be supported, but which will generally not be supported where coordinated approaches to coastal protection are being implemented, unless they are consistent with those coordinated approaches;

      and

   iii. Apply the Special Control Area or other suitable mechanism to coastal areas across the whole of the coast, to an area generally aligned with the seaward side of the 2123 coastal erosion hazard line.

c. Introduce controls on minimum FFLs for new development throughout the whole of the City through a suitable mechanism which would set out that –

   i. Unless a higher minimum FFL is required elsewhere in the Scheme, or through the application of the BCA, the minimum FFL for new habitable floorspace is -

      I. Generally 2.7m AHD; and

      II. A reduction to 2.2m AHD may be considered, subject to –

         - Development being additions or extensions;
         - Electrical wiring and installations being placed at or above 2.7m AHD; and
         - Structures being moisture proofed up to 2.7m AHD.

   ii. Subject to resolution of detailed boundary and interface issues, in an area generally bound by Geographe Bay, Station Gully Drain, Caves Road, Quindalup Siding Road, Vasse-Yallingup Siding Road, the section of Bussell Highway between Vasse-Yallingup Siding Road and Caves Road, the section of Caves Road between Bussell Highway and Buayanyup Drain, and the section of Buayanyup Drain between Caves Road and Geographe Bay, and in an area bound by Geographe Bay, the Shire of Capel boundary, Ludlow North Road, Tuart Drive, the section of Layman Road between Tuart Drive and the Vasse Estuary Channel, and the Vasse Estuary Channel, unless a higher minimum

FFL is required through the application of the BCA, the minimum FFL for new habitable floorspace is –

I. Generally 3.4m AHD; and

II. A reduction to 3.0m AHD may be considered, subject to –

- Development being additions or extensions;
- Electrical wiring and installations being placed at or above 3.4m AHD; and
- Structures being moisture proofed up to 3.4m AHD.

iii. For the purposes of assessing compliance with height, overlooking, overshadowing, building separation or setback controls, if Natural Ground Level is less than the generally applicable minimum FFL, NGL shall be assumed to be the generally applicable minimum FFL.

Key rationale:

The CHRMAP is a strategic and relatively high level document that seeks to set the broad direction and provide a basis for undertaking more detailed work after a final CHRMAP is adopted. Implementation of some of the recommendations of the CHRMAP will require amendments to the town planning scheme and the development of a local planning policy.

Part (a) reflects the progress on the CHRMAP since the City's Local Planning Strategy was adopted in 2019 and the need to update the strategy accordingly.

Part (b) generally reflects the need to provide clarity that development, whether within or outside the infill area, would always require development approval and that further guidance and advice would be set out in a local planning policy for the Special Control Area. This would be applied to all Management Units.

Part (c) reflects the need to give statutory effect to the principles set out in the CHRMAP on minimum FFLs throughout the City.

RECOMMENDATION 6

That the above recommendations are all incorporated into the City's:

a. Community Strategic Plan;

b. Corporate Business Plan;

c. Long Term Financial Plan;

d. Rolling, ten-year Coastal Management Programme;

e. Local Emergency Management Arrangements.

Key rationale:
This reflects the fact the CHRMAP, in and of itself, does not set the direction for the City. Rather, the direction set out in the CHRMAP needs to be reflected in a suite of other documents. It also reflects a view that coastal adaptation planning has been too narrowly focused on and driven by town planning considerations to date, rather than from the 'whole-of-government' perspective that is required.

RECOMMENDATION 7

That the City provide an annual update to the community and other relevant stakeholders on progress towards implementation of the findings and recommendations of the CHRMAP.

Key rationale:
This reflects the fact this is a very significant issue for the community, and that annual updates to the community would be appropriate, and a useful tool to keep the community engaged and informed.

RECOMMENDATION 8

That the CHRMAP is the subject of scheduled periodic review, at least once every ten years.

Key rationale:
This reflects the fact that periodic review is likely to be appropriate, as further information becomes available. Also, community values and aspirations may change over time.

RECOMMENDATION 9

Management Unit Specific Adaptation Pathways

Recommendation 9 sets out the direction for each of the 21 Management Units. It sets out the adaptation pathways for three time periods: short-term (through to 2043); medium-term (2043-2073); and long-term (2073-2123). In some cases, the fundamental adaptation pathway differs between the two key coastal hazards of erosion and inundation. Four sets of adaptation responses are also identified: planning; infrastructure/coastal management; emergency management; and foreshore management/use.

MU 01 Smiths Beach

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

X Inundation Hazard **AVOID**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the beach, beach amenity, fore dune, infrastructure and buildings, maintain existing fore dune and beach as much as possible, and install coastal protection structures, such as seawalls or groynes, as necessary.
2. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Note: Management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Smiths Beach

- West-facing sandy beach situated between rocky headlands extending south to the 2123 coastal erosion hazard line.
- Dunes within westernmost section of the foreshore reserve up to 10m AHD.
- Includes the Gunyulgup Brook mouth.
- The continuous public foreshore reserve is currently unallocated Crown land and its northern end is contiguous with the Leeuwin-Naturaliste National Park.
- There are no current coastal protection structures.

MU 01 Smiths Beach

Adaptation Pathway

2043 - 2073

Erosion Hazard
PROTECT

Inundation Hazard
AVOID

Responses

Planning Response

As per 'Current – 2043'

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall from the western end of the beach to a point between the most eastward beach access path and Gunyulgup Brook.
2. To protect the beach and beach amenity, construct one or more groynes between the western end of the beach to a point between the most eastward beach access path and Gunyulgup Brook.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

As per 'Current - 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period..

Adaptation Pathway

2073 - 2123

Erosion Hazard
PROTECT

Inundation Hazard
AVOID

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

Key Issues

- Public foreshore reserves, tourist and recreational assets are vulnerable to coastal erosion risk.
- Limited public access to the beach.
- Strategic tourism node on west coast (one of two outside the Leeuwin-Naturaliste National Park).

Key Rationale

- The public foreshore reserve is vulnerable to erosion and one of only a few places where there is easy public access to the beach on, or near the City's west coast, not in National Park.
- Further work would be required to determine the most appropriate approach to erosion protection due to high energy nature of coast.
- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 01

Smiths Beach

MU 02 Yallingup

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

X Inundation Hazard **AVOID**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall and/or bank stabilisation structure from a point just to the north of Yallingup Brook to a point between the Dawson Drive and Rabbits Hill beach access paths.
2. To protect the beach and beach amenity, construct one or more groynes from a point just to the north of Yallingup Brook to a point between the Dawson Drive and Rabbits Hill beach access paths.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Note: Management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Yallingup

- Southern section of a west-facing sandy beach situated between a rocky headland and a rock platform extending to the 2123 coastal erosion hazard line.
- Continuous public foreshore reserve partly within the Leeuwin-Naturaliste National Park with the remainder vested in the City.
- Dunes within the foreshore reserve range from 5m AHD to 20m AHD.
- There are no current coastal protection structures.

MU 02 Yallingup

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

X Inundation Hazard
AVOID

Responses

Planning Response

As per 'Current – 2043' .

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per 'Current – 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period..

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

X Inundation Hazard
AVOID

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

Key Issues

- Public foreshore reserves, tourist, recreational and private assets are vulnerable to coastal erosion risk. Yallingup Beach Road may also be vulnerable.
- Limited public access to the beach.
- Strategic tourism node on west coast (one of only two outside the Leeuwin-Naturaliste National Park).

Key Rationale

- The public foreshore reserve is vulnerable to erosion and one of only a few places where there is easy public access to the beach on, or near the City's west coast, not in National Park.
- Further work would be required to determine the most appropriate approach to erosion protection due to high energy nature of coast.
- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 02 Yallingup

MU 03 Bunker Bay

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

X Inundation Hazard **AVOID**

Responses

Planning Response

1. As per general recommendations.
2. As a condition of approval of any development or subdivision of what is currently Lots 50 and 203 require, on the southern side of the vegetated dunes, a public foreshore reserve, configured such that the western section is approximately 1.5ha and able to be developed for a car park and facilities similar to those at Meelup Beach.

Infrastructure / coastal management response

To protect the beach, beach amenity, fore dune, infrastructure and buildings, maintain existing fore dune and beach as much as possible, without installing coastal protection structures, such as seawalls or groynes.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Note: Management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Bunker Bay

- North-facing sandy beach situated between rocky headlands extending to the 2123 coastal erosion hazard line.
- Dunes within the foreshore reserve range from 5m AHD to 10m AHD.
- Limited public foreshore reserve and facilities.
- Flows from Lake Jingi breach the dune barrier and discharge into the ocean.
- There are no current coastal protection structures.

MU 03 Bunker Bay

Adaptation Pathway

2043 - 2073

Erosion Hazard
PROTECT

Inundation Hazard
AVOID

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall from the northern end of the beach to a point to the east of the eastern end of Lake Jingi, with a gap to allow continued water flow from Lake Jingi into the ocean.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment

Emergency management response

As per 'Current – 2043'

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

Erosion Hazard
PROTECT

Inundation Hazard
AVOID

Responses

Planning Response

As per '2043 – 2073'

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per '2043 - 2073'

Foreshore management/use response

As per '2043 - 2073'

Key Issues

- Public foreshore reserve, tourist, recreational and private assets are vulnerable to coastal erosion risk.
- Public access to the beach is limited and there are currently no opportunities to provide additional access or facilities.
- There is no continuous public foreshore reserve east of the 'Pullman' tourist site.

Key Rationale

- The public foreshore reserve is vulnerable to coastal erosion.
- Through potential development of the 'Farmbreak' site of the east of the tourist site at Bunker Bay, there is also an opportunity to provide a second public foreshore area, in an area where opportunities to provide additional access or facilities are highly constrained.
- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 03

Bunker Bay

MU 04 Eagle Bay

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall from a point somewhat to the north of the northern extent of the town site to a point somewhat to the south-east of the south-eastern extent of the town site, with a gap to allow continued water flow from Jingarmup Brook into the ocean.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Note: Management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Eagle Bay

- Northwest-facing sandy beach with a series of rock platforms and outcrops, extending to the 2123 coastal erosion hazard line.
- Includes the Jingarmup Brook outlet.
- Continuous public foreshore reserve contiguous with Meelup Regional Park.
- There are no current coastal protection structures.

