TOWN OF COTTESLOE



ATTACHMENTS

COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN (CHRMAP) STEERING COMMITTEE – 27 NOVEMBER 2024

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COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN (CHRMAP) STEERING COMMITTEE

ATTACHMENT

ITEM 8.1.1A:
R01 ESTABISH THE CONTENT



Town of Cottesloe CHRMAP

Chapter Report: Establish the Context

Town of Cottesloe

18 January 2023







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EXECUTIVE SUMMARY

In the context of climate change and corresponding sea level rise, increased coastal inundation and erosion, the Western Australian Government introduced the Western Australian Planning Commission's State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is vulnerable to coastal hazards. Specific CHRMAP Guidelines have been developed to assist in this process (WAPC, 2019).

The aim of the present study is to investigate and plan for coastal hazards which are likely to affect Town of Cottesloe, which consists of various shoreline types and many coastal assets.

This CHRMAP project is expected to increase knowledge and understanding of coastal hazard risks and identify risk management and adaptation measures for implementation. The outcomes will be used to inform local government policies, strategies and plans, including (but not limited to); planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans. The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with the objectives identified by these guidelines and SPP2.6. The project will identify the strategic direction for coastal adaptation scenarios from the present to 2122 (100-year management time frame) and identify an implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway for the region and serve as a key reference for management, planning and policy making for the short-term (0-25 years), medium-term (25-50 years), and long-term (100 years).

This report presents the Stage 1 - Establish the Context Chapter Report, which outlines the key management and adaptation issues that need to be considered in the CHRMAP. The flow chart displayed in Figure 1-4 indicates where this component sits with reference to the greater study; the Establish the Context stage has the following sections— Purpose, objectives, scope, study area, community and stakeholder engagement, values, existing controls and success criteria.

Section 7 presents a summary of the relevant planning framework for the Town of Cottesloe and the key considerations for the CHRMAP. Presently there are Town-wide coastal hazard controls in place in the study area. For context, available planning controls for addressing coastal hazards within the study area are presented in Table 7-2, together with their advantages and disadvantages.

Physical controls for the study area are summarised in Section 7.2.

During Stage 1, a Community and Stakeholder Engagement Plan was developed in order to identify relevant stakeholders and determine the structure and pathways for their engagement throughout the CHRMAP process. The objective of the engagement process is to facilitate an understanding of coastal challenges, hazards and risks, and to select appropriate adaptation strategies to respond to the risks. The activities undertaken during this stage were: Targeted Stakeholder Conversations, Aboriginal Engagement Session, Pop-up Information Sessions, Coastal Values Survey. A summary of the engagement findings to date is presented in Section 6.

The coastal values collated from the engagement to date have been used to generate the success criteria for the vulnerability and risk assessment component of the CHRMAP. These will be key to the whole CHRMAP as it is these that will ultimately drive the selection of adaptation options. The success criteria are defined in Section 8. These criteria will be revised during the course of the CHRMAP to ensure the final document reflects all stakeholder views. The current success criteria are listed below:

- Preserve and protect the Town's beaches and natural assets such as vegetation and dunes.
- Ensure the natural environment is protected and sustained in its current condition or an improved condition.

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- Maintaining the natural state of any undeveloped areas is important.
- Preserve and consider the cultural significance of Mudurup Rocks.
- Preserve the function and opportunity for all types of water-based activities, particularly those that help to improve the health and well-being of people.
- Preserve and accommodate the existing surf lifesaving clubs as these facilities were seen as a hub of water and land-based activities that also helped to improve social connection and mental wellbeing.
- Continue to provide public amenities at the coast, such as parks, restrooms parking and access paths.
- Ensure that areas for community events and access to remain within the coastline. Provide and maintain spaces and infrastructure for community events, arts and entertainment.
- Minimise impacts on existing private property.
- Consider treatments for coastal areas that have current inundation and erosion issues. Preserve the current uses of the beach areas.
- Develop solutions to coastal processes that are sustainable (financially, socially and built form) and locally responsive.
- Revisit regularly with community and key stakeholders their values in relation to development adjacent the foreshore.