MU 04 Eagle Bay

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per 'Current - 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

Key Issues

- Narrow public foreshore reserves.
- Recreational and private assets are vulnerable to coastal erosion.

Key Rationale

- Should the foreshore reserves be lost to coastal erosion, it would not be possible to provide replacement access to the beach or facilities without private land acquisition, or further development of facilities in highly sensitive and valuable areas in Meelup Regional Park.
- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 04 Eagle Bay

MU 05 Old Dunsborough

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a seawall from a point somewhat to the north of the northern extent of the town site to the southern boundary of the management unit, other than where natural rock formations already provide protection.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Old Dunsborough

- East-facing mixed sandy/rocky coastline, including Point Daking and Point Dalling, with rock platforms outcrops, extending to the 2123 coastal erosion hazard line.
- Continuous public foreshore reserve but often very narrow. The foreshore reserve lies generally at 5.0m AHD, with some sections lower.
- There are no current coastal protection structures.

MU 05 Old Dunsborough

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per 'Current - 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

Key Issues

- Narrow public foreshore reserves.
- Recreational and private assets are vulnerable to coastal erosion.

Key Rationale

- Should the foreshore reserves be lost to coastal erosion, it would not be possible to provide replacement access to the beach or facilities without private land acquisition, or further development of facilities in highly sensitive and valuable areas in Meelup Regional Park.
- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 05

Old Dunsborough

MU 06 Dunsborough Townsite*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall/bund from a point somewhat to the north of the northern extent of the town site to the southern boundary of the management unit.
2. To protect the beach and beach amenity, maintain, upgrade and supplement as necessary the existing groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Dunsborough Townsite*

- Northeast- facing sandy beach in the lee of a rocky headland extending to the 2123 coastal erosion hazard line.
- Includes the Dunn Bay Bar and the mouths of the Dandatup and Dugalup Brooks.
- The foreshore reserve generally lies below 5.0m AHD. Continuous public foreshore reserve (including vegetation and habitat).
- Coastal protection structures: buried geotextile sand container (GSC) seawall installed in 2012.

** Denotes management units where there are existing coastal protection structures*

MU 06 Dunsborough Townsite*

Adaptation Pathway

2043 - 2073

Erosion Hazard
PROTECT

Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current – 2043'

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund to an approximate height of 3.5 - 4.0m AHD.

Emergency management response

As per 'Current – 2043'

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

Erosion Hazard
PROTECT

Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

Key Issues

- Urban area that is vulnerable to coastal erosion and coastal inundation..

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 06 Dunsborough Townsite*

MU 07 Quindalup*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall/bund from the western boundary of the management unit to a point somewhat to the east of the existing cycle/pedestrian bridge across Toby Inlet.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Quindalup*

- Northeast- facing sandy beach that includes the point of land fall for the Dunn Bay Bar and Station Gully Drain outlet, extending to the 2123 coastal erosion hazard line.
- Continuous public foreshore reserve (with significant vegetation & habitat values).
- Toby Inlet runs generally parallel to the coast and discharges into the ocean west of Station Gully Drain.
- Coastal protection structures: stone revetment (1973), timber groynes (1982) and Quindalup Sea Rescue trial groyne (2013).

** Denotes management units where there are existing coastal protection structures*

MU 07 Quindalup*

Adaptation Pathway

2043 - 2073

Erosion Hazard
PROTECT

Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund to an approximate height of 3.5 -4.0m AHD.
2. Increase the level of the fore dune from a point to the east of the existing cycle/pedestrian bridge across Toby Inlet to a point somewhat to the east to an approximate height of 3.5 – 4.0m AHD, construct a storm surge barrier across Toby Inlet at that point, and elevate portion of Caves Road to that height, to prevent storm surge events affecting property in the management unit.

Emergency management response

Establish emergency management plans and protocols will be necessary to ensure that the elevated fore dune to the east of the eastward limit of the buried seawall/bund is sufficiently robust, and Caves Road may also need to be closed to traffic.

Foreshore management/ use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

Erosion Hazard
PROTECT

Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'..

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

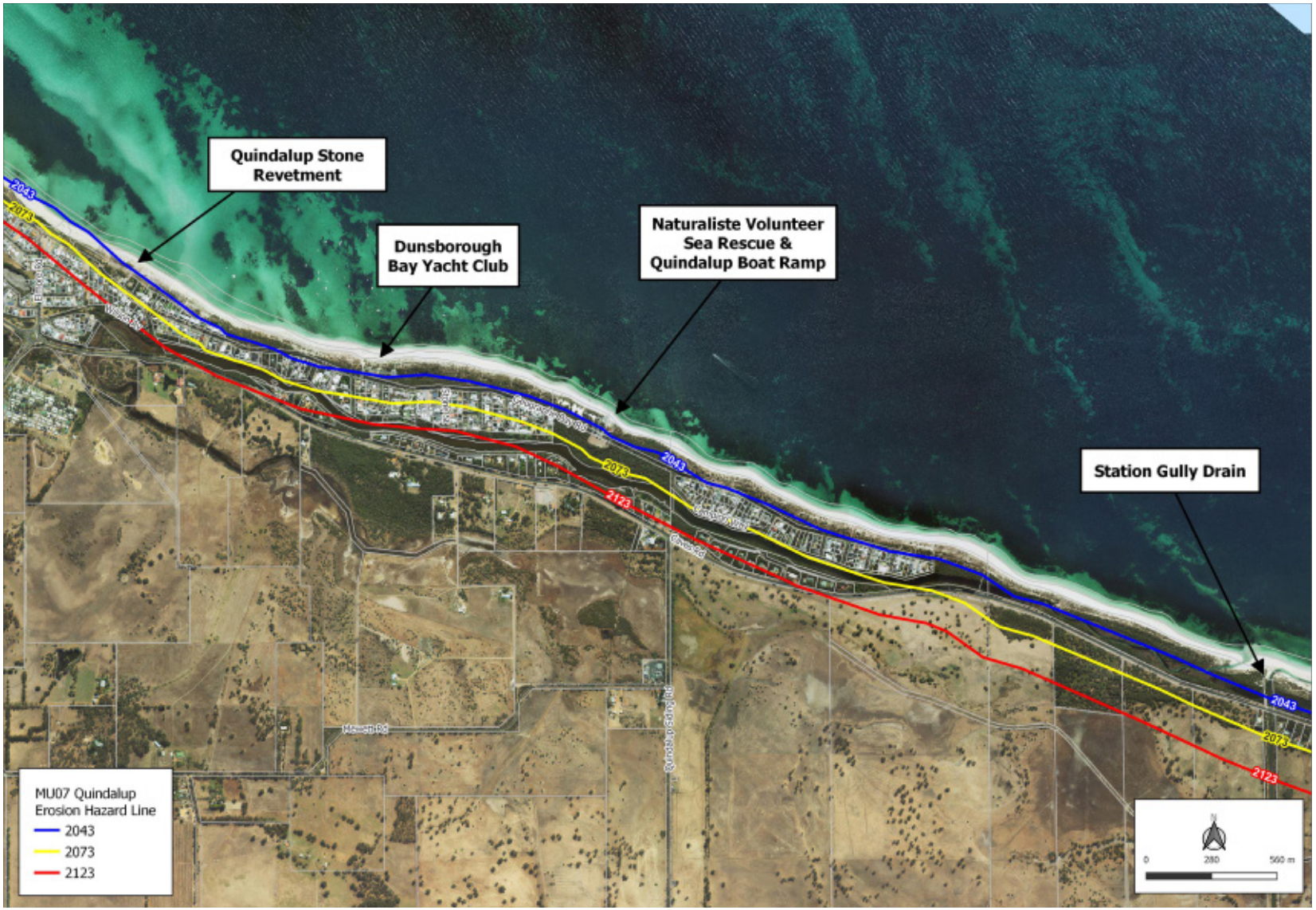
Key Issues

- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 07 Quindalup*



MU 08A Marybrook West

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

To protect the beach, fore dune, beach amenity, foreshore reserve, infrastructure and buildings –

1. Construct one or more groynes along the beach;
2. Construct a buried seawall/bund/levee or reinforced fore dune; and
3. Supplement the infrastructure described above with beach nourishment as necessary.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the projected maximum potential water level for an expected storm surge event. Caves Road may also need to be closed to traffic.

Foreshore management/ use response

Consider accommodating new community infrastructure within the foreshore reserve.

Overview

Marybrook West

- North-facing sandy beach.
- To the north of Caves Road, contains land from Station Gully Drain east as far as the western boundary of Lot 66 Caves Road, Marybrook.
- To the south of Caves Road, contains all land from Station Gully Drain east to the Lennox River Drain, extending south to the 2123 coastal erosion hazard line.
- The Management Unit includes the Marybrook Drain outlet.