The next report will cover Stage 2 - Risk identification where the following tasks will be conducted and presented:

- Hazard Assessment to identify erosion and inundation hazard extents for various planning timeframes (up
 to and including 100 years from time of assessment).
- Identification of coastal assets both man-made and natural (social, economic, environment), public and private impacted by coastal hazards at each project planning timeframe.

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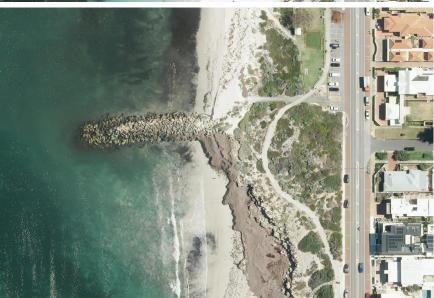


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1 INTRODUCTION

It is internationally recognised that the mean sea level has been rising globally since the nineteenth century and is predicted to rise at an increasing rate in the future (IPCC, 2021). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary coastal flooding), storm erosion and long-term shoreline recession. State governments across Australia have introduced obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is vulnerable to coastal hazards. Specific CHRMAP Guidelines have been developed to assist in this process (WAPC, 2019).

One of the key objectives of SPP2.6 is to establish coastal foreshore reserves which include allowances for the protection, conservation and enhancement of coastal values across the state. Risk assessment processes are then utilised to identify risks that are intolerable to the community, and other stakeholders such as local governments, indigenous and cultural interests, and private enterprise. Adaptation measures are then developed according to the preferential adaptation hierarchy outlined in SPP2.6.

The study area for this CHRMAP is the entire shoreline within the Town's jurisdiction (see Figure 1-1). Zoomed in images of the study area is shown in Figure 1-2 and Figure 1-3 for North and South areas respectively. The study area consists of various shoreline types and many coastal assets, involving multiple stakeholders:

- Physical controls rubble mound rock groynes at Beach Street and Cottesloe Beach; seawalls at Cottesloe Beach
- Sandy pocket and "perched" beaches backed and underlain by rock shelves and adjacent narrow foreshore reserve:
- Presence of various rock features including shore-attached reef and rock outcrops and cliffs
- Roads along the shoreline Curtin Avenue and Marine Parade;
- Two Surf Life Saving Clubs
- Registered Aboriginal Heritage Site at Mudurup Rocks, south of the Cottesloe Surf Club
- Significant built infrastructure buildings, car parks, shore-parallel dual use path, utilities, playgrounds
- Large number of foreshore amenities such as showers, fencing, information signage, access paths and stairways.
- Highly valued recreational assets beach and ocean areas used heavily by locals and visitors for a large number of different pursuits.

This CHRMAP project is expected to increase knowledge and understanding of coastal hazard risks and identify risk management and adaptation measures for implementation. The outcomes will be used to inform local government policies, strategies and plans, including (but not limited to); planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans. The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with the objectives identified by these guidelines and SPP2.6. The project will identify the strategic direction for coastal adaptation scenarios from the present to 2122 (100-year management time frame) and detail an implementation plan describing risk management measures to be undertaken to achieve preferred risk treatments. Overall, this CHRMAP will develop a flexible adaptation pathway for the Town of Cottesloe and serve as a key reference for management, planning and policy making for the short-term (0-25 years), medium-term (25-50 years), and long-term (50-100 years).

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This report presents the Establish the Context Chapter Report, which outlines the key management and adaptation issues that need to be considered in the CHRMAP. The flow chart displayed in Figure 1-4 indicates where this component sits with reference to the greater study; the 'Establishing the Context' phase is the top bubble shaded in red.

Delivery of this project will occur over 8 stages (as summarised in Figure 1-4), each of which represents a key hold point. The staged approached is developed according to the Town of Cottesloe's scope and is in line with CHRMAP Guidelines (WAPC, 2019).

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Figure 1-1 Study Area

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Figure 1-2 Study Area - North



Figure 1-3 Study Area - South

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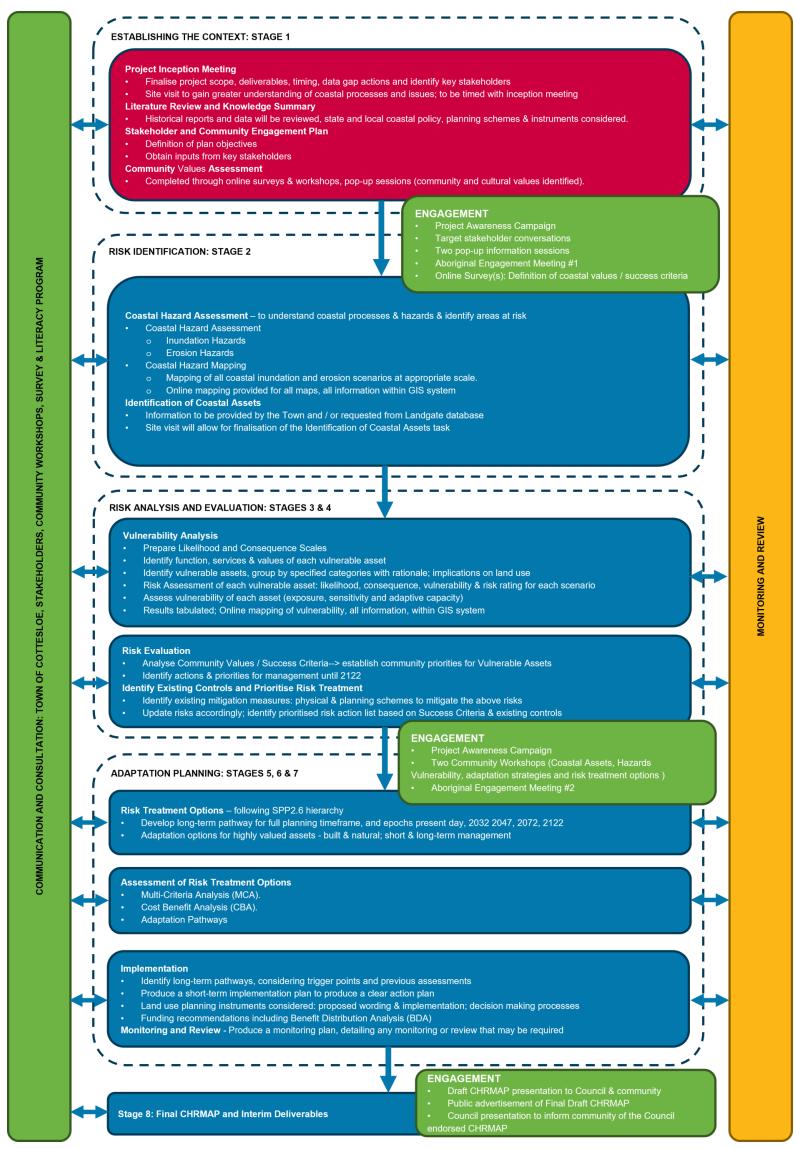


Figure 1-4 CHRMAP Methodology

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2 PURPOSE

The purpose of this project is to prepare a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for Town of Cottesloe.

The CHRMAP will set the framework for the assessment, by identifying coastal hazards, analysing vulnerability for specific assets, identifying and prioritising management and adaptation responses, and providing an implementation plan. It will also inform the community and stakeholders about potential coastal hazard risks; identify community and stakeholders' values as well as key coastal infrastructure and assets at risk; and provide a clear pathway for Town of Cottesloe to address coastal hazard risks over time. Ultimately, the CHRMAP will provide strategic guidance for coordinated, integrated and sustainable land use planning and management decision-making by the Town of Cottesloe. The CHRMAP will also guide necessary changes to the Town of Cottesloe Local Planning Strategy, Local Planning Scheme and other relevant strategies and local planning policies.