MU 08A Marybrook West

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per 'Current – 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period as required.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

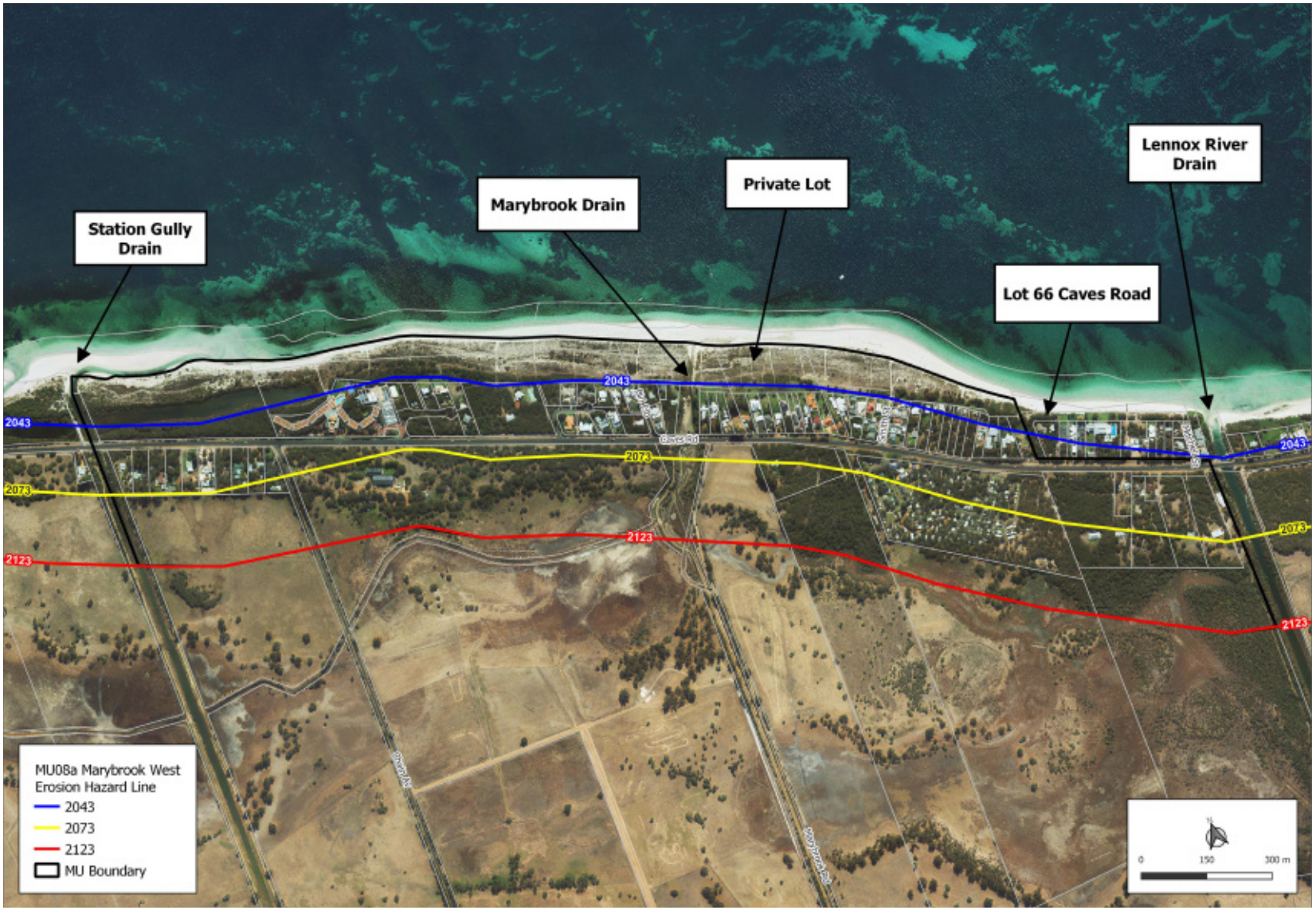
Key Issues

- Wide beach and foreshore reserve, tourist development, residences and Caves Road/utilities vulnerable to coastal erosion and coastal inundation.
- The existing foreshore reserve is not entirely in public ownership.
- Other than a dual use path west of Birl Elbow, there is no public infrastructure or formalised beach access (e.g. public car park) within the foreshore reserve.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. There is public access and use of the foreshore in Marybrook and some areas could accommodate community infrastructure at some point in the future.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for adaptation response to coastal inundation risk.

MU 08A Marybrook West



MU 08B Marybrook/Siesta Park Central*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. Subject to resolution of land tenure and access issues, implement an integrated erosion protection strategy to protect properties from coastal erosion hazard, with works funded and costs apportioned between State/ Federal Government, City of Busselton ratepayers as a whole and direct contributions from landowners.
2. Protect beach, buildings and foreshore through an integrated approach using a combination of groynes, beach nourishment and seawall, subject to detailed design, costings, further consultation and land access agreements where necessary.
3. Engage with the State Government (in particular, Water Corporation) to address and resolve erosion issues relating to management of the Lennox River Drain outlet.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event. Caves Road may also need to be closed to traffic.

Foreshore management/ use response

Foreshore reserve insufficient to accommodate significant community infrastructure.

Overview

Marybrook/ Siesta Park Central*

- North-facing sandy beach.
- To the north of Caves Road only, from the western boundary of Lot 66 Caves Road, Marybrook to the western boundary of the Siesta Park Holiday Resort.
- This Management Unit contains the Lennox River Drain outlet.
- Coastal protection structures: Siesta Park jetty groyne (1950s), East Lennox timber groyne field (1960s) and a number of private coastal protection structures.

** Denotes management units where there are existing coastal protection structures*

MU 08B Marybrook/Siesta Park Central*

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. Upgrade and maintain infrastructure constructed in the preceding period as required.
2. Approach to funding infrastructure development and maintenance to be determined subject to further investigation and progress at State level towards identification of sustainable, equitable and efficient funding of coastal adaptation.

Emergency management response

As per 'Current - 2043'.

Financial response

As per 'Current – 2043'

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per '2043 - 2073'

Infrastructure / coastal management response

As per '2043 - 2073'

Emergency management response

As per '2043 - 2073'

Financial response

As per '2043 - 2073'

Key Issues

- Vulnerable to coastal erosion and coastal inundation.
- Absence of a continuous substantial foreshore reserve.
- Land tenure and limited public access.
- Management of the Lennox River Drain outlet.

Key Rationale

- Properties in this Management Unit are privately owned, with a narrow or absent foreshore area and highly vulnerable to coastal erosion risk. This risk has manifested in a number of private coastal protection structures that have been constructed by individual landowners at their cost. Private coastal protection structures have the potential to cause unintended off-site impacts (such as protection on one property increasing erosion elsewhere) when implemented in an uncoordinated manner. The adaptation direction set out by the CHRMAP is for an integrated erosion protection approach, led by the City, which would be more efficient, effective and at a lower overall cost, and with less unintended consequences.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for adaptation response to coastal inundation risk.

MU 08B Marybrook/Siesta Park Central*

MU 09A Siesta Park Holiday Resort

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

1. As per general recommendations.
2. By 31 December 2023, a development application shall be lodged by the landowners seeking approval for an integrated coastal adaptation strategy for the management unit, identifying –
   a. Designs, specifications and schedule of actions necessary to protect existing development on the properties from projected potential coastal erosion for a period of at least 20 years, whilst maintaining a continuous beach and foreshore reserve for the full width of the properties, and identifying, considering and mitigating potential impacts on other sections of the coast;
   b. The strategy may include proposals for maintenance or upgrade of existing coastal protection structures, development and maintenance of new coastal protection structures, including groynes and/or seawalls, actions to reinforce the fore dune and/or beach nourishment;
   c. If the strategy does not propose the protection of all development, it shall identify how and when development may be relocated or demolished prior to it being affected by coastal erosion;
   d. The strategy shall identify that a review shall take place no later than 10 years after approval of the development application – that requirement would likely be reflected in a condition of development approval; and
   e. Lodgement of the application shall be preceded by the City obtaining power to licence over the foreshore reserve, within which some works may need to be undertaken, and a licence agreement with the landowner will be required to undertake and maintain any works within the foreshore reserve.

Infrastructure / coastal management response

To be determined through process described in Planning Response Recommendation 2.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event. Caves Road may also need to be closed to traffic.

Foreshore management/use response

Foreshore reserve insufficient to accommodate significant community infrastructure.

Overview

Siesta Park Holiday Resort

- North-facing sandy beach.
- North of Caves Road only, consists of Lot 106 (No. 367) and Lot 105 (No. 388) Caves Road, Siesta Park.

MU 09A Siesta Park Holiday Resort

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

1. As per 'Current – 2043' for Recommendations 1-2.
2. Approach to coastal adaptation to address coastal erosion risk to be considered as part of review process identified in Recommendation 2.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required.

Emergency management response

As per 'Current – 2043'

Foreshore management/use response

As per 'Current – 2043'

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per '2043 - 2073'

Infrastructure / coastal management response

As per '2043 - 2073'

Emergency management response

As per '2043 - 2073'

Foreshore management/use response

As per '2043 - 2073'

Key Issues

- Tourist development vulnerable to coastal erosion and coastal inundation.
- Management Unit has a coastal frontage of approximately 400m in single ownership, with a continuous public foreshore reserve.

Key Rationale

- The Siesta Park Holiday Resort has nearly 400m of coastal frontage, with a continuous public foreshore reserve. Logically, this supports the identification of this area as a 'stand-alone' Management Unit and allows consideration and implementation of an integrated erosion protection strategy, to be developed by the landowner in conjunction with the City.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for adaptation response to coastal inundation risk.

MU 09A

Siesta Park Holiday Resort

MU 09B Siesta Park East*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

To protect the beach, fore dune, beach amenity, foreshore reserve, infrastructure and buildings –

1. Construct one or more groynes along the beach;
2. Construct a buried seawall/bund/ levee or reinforced fore dune; and
3. Supplement the infrastructure described above with beach nourishment as necessary.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the projected maximum potential water level for an expected storm surge event. Caves Road may also need to be closed to traffic.

Foreshore management/ use response

Consider accommodating new community infrastructure within the foreshore reserve.

Overview

Siesta Park East*

- North-facing sandy beach.
- To the north of Caves Road, contains land from the eastern boundary of the Siesta Park Holiday Resort east to Locke Swamp Drain.
- To the south of Caves Road, contains all land from Lennox River Drain east to Locke Swamp Drain, extending south to the 2123 coastal erosion hazard line.
- Coastal protection structures: Siesta Park groyne (1965/67).