The CHRMAP will be prepared in accordance with the CHRMAP Guidelines and State Planning Policy 2.6 – State Coastal Planning Policy (SPP2.6).

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3 OBJECTIVES

The project objectives will be achieved by the production of a CHRMAP for the study area in accordance with the CHRMAP Guidelines and SPP2.6, which is adopted by the Town of Cottesloe and used to guide future decision making for vulnerable assets in its coastal zone.

The objectives of this CHRMAP are to:

- Improve understanding of coastal features, processes and hazards in the study area
- Identify significant vulnerability trigger points and respective timeframes for the relevant sediment cells to mark the need for immediate or medium-term risk management measures
- Identify assets (natural and built) and the services and functions they provide situated in the coastal zone
- Gain an understanding of asset(s)' vulnerability
- Identify the value of the assets that are vulnerable to adverse impacts from coastal hazards
- Determine the consequence and likelihood of coastal hazards on the assets, and assign a level of risk
- Identify possible (effective) risk management measures (or 'actions') and how these can be incorporated into short and longer-term decision-making
- Engage stakeholders and the community in the planning and decision-making process.

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4 SCOPE

The Town of Cottesloe CHRMAP is specifically being formulated to identify risks that are identified as intolerable by the community and stakeholders, and ensure risk management measures are formulated to reduce these risks down to acceptable or tolerable levels. In this regard the CHRMAP will provide strategic guidance on medium to long-term risk management strategies, with a focus on short-term risk management measures (<25 years).

The Scope is divided in 8 stages as per CHRMAP Guidelines (WAPC, 2019), refer to Figure 1-4:

- (i) Establish the Context: Outlines the framework within which the CHRMAP shall be undertaken. It enables stakeholders to start from a common understanding of the exercise, and how to approach the analysis.
- (ii) Risk Identification: Coastal hazard identification establishes an understanding of potential impacts of erosion and storm surge inundation on the assets, and their values, including from coastal physical processes and sea level rise.
- (iii) Vulnerability Assessment: Identifies how the effects of coastal hazards are likely to impact on assets within the coastal zone. It defines the degree to which an asset is susceptible to, and unable to cope with, the adverse effects of coastal hazards.
- (iv) Risk Evaluation: Aims to prioritise risk management measures. It is an important part of the process as it may not be possible or necessary to treat every risk.
- (v) Risk Treatment: Risk treatment options should be described and assessed including both a multicriteria analysis and cost benefit analysis to assist with identifying risk treatment options that provide the greatest benefit (relative to cost and other key criteria) in treating the highest priority risks
- (vi) Implementation: details risk management measures to be undertaken to achieve selected risk treatment option(s) like land use planning instruments and funding.
- (vii) Monitoring and Review: Regular monitoring and review will ensure that the risk management measures identified and established remain relevant.
- (viii) Final CHRMAP: ensures the Steering Committee reviewed and approved the final document to be released to the public.

This report is the first stage entitled "Establish the Context" and its specific sections are presented below.

As per CHRMAP Guidelines (WAPC, 2019) the Stage 1 report presents:

- Purpose
- Objectives
- Scope
- Study area
- Community and Stakeholder engagement
- Community and Stakeholder coastal values (social, environmental, infrastructure, and economic)
- Existing controls
- Success criteria

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5 STUDY AREA

The Town of Cottesloe's coastline spans approximately 4km from North Street to Vlamingh Memorial in the south and includes the iconic Cottesloe Beach and popular swim spot, Grant Street Beach. The Town's coastline is visited by residents and visitors alike, with beaches in the north popular for swimming and sunbathing, while the southern portion of the coastline is frequented by board riders and dogwalkers.