** Denotes management units where there are existing coastal protection structures*

MU 09B Siesta Park East*

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per 'Current - 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period as required.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

Key Issues

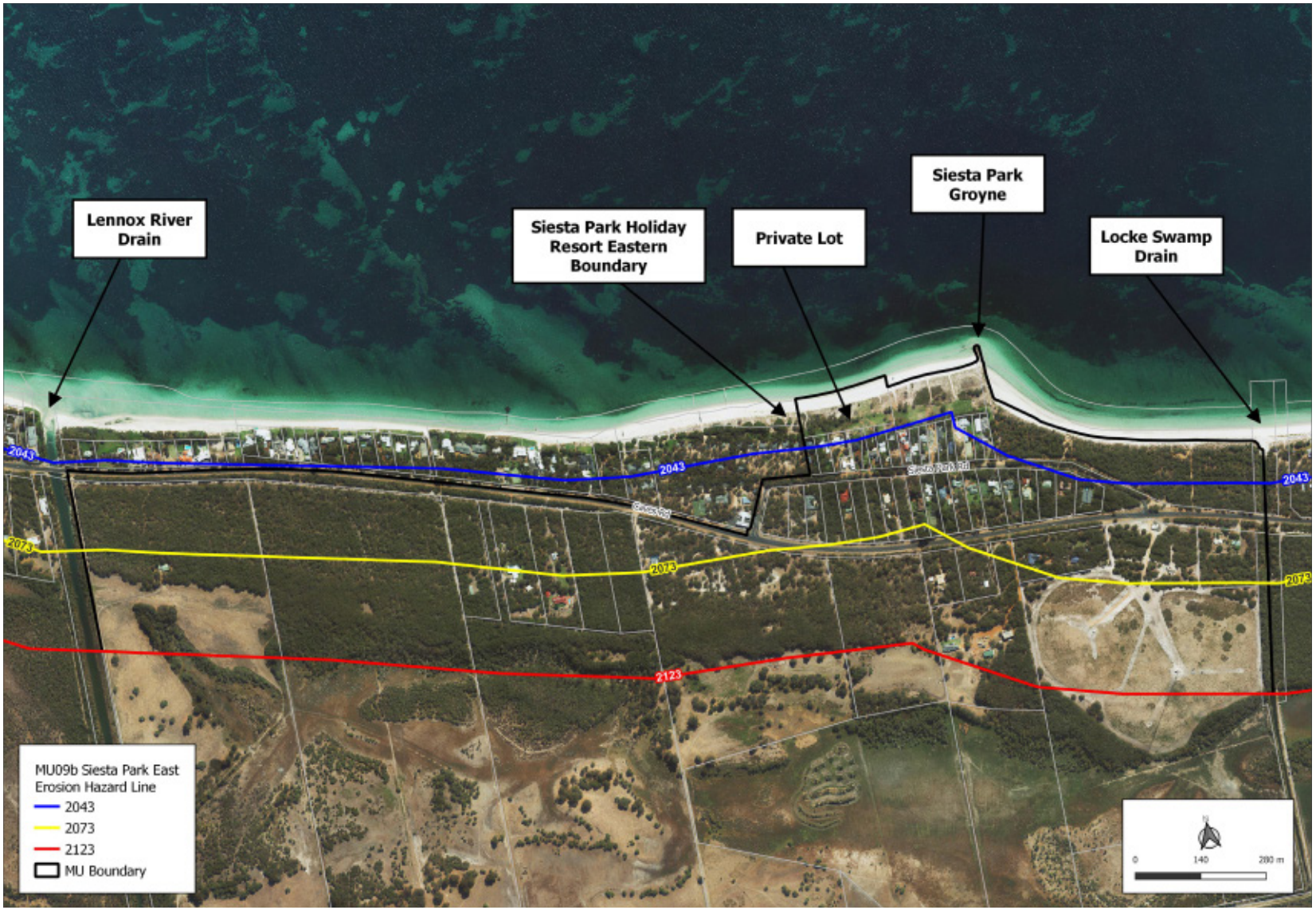
- Wide beach and foreshore reserve influenced by the Siesta Park groyne (although not entirely in public ownership).
- Residences and Caves Road/utilities vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. There is public access and use of the foreshore in Siesta Park and some areas could accommodate community infrastructure at some point in the future.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for adaptation response to coastal inundation risk.

MU 09B

Siesta Park East*



MU 10 Locke Estate*

Adaptation Pathway

Current - 2043

P Erosion Hazard
PROTECT Keep option of managed retreat possible post 2073

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

1. As per general recommendations.
2. Continue to offer leasehold tenure consistent with the reserve purpose and granting of the land to the Crown for periods no greater than 21 years.

Infrastructure / coastal management response

1. To protect buildings, construct a buried seawall from a point somewhat to the east of the Locke Swamp Drain to the Buayanyup River Drain.
2. To protect the beach and beach amenity, maintain and upgrade as necessary the existing groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event. Caves Road may also need to be closed to traffic.

Foreshore management/ use response

Foreshore reserve insufficient to accommodate significant community infrastructure

Overview

Locke Estate*

(Note: There is no privately owned land in this management unit)

- North-facing sandy beach backed by camp lease sites and, further inland, the Locke Nature Reserve, and extending south to the 2123 coastal erosion hazard line.
- Includes the Locke Swamp and Buayanyup River Drain outlets.
- Coastal protection structures: Buayanyup River Drain training wall (1985), groyne field (1988-1992 & 2014/15), Locke Estate seawall (1985-1992/2014).

** Denotes management units where there are existing coastal protection structures*

MU 10 Locke Estate*

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT Keep option of managed retreat possible post 2073

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per 'Current – 2043'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment.

Emergency management response

As per 'Current – 2043'.

Foreshore management/use response

As per 'Current – 2043'..

Adaptation Pathway

2073 - 2123

Erosion Hazard
TO BE DETERMINED

Inundation Hazard
TO BE DETERMINED

Responses

Planning Response

To be determined.

Infrastructure / coastal management response

To be determined.

Emergency management response

To be determined.

Foreshore management/use response

To be determined.

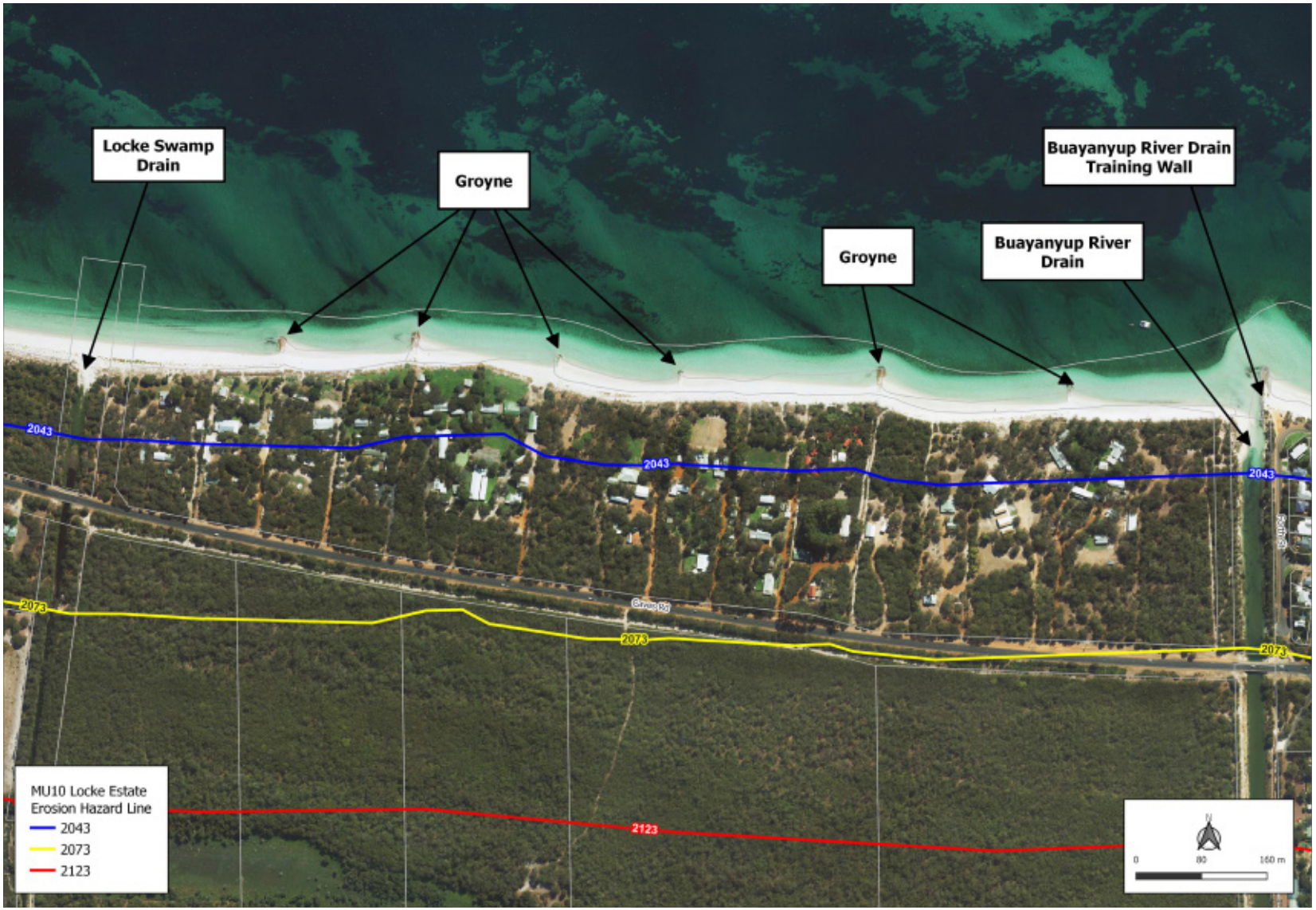
Key Issues

- Vulnerable to coastal erosion and coastal inundation.
- All of the land in this Management Unit is in public ownership.