The adjacent foreshore reserves support a variety of recreational and commercial land uses, including substantial built infrastructure situated in close proximity to the shoreline. Such infrastructure includes the Cottesloe and North Cottesloe Life Saving Clubs (SLC), Indiana Teahouse, restaurants and cafes, playgrounds, footpaths and several carparks, which may be subject to the impacts of coastal hazards at present or into the future.

5.1 Site Description

5.1.1 Segment 1: North Street to Eric Street

Segment 1 extends from the Town's northern boundary at North Street to Eric Street and is classified as a mixed sandy and rocky coastline. The section of coast consists of perched beaches backed by remnant sand dunes. Winter storms often wash away sand at Grant Street Beach, exposing rocky platforms, at, and above MSL (see Figure 5-1). Sand generally reaccumulates during spring, burying most of the rock by the summer months. The remainder of the segment's rock remains largely buried year-round. The southern boundary of the segment was defined due to a change in land use south of Eric Street, changing from a largely residential area (with the exceptions of North Cottesloe SLC and adjoining restaurant and cafe) to a more developed stretch of coastline.



Figure 5-1 Portion of the coastline looking north from North Cottesloe SLC, exposed rock can be seen in the top of frame, captured in August 2017

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5.1.2 Segment 2: Eric Street to Mudurup Rocks

Segment 2 extends from Eric Street to Mudurup Rocks, a mixed sandy and rocky coastline which includes the iconic Cottesloe Beach. The segment consists of perched beaches which remain largely sand covered year-round. The section of beach adjacent to Overton Gardens is an exception to this, with rock platforms often becoming exposed during winter. Cottesloe Groyne is located at Mudurup Rocks, the southern boundary of the segment. Built in 1960, the groyne was constructed to trap the southwards transport of sediment during winter, preventing rock being exposed, and in turn, increasing the amenity and popularity of the beach.

The segment includes a number of commercial and residential developments along Marine Parade as well as the Indiana Teahouse, carpark and Cottesloe SLC which lie seaside of Marine Parade. A concrete seawall exists between Forrest Street and Warnham Road, running in front of the Indiana Teahouse and southern half of the main carpark. Winter storms coinciding with high water levels have resulted in wave action occasionally impacting the seawall in front of the Teahouse (see Figure 5-2).



Figure 5-2 Portion of the coastline looking south from Cottesloe Main carpark, waves can be seen impacting the southern section of the seawall, captured in May 2018

5.1.3 Segment 3: Mudurup Rocks to Beach Street Groyne

Segment 3 extends from Mudurup Rocks to the Beach Street Groyne (see Figure 5-3) and is comprised of calcarenite cliffs fronted by an intertidal rock platform which anchors the beach to its south. The segment is bound by the Beach Street and Cottesloe Groynes which interrupt sediment transport regimes and are likely the cause for the thin beach along this stretch of coastline. Exposed rock above MSL is present year-round immediately south of Mudurup Rocks. During the winter months the area exposed extends over 200 m southward. Several nearshore reefs result in a reduction of wave energy, providing a level of protection for this

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section of the Town's coastline. The calcarenite cliffs are backed by a thin foreshore reserve, Marine Parade, residential properties and Sea View Golf Club.



Figure 5-3 A portion of shoreline to the north of Beach Street Groyne captured in May 2022, Mudurup rocks and Cottesloe Groyne can be seen in the distance

5.1.4 Segment 4: Beach Street Groyne to Vlamingh Memorial

Segment 4 extends from the Beach Street Groyne to Vlamingh Memorial, the southern boundary of the study area. The segment is a mixed sandy and rocky coastline (see Figure 5-4). Geotechnical survey (GPG Maps, 2010) shows rock at, or above MSL for most of this segment of coastline with rocky outcrops visible immediately south of the Beach Street Groyne and adjacent to the Vlamingh Memorial. Natural and artificial (Cables Station) nearshore reefs reduce the wave energy impacting the shoreline. Segment 4 is backed by a steep dune system, Marine Parade and residential properties.