Key Rationale

- Campsites on the seaward side of Caves Road are leasehold facilities and the lease terms in place cannot extend beyond 21 years at present.
- There are already coastal protections in place with a design life that extends for at least another 10 years – that also provide some protection from coastal inundation risk, along with establishing minimum floor levels for new development and emergency management approaches.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for adaptation response to coastal inundation risk.
- The option of retreat over the medium to long term is left open for future decision-makers.

MU 10 Locke Estate*



MU 11 Abbey*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall/bund/levee or reinforced fore dune from the Buayanyup River Drain to the eastern boundary of the management unit.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Abbey*

- Buayanyup River Drain outlet to the Holgate Road groyne, extending south to the 2123 coastal erosion hazard line.
- North-facing sandy beach with a continuous, narrow public foreshore reserve (including vegetation and habitat).
- Coastal protection structures: boat ramp headland (1978, refurbished 2011 & 2013), groyne field (1990s, 2011 & 2012/13), Abbey West groyne (2012/13).

** Denotes management units where there are existing coastal protection structures*

MU 11 Abbey

Adaptation Pathway

2043 - 2073

Erosion Hazard
PROTECT

Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund/levee or reinforced fore dune to an approximate height of 3.5 – 4.0m AHD.
2. Beyond 2043, integrated flood protection through the seawall/bund/levee or reinforced fore dune is to be continuous.
3. Engage with the State Government (in particular, Water Corporation), to advocate for the upgrade of the eastern bank of the Buayanyup River Drain to an approximate height of 3.5 – 4.0m AHD, and to be structurally capable of protecting land to the east from a major storm (coastal inundation hazard) event.

Emergency management response

As per 'Current – 2043'

Note: If the buried seawall/bund and eastern bank of the Buayanyup River Drain has been constructed to a minimum height of 3.4m AHD, the management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

Erosion Hazard
PROTECT

Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/ use response

As per '2043 - 2073'.

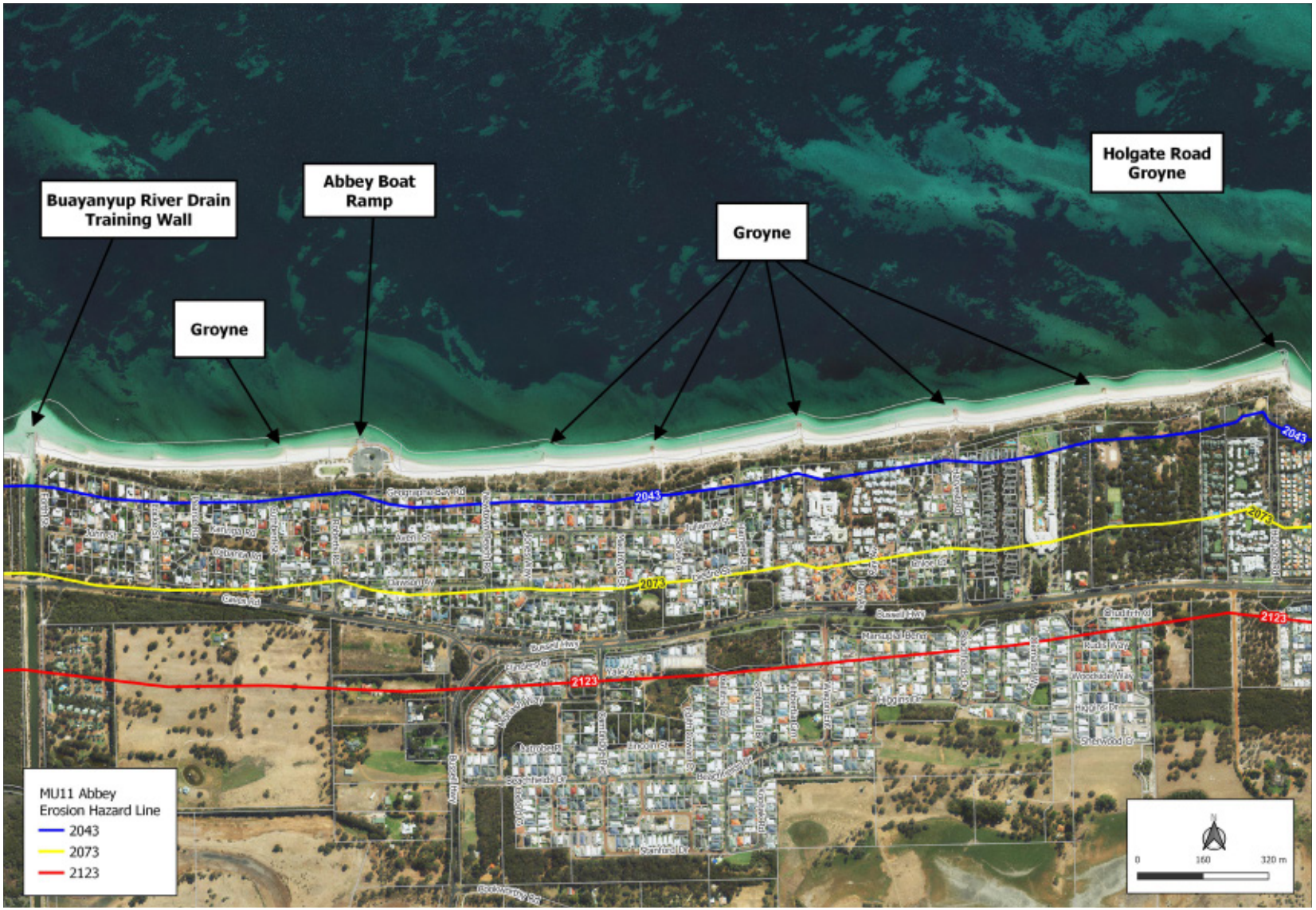
Key Issues

- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 11 Abbey*


Buayanyup River Drain Training Wall
Abbey Boat Ramp
Groyne
Groyne
Holgate Road Groyne
2043
2073
2123
MU11 Abbey
Erosion Hazard Line
2043
2073
2123
0
160
320 m

MU 12 Broadwater

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, significant remnant vegetation, infrastructure and buildings, construct a buried seawall/bund from the western to the eastern boundary of the management unit.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Broadwater*

- North-facing sandy beach with a wide continuous public foreshore reserve (including vegetation and habitat) extending south to the 2123 coastal erosion hazard line.

  Landfall for the Abbey sand bar.

  Coastal protection structures: two trial groynes (2011).

** Denotes management units where there are existing coastal protection structures*

MU 12 Broadwater

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

Upgrade infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund to an approximate height of 3.5 – 4.0m AHD.

Emergency management response

As per 'Current – 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

Key Issues

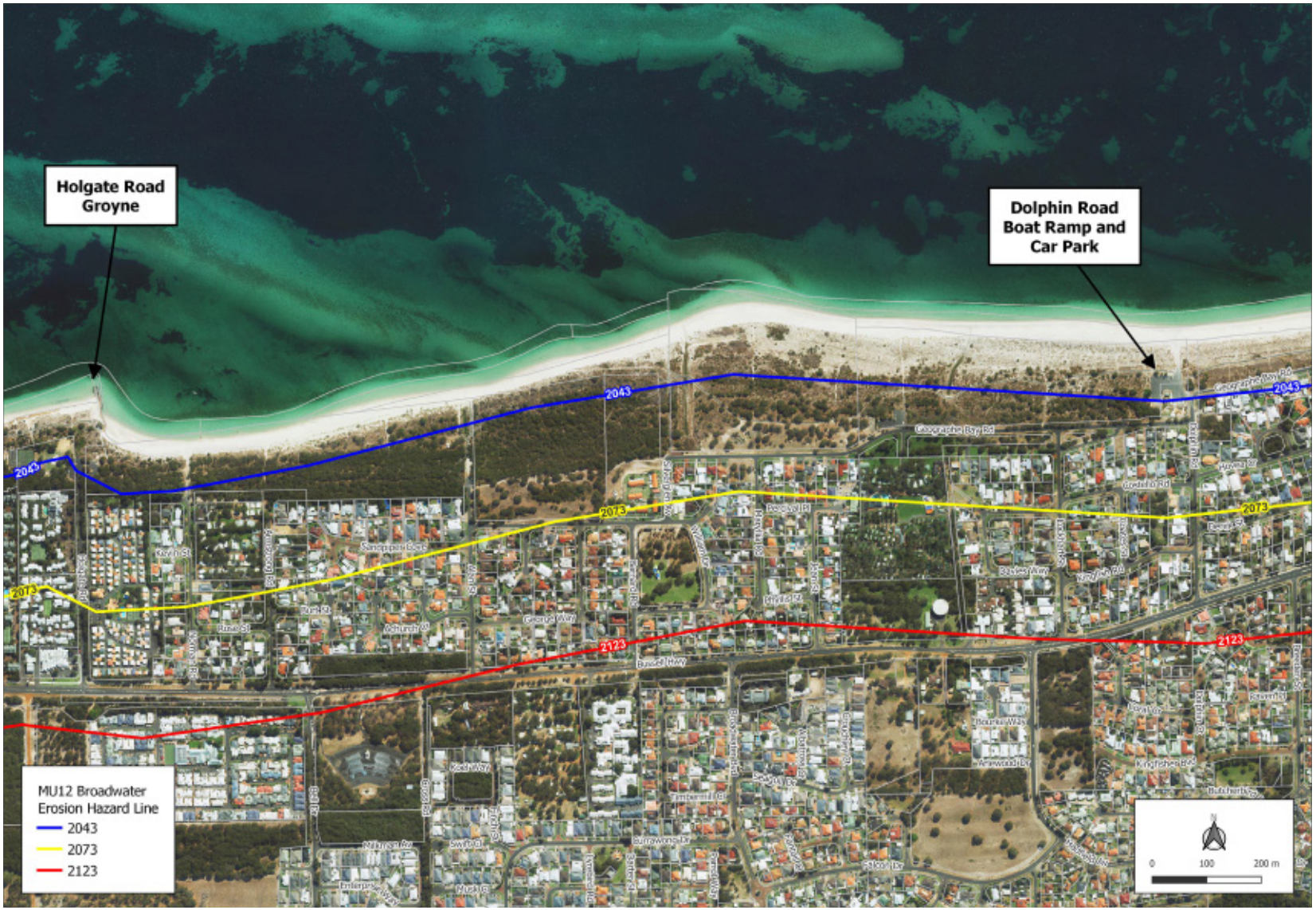
- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 12

Broadwater*



MU 13 Busselton West (A)*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall/bund from the western boundary of the management unit to the Vasse Diversion Drain.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Busselton West (A)*

- North-facing sandy beach with a narrow continuous public foreshore reserve extending south to the 2123 coastal erosion hazard line.
- Includes the Vasse Diversion Drain outlet.
- Coastal protection structures: seawalls (1970s), groynes (1990-1995 & 2016) and Vasse River Diversion Drain outlet training wall (1983).

** Denotes management units where there are existing coastal protection structures*

MU 13 Busselton West (A)*

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund to an approximate height of 3.5 – 4.0m AHD.
2. Engage with the State Government (in particular, Water Corporation), to ensure that Water Corporation constructs a storm surge barrier at the mouth of the Vasse Diversion Drain.

Emergency management response

As per 'Current – 2043'

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/ use response

As per '2043 - 2073'.

Key Issues

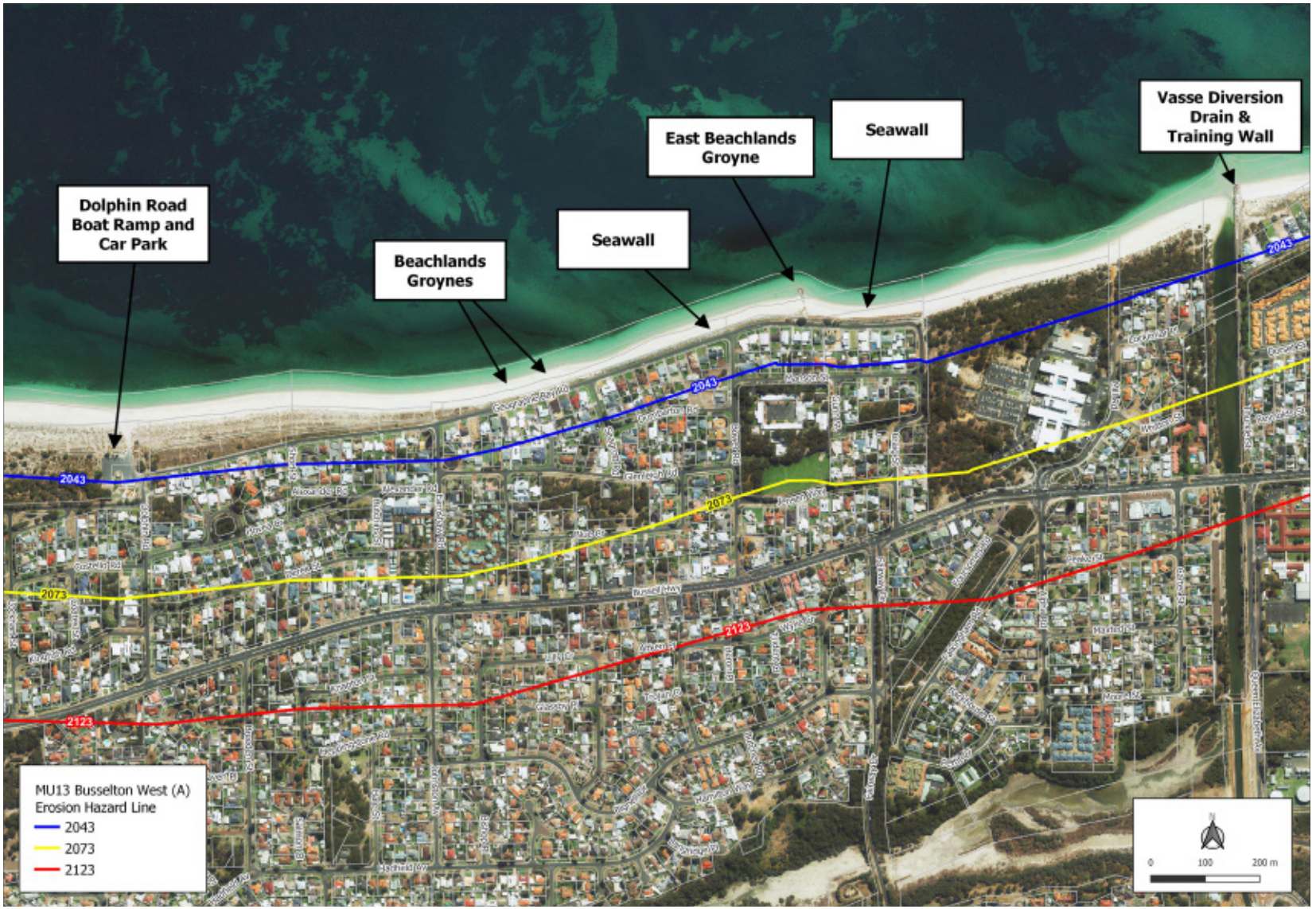
- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 13

Busselton West (A)*



MU 14 Busselton West (B)*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, construct a buried seawall/bund from the Vasse Diversion Drain to the eastern boundary of the management unit.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Busselton West (B)*

- Northwest-facing sandy beach with a generally narrow, continuous public foreshore reserve, extending south to the 2123 coastal erosion hazard line.
- Includes the Vasse Diversion Drain outlet.
- Coastal protection structures: King Street carpark buried geotextile sand container seawall (2013).

** Denotes management units where there are existing coastal protection structures*

MU 14 Busselton West (B)*

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund to an approximate height of 3.5 – 4.0m AHD.
2. Engage with the State Government (in particular, Water Corporation), to ensure that Water Corporation constructs a storm surge barrier at the mouth of the Vasse Diversion Drain.

Emergency management response

As per 'Current – 2043'

Note: If the buried seawall/bund and Vasse Diversion Drain storm surge barrier has been constructed to a minimum height of 3.5 – 3.8m AHD, the management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/ use response

As per '2043 - 2073'.

Key Issues

- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 14

Busselton West (B)*

MU 15 Busselton Central*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, extend and maintain the existing buried seawall/bund for the full length of the management unit.
2. To protect the beach and beach amenity, supplement as necessary groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Busselton Central

- Northwest-facing sandy beach with a continuous public foreshore reserve that widens to the east extending south to the 2123 coastal erosion hazard line.
- Includes the Busselton Foreshore Precinct and significant heritage assets.
- Coastal protection structures: Busselton Jetty GSC groynes (2008), seawalls (refurbished 2011, 2015 & 2017), Scout Road groynes (2013)..

** Denotes management units where there are existing coastal protection structures*

MU 15 Busselton Central*

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund to an approximate height of 3.5 – 4.0m AHD.

Emergency management response

As per 'Current – 2043'.

Note: If the buried seawall/bund has been constructed to a minimum height of 3.5 – 3.8m AHD, the management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/use response

As per '2043 - 2073'.

Key Issues

- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 15

Busselton Central*

MU 16 Busselton East

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure and buildings, extend and maintain the existing buried seawall/bund for the full length of the management unit.
2. To protect the beach and beach amenity, supplement as necessary groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Busselton East

- Northwest-facing sandy beach with a continuous public foreshore reserve, extending to the 2123 coastal erosion hazard line.
- Land fall for the Busselton Jetty sand bar.
- No current coastal protection structures.

MU 16 Busselton East

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund to an approximate height of 3.5 – 4.0m AHD.

Emergency management response

As per 'Current – 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073.

Emergency management response

As per '2043 - 2073.

Foreshore management/use response

As per '2043 - 2073.

Key Issues

- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 16 Busselton East

MU 17 Port Geographe*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect infrastructure and buildings, engage with the State Government (in particular, Department of Transport), to ensure that the Department of Transport maintains the existing seawall/bund.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Port Geographe*

- Port Geographe Marina and canal development, extending to the 2123 coastal erosion hazard line.
- Public foreshore reserve from the inner marina entry wall extending along the seawall.
- Coastal protection structures: Port Geographe seawall and west breakwater.

** Denotes management units where there are existing coastal protection structures*

MU 17 Port Geographe*

Adaptation Pathway

2043 - 2073

Erosion Hazard
PROTECT

Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. Engage with the State Government (in particular, Department of Transport), to ensure that the Department of Transport upgrade and maintain the infrastructure in place in the preceding period as required.
2. Engage with the State Government (in particular, Department of Transport), to investigate options for storm surge protection at the Marina Entry Channel in conjunction with land-based protection (bund or levee) for the remainder of the Management Unit.
3. Potentially, in parallel with 2 above, a mechanical flushing system may be required to protect water quality in the Marina and canals.

Emergency management response

As per 'Current – 2043'.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

Erosion Hazard
PROTECT

Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073'.

Infrastructure / coastal management response

As per '2043 - 2073'.

Emergency management response

As per '2043 - 2073'.

Foreshore management/ use response

As per '2043 - 2073'.

Key Issues

- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 17

Port Geographe*

MU 18 Wonnerup*

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure, buildings, and Vasse Estuary, construct a buried seawall/ bund from a point somewhat to the north of the northern extent of the town site to the southern boundary of the management unit.
2. To protect the beach and beach amenity, supplement as necessary groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Continue to support and consider accommodating new community infrastructure within the foreshore reserve.