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Figure 5-4 A portion of shoreline to the north of Vlamingh memorial captured in May 2022, Beach Street Groyne can be seen in the distance

5.2 Coastal Processes

5.2.1 Geomorphology and Bathymetry

The study area has a mixed sandy and rocky coastline, consisting of limestone platforms overlain by a mix of calcium carbonate sands and eroded limestone (Damara & CZM 2008). The stable component of the Town's geomorphology is Tamala Limestone which underlies and backs the beaches and also forms headlands and offshore reefs (Cardno 2017). In 2010 and 2011, the Town commissioned GPG Maps to undertake geotechnical surveys to address the key knowledge gap in understanding the Study Area's local geology. Based on testing of a longshore segment between Curtin Avenue and North Street, the depth between ground level and bedrock ranged between approximately 5 metres and greater than 10 metres. Between just south of Curtin Avenue and Gibney Street this bedrock was mainly at or above mean sea level (MSL). Other sections of the survey showed that bedrock was below MSL, by greater than 2 metres in places.

The Town's coastline is predominantly classified as a 'mixed sandy and rocky coastline' according to the coastal classifications defined in SPP2.6 Schedule One (WAPC, 2013). Much of the Town's coastline comprises rock platforms overlain by a sandy beach backed by remnant sand dunes. Nearshore reefs are present along much of the coastline and exposed rock is present above MSL in sections, particularly during the winter months.

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The Town's coastline has been divided into four segments for further shoreline description and classification in the following sub-sections. The segments have been defined at this stage by considering natural and manmade shoreline features, such as presence of exposed rock or nearshore reefs, Cottesloe and Beach Street groynes as well as land use type.

5.2.2 Wind

Located on the Perth coastline, the Town experiences typical oceanographic conditions of the area, dominated by two distinct seasonal weather patterns. The summer months are characterised by consistent and moderate to strong south-westerly sea breezes which develop in the afternoon. The winter months are characterised by intermittent storms attributed to mid latitude low pressure systems, shifting the dominant wind direction to north-westerly, sometimes exceeding 20 m/s.

5.2.3 Water Levels

Like the rest of the Perth coast, the Town experiences a low tidal range from mixed but mainly diurnal tides. The tidal range varies from 0.3 m during neap tides to 0.7 m during springs. This small tidal movement allows wind to be the major driver of currents, particularly within the nearshore zone. Longshore currents correspond to seasonal wind and wave conditions, predominantly propagating northward during summer and to the south during winter. The interaction of these currents with shoreline features can form local eddy and rip currents, particularly when swell is present, driving substantial water movement perpendicular to the shore. The present-day astronomical tidal planes at Fremantle have been included in Table 5-1. The full tidal range between LAT and HAT is quite small at 1.1 m.

Table 5-1 Fremantle tide level (DoT, 2017)

Tidal Water Levels	m AHD	m CD
Highest Astronomical Tide (HAT)	0.63	1.40
Mean High Water Spring (MHWS)	0.38	1.15
Mean High Water Neap (MHWN)	0.27	1.04
Mean Sea Level (MSL)	0.00	0.81
Mean Low Water Neap (MLWN)	-0.20	0.57
Mean Low Water Spring (MLWS)	-0.30	0.47
Lowest Astronomical Tide (LAT)	-0.51	0.26

5.2.3.1 Sea Level Rise

Globally, MSL has risen since the nineteenth century and is predicted to continue to rise, at an increasing rate, through the twenty first century (Intergovernmental Panel on Climate Change [IPCC], 2021). Changes to MSL over the past century have been observed along the WA coastline and are predicted to continue, including for the study area (CSIRO and BoM, 2015). Sea Level Change in Western Australia – Application to Coastal Planning (Department of Transport [DoT], 2010) reviewed information relating to SLR at a local scale and recommended an allowance for SLR be adopted for planning purposes. Recommendations were based on the upper bound of the global average SLR projections from IPCC's Fourth Assessment Report [AR4] (IPCC, 2007). In the intervening years, following