Overview

Wonnerup*

- Northwest-facing sandy beach and low lying coastal barrier backed by the Vasse-Wonnerup Estuary.
- Includes the mouth of the Wonnerup Inlet and extends to the 2123 coastal erosion hazard line.
- Continuous public foreshore reserve.
- Coastal protection structures: Wonnerup groyne field (2004-2006), buried seawall and Baudin Reserve GSC groynes (2017).
- Flood protection structures: Vasse Estuary storm surge barrier.

** Denotes management units where there are existing coastal protection structures*

MU 18 Wonnerup*

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

1. Upgrade infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including increasing the height of the buried seawall/bund to an approximate height of 3.5 – 4.0m AHD.
2. Consider increasing the height of Layman Road, from a point just to the north of Vasse Estuary inlet channel to a point somewhat to the north of Tuart Drive to an approximate height of 3.5 – 4.0m AHD.

Emergency management response

As per 'Current – 2043'

Note: If the seawall/bund and storm surge (coastal inundation hazard) protection has been constructed to a minimum height of 3.4m AHD, the management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

P Inundation Hazard
PROTECT

Responses

Planning Response

As per '2043 - 2073.

Infrastructure / coastal management response

As per '2043 - 2073.

Emergency management response

As per '2043 - 2073.

Foreshore management/ use response

As per '2043 - 2073.

Key Issues

- Urban area vulnerable to coastal erosion and coastal inundation.

Key Rationale

- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 18 Wonnerup*

MU 19 Forrest Beach

Adaptation Pathway

Current - 2043

P Erosion Hazard **PROTECT**

A Inundation Hazard **ACCOMMODATE**

Responses

Planning Response

As per general recommendations.

Infrastructure / coastal management response

1. To protect the fore dune, infrastructure, buildings, and Wonnerup Estuary, construct a buried seawall/bund from a point somewhat to the east of the eastern end of the Deadwater to the eastern boundary of the management unit.
2. To protect the beach and beach amenity, construct one or more groynes along the beach.
3. Supplement the infrastructure described above with beach nourishment.

Emergency management response

Establish emergency management plans and protocols to identify, and evacuate or provide temporary protection for, any remaining buildings with habitable floor space below the maximum potential water level for an expected storm surge event.

Foreshore management/ use response

Consider accommodating new community infrastructure within the foreshore reserve.

Overview

Forrest Beach

- Northwest-facing sandy beach and coastal barrier backed by the Vasse-Wonnerup Estuary. Includes the Wonnerup Inlet, the 'Deadwater' wetland and a continuous public foreshore reserve and extends to the 2123 coastal erosion hazard line.
- No current coastal protection structures.
- Flood protection structures: Wonnerup Estuary storm surge barrier.

MU 19 Forrest Beach

Adaptation Pathway

2043 - 2073

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

As per 'Current - 2043'.

Infrastructure / coastal management response

Upgrade and maintain infrastructure constructed in the preceding period as required and continue to supplement with beach nourishment, including extending to the buried seawall progressively to the west.

Emergency management response

As per 'Current - 2043'.

Note: If the seawall/bund and storm surge (coastal inundation hazard) protection has been constructed to a minimum height of 3.4m AHD, the management unit should not be vulnerable to coastal inundation events during this period.

Foreshore management/use response

Upgrade and maintain infrastructure constructed in the preceding period.

Adaptation Pathway

2073 - 2123

P Erosion Hazard
PROTECT

A Inundation Hazard
ACCOMMODATE

Responses

Planning Response

To be determined.

Infrastructure / coastal management response

To be determined.

Emergency management response

To be determined.

Foreshore management/ use response

To be determined.

Key Issues

- Public foreshore reserve and Forrest Beach Road are vulnerable to coastal erosion.
- Inland flood risk linked to management of the Vasse-Wonnerup Estuary inlet.
- Environmental implications for the Vasse-Wonnerup Estuary transforming from a freshwater estuary to a saltwater inlet.

Key Rationale

- There is a substantial public foreshore reserve in this area which means that the costs of protection, especially in the short term, are much lower.
- There is a rationale for the community in general to meet some of the costs of protecting the coast as there is a foreshore reserve and beach that can be used by the community in general, as well as significant environmental values.
- The direction set for adaptation response to coastal erosion risk is to protect public assets and infrastructure (including foreshore areas) as well as private properties. Public assets are protected at the City's cost and those assets should be available and able to be used by the whole community. Protection from coastal erosion risk provides the opportunity to consider new or expanded public infrastructure within foreshore reserves, available for use by the whole community.
- Refer to section 7.1 of the CHRMAP which sets out the rationale for the direction set for the adaptation response to coastal inundation risk.

MU 19 Forrest Beach

References

ACIL Tasman (2012) *Climate Change Adaptation Options Assessment – Developing Flexible Adaptation Pathways for the Peron-Naturaliste Coastal Region of Western Australia.* Prepared for the Peron-Naturaliste Partnership.

Advisian (2020a) *City of Busselton Coastal Hazard Risk Management and Adaptation Plan - Technical Assessment Report.* Prepared for the City of Busselton.

Advisian (2020b) *City of Busselton Coastal Hazard Risk Management and Adaptation Plan – Instruction Manual for Financial Model.* Prepared for the City of Busselton.

Baird (2020) *Coastal Inundation Study (CIS) for Newport Geographe – Port Geographe, Busselton.* Prepared by Baird Australia Pty Ltd for Aigle Royal Developments.

Barr S, Staples O, Eliot I, Darby O, Abrahamse D, Stul T. (2017) *Adaptation to Coastal Inundation in a Low Lying, Highly Dynamic Regional Area.* Coasts and Ports 2017 Conference – Cairns, 21-23 June 2017.

CoastAdapt (2017) *Coastal Climate Change Infographics Series.* Available at https://coastadapt.com.au/infographics

CoastAdapt (2018) *Coast and Climate Dynamics.* Available at https://coastadapt.com.au/infographics

Damara WA Pty Ltd (2011) *Shire of Busselton Coastal Erosion Study – Assessment of Climate Change Impacts.* Prepared for the Shire of Busselton.

Damara WA Pty Ltd (2012) *Coastal Hazard Mapping for Economic Analysis of Climate Change Adaptation in the Peron-Naturaliste Region.* Prepared for the Peron-Naturaliste Partnership.

Damara WA Pty Ltd (2017) *Cape Naturaliste Settlements Coastal Vulnerability Assessment.* Prepared for the City of Busselton.

Department of Water (2010) *Vasse Wonnerup Wetlands and Geographe Bay Water Quality Improvement Plan.*

Geoscience Australia (2014) *Coastal Inundation Modelling for Busselton, Western Australia Under Current and Future Climate.* Record 2014/03. Prepared by Geoscience Australia for the Western Australian Planning Commission.

Research Solutions (2018) *City of Busselton Coastal Adaptation Research.* Prepared for the City of Busselton.

Seashore Engineering (2018) *Design Storms for Western Australian Coastal Planning – Tropical Cyclones.* Report SE015-01. Prepared by Seashore Engineering Pty Ltd for Department of Transport.

Shore Coastal (2013) *City of Busselton Coastal Management Programme 2014 – 2018.* Prepared for the City of Busselton.

Shore Coastal (2017) *Busselton Coastal Management Programme – Coastal Flooding Risk, Response and Mitigation.* Prepared for the City of Busselton.

Shore Coastal (2020) *City of Busselton Coastal Management Programme 10 Year Plan (2020 – 2030).* Prepared for the City of Busselton.

WAPC (2005) *Busselton Wetlands Conservation Strategy.* Published by the Western Australian Planning Commission, Perth, Western Australia.

WAPC (2013) *State Planning Policy No. 2.6 State Coastal Planning Policy.* Published by the Western Australian Planning Commission, Perth, Western Australia.

WAPC (2017) *WA Coastal Zone Strategy.* Published by the Western Australian Planning Commission, Perth, Western Australia.

WAPC (2019) *Coastal Hazard Risk Management and Adaptation Planning Guidelines.* Published by the Western Australian Planning Commission, Perth, Western Australia.

Glossary of terms

'accretion' refers to shoreline movement where the shoreline shifts seaward increasing the width of a coastal foreshore reserve and/or the distance to a fixed feature on the adjoining land.

'coastal foreshore reserve' is the area of land on the coast set aside in public ownership to allow for likely impacts of coastal hazards and provide protection of public access, recreation, safety, biodiversity and ecosystem integrity, landscape, visual landscape, indigenous and cultural heritage.

'coastal hazard' means the consequence of coastal processes that affect the environment and safety of people. Potential coastal hazards include erosion, accretion and inundation.

'coastal processes' means any action of natural forces on the coastal environment.

'coastal zone' includes the areas of water and land that may be influenced by coastal processes.

'erosion' refers to shoreline movement where the shoreline shifts landward reducing the width of a coastal foreshore reserve and/or the distance to a fixed feature on the adjoining land.

'horizontal shoreline datum (HSD)' defines the active limit of the shoreline under storm activity. It is the line from which a physical processes allowance will be applied from.

'inundation' means the flow of water onto previously dry land. It may either be permanent (for example due to sea level rise) or a temporary occurrence during a storm event.

'sediment cell framework' means the hierarchy of sediment cells along the Western Australian coast between the Moore River and Cape Naturaliste. The hierarchy includes primary, secondary and tertiary sediment cells.

'sediment cell' means a length of shoreline in which interruptions to the movement of sediment along beaches or near shore sea bed do not significantly affect beaches in the adjacent lengths of coastline. Within a sediment cell the sediments sources, transport pathways and sinks should be clearly definable.

Appendices

MU 01 Smiths Beach

	Acceptability Criteria			Feasibility Criteria			Financial Criteria				
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1		
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.										
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue		
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid												fatal flaw
Managed Retreat	2	2	2	1	1	1	1	1	1	12	39	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	1	1	2	2	1	11	35	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	2	2	2	2	1	3	2	1	1	16	51	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	1	1	2	2	1	11	35	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	2	3	3	2	2	4	2	1	2	21	63	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	1	1	2	2	1	11	35	

MU 02 Yallingup

	Acceptability Criteria			Feasibility Criteria			Financial Criteria				
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1		
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.										
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue		
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	1	1	2	1	1	1	1	2	1	11	33	
Accommodate										0	0	fatal flaw
Protect	1	2	2	1	3	2	3	3	1	18	56	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	3	2	2	2	3	3	3	2	2	22	69	
Accommodate										0	0	fatal flaw
Protect	1	2	2	1	3	2	3	3	1	18	56	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	3	2	2	2	3	3	3	2	2	22	69	
Accommodate										0	0	fatal flaw
Protect	1	3	2	1	4	2	4	4	1	22	70	

MU 03 Bunker Bay

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	1	1	1	1	1	1	1	1	1	9	28	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	2	1	2	1	1	11	36	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	2	2	1	2	2	2	2	1	1	15	50	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	2	1	2	2	1	12	38	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	2	2	3	2	3	3	3	1	2	21	66	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	2	1	2	3	1	13	40	

MU 04 Eagle Bay

	Acceptability Criteria			Feasibility Criteria			Financial Criteria				
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1		
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.										
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue		
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	1	2	1	2	1	1	1	1	1	11	37	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	1	1	2	2	1	11	35	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	2	3	2	2	3	3	3	1	2	21	67	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	1	1	2	3	1	12	37	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	3	3	3	2	3	4	4	1	3	26	81	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	1	1	2	3	1	12	37	

MU 05 Old Dunsborough

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	2	3	1	4	3	3	2	1	1	20	68	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	1	1	2	2	1	11	35	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	3	4	2	4	4	4	3	1	2	27	89	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	2	1	2	3	1	13	40	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	3	4	4	4	4	1	3	31	102	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	2	1	3	4	1	17	55	

MU 06 Dunsborough Townsite

	Acceptability Criteria			Feasibility Criteria			Financial Criteria				
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1		
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.										
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue		
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	3	3	2	3	4	4	2	2	1	24	76	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	1	2	2	2	1	13	39	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	3	3	3	4	4	3	3	3	30	92	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	2	2	2	3	1	15	44	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	3	3	3	4	4	4	3	4	32	98	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	2	2	2	4	1	16	46	

MU 07 Quindalup

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	2	3	3	3	3	3	1	1	1	20	64	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	2	1	2	2	1	13	41	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	3	2	2	31	101	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	2	1	3	3	1	16	53	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	4	2	3	33	107	
Accommodate										0	0	fatal flaw
Protect	1	1	3	2	3	2	4	3	1	20	65	

MU 08 Marybrook

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	2	2	2	2	1	2	1	1	1	14	45	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	1	2	2	2	1	14	44	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	2	4	4	4	4	3	1	1	27	90	
Accommodate										0	0	fatal flaw
Protect	1	1	3	2	1	2	3	3	1	17	54	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	2	4	4	4	4	3	1	1	27	90	
Accommodate										0	0	fatal flaw
Protect	1	1	3	2	1	2	3	3	1	17	54	

MU 09 Siesta Park

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	4	2	2	2	2	2	3	1	1	19	66	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	3	2	2	2	1	15	45	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	2	4	4	4	1	1	28	93	
Accommodate										0	0	fatal flaw
Protect	1	1	3	1	3	2	2	3	1	17	50	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	2	4	4	4	1	1	28	93	
Accommodate										0	0	fatal flaw
Protect	1	1	3	2	3	3	3	3	1	20	61	

MU 10 Locke Estate

	Acceptability Criteria			Feasibility Criteria			Financial Criteria				
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1		
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.										
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue		
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	1	2	2	2	2	2	1	1	1	14	44	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	1	2	1	2	1	12	34	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	3	4	4	4	4	4	3	1	1	28	94	
Accommodate										0	0	fatal flaw
Protect	1	1	3	1	1	2	2	2	1	14	42	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	3	4	4	4	4	4	3	1	1	28	94	
Accommodate										0	0	fatal flaw
Protect	1	1	3	2	1	2	3	3	1	17	54	

MU 11 Abbey

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	3	4	3	3	4	4	2	2	1	26	83	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	1	2	1	2	1	12	34	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	3	4	4	4	4	2	4	33	105	
Accommodate										0	0	fatal flaw
Protect	1	1	3	1	1	2	2	3	1	15	44	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	4	2	4	34	108	
Accommodate										0	0	fatal flaw
Protect	1	1	3	1	1	2	3	3	1	16	49	

MU 12 Broadwater

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	2	2	2	2	2	2	1	1	1	15	48	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	1	2	2	1	1	12	37	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	3	4	4	4	4	4	3	2	3	31	98	
Accommodate										0	0	fatal flaw
Protect	1	1	3	1	1	2	3	2	1	15	47	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	3	4	4	4	4	2	4	33	105	
Accommodate										0	0	fatal flaw
Protect	1	1	3	1	1	2	3	3	1	16	49	

MU 13 Busselton West (A)

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	3	3	2	3	3	3	2	2	1	22	72	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	1	2	2	2	1	13	39	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	3	3	4	3	3	2	3	29	93	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	2	2	2	3	1	15	44	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	4	2	4	34	108	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	3	3	3	4	1	19	55	

MU 14 Busselton West (B)

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	2	3	3	3	2	2	1	24	80	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	1	2	2	2	1	13	39	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	3	3	4	3	3	2	3	29	93	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	2	2	2	3	1	15	44	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	4	2	4	34	108	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	3	3	3	4	1	19	55	

MU 15 Busselton Central

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	3	4	4	3	2	2	30	96	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	1	2	1	2	1	12	34	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	4	2	3	33	107	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	2	2	2	3	1	15	44	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	4	2	4	34	108	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	3	3	3	4	1	19	55	

MU 16 Busselton East

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	3	3	2	2	3	3	2	1	1	20	65	
Accommodate										0	0	fatal flaw
Protect	1	1	1	1	1	2	2	1	1	11	34	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	3	2	3	4	4	4	2	3	29	92	
Accommodate										0	0	fatal flaw
Protect	1	1	2	1	1	2	3	2	1	14	44	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	3	4	4	4	4	4	2	4	33	104	
Accommodate										0	0	fatal flaw
Protect	1	1	3	1	1	2	3	3	1	16	49	

MU 17 Port Geographe

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	3	2	2	4	4	4	3	2	2	26	83	
Accommodate										0	0	fatal flaw
Protect	1	1	1	2	1	2	1	2	1	12	36	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	4	2	3	33	107	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	3	4	4	3	1	21	64	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	4	2	4	34	108	
Accommodate										0	0	fatal flaw
Protect	1	1	3	2	3	4	4	3	1	22	67	

MU 18 Wonnerup

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	3	3	2	3	3	3	3	1	2	23	76	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	1	2	2	2	1	14	44	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	3	1	3	31	100	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	1	3	3	2	1	16	50	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	4	4	4	4	4	4	3	2	3	32	102	
Accommodate										0	0	fatal flaw
Protect	1	1	3	2	1	4	4	3	1	20	61	

MU 19 Forrest Beach

	Acceptability Criteria			Feasibility Criteria			Financial Criteria					
Criteria weighting (1 – 5) *1 = least important* *5 = most important*	4	4	3	5	3	1	5	2	1			
	1. (is) – socially & environmentally acceptable, easily adaptable, long term effectiveness, low cost; 2. (may) - minor social & environment impacts, may be acceptable, partially adaptable, medium term effectiveness, acceptable cost; 3. (likely) – significant social & environmental impacts, difficult to adapt, limited or short term effectiveness, high cost; 4. (will) - unacceptable social & environmental impact, not adaptable, ineffective, cost prohibitive.											
Risk Management Option	Social Impact - Property & Infrastructure	Social Impact - Community use	Environmental Impact	Effectiveness in Risk Reduction	Practicability	Reversibility Adaptability	Cost Implementation	Ongoing Cost Maintenance	Ongoing Cost Lost Revenue			
	Social Impact (property & infrastructure) – loss or damage to private property or privately operated leasehold land, reticulated services, roads etc	Social Impact (community use) – ability to use a beach and foreshore/public recreational infrastructure (e.g. DUP)	Environmental Impact – possible damage or loss of the beach/foreshore, impact on coastal ecosystem (e.g. dune vegetation, seagrass, fauna habitat), wetlands, Aboriginal and European heritage	Effectiveness in risk reduction – how effective the option is at managing vulnerability and risk, how well tested the option is, how long the option may be effective	Practicability – can a risk management option actually be implemented (e.g. is it 'do-able'/workable/politically practicable?)	Reversibility / adaptability – can it be reversed or adapted	Cost (implementation) – cost to implement a specific risk management option (includes modifying/relocating/voluntary acquisition costs)	Ongoing cost (maintenance) – cost to keep maintaining a risk management option	Ongoing cost (lost revenue) – how much revenue (specifically rates) would be lost due to a risk management option	Total Score	Weighted Total Score	
2040												
Avoid										0	0	fatal flaw
Managed Retreat	2	1	2	1	2	1	2	1	1	13	43	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	2	1	3	2	1	15	51	
2070												
Avoid										0	0	fatal flaw
Managed Retreat	3	2	4	3	4	4	3	1	1	25	81	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	3	3	4	2	1	19	61	
2120												
Avoid										0	0	fatal flaw
Managed Retreat	3	2	4	3	4	4	3	1	1	25	81	
Accommodate										0	0	fatal flaw
Protect	1	1	2	2	3	4	4	2	1	20	62	

Where environment, lifestyle and opportunity meet!

City of Busselton
Geographe Bay

Join Our Community

T (08) 9781 0444
E city@busselton.wa.gov.au

2 Southern Drive Busselton
Western Australia

Locked Bag 1 Busselton WA 6280
www.busselton.wa.gov.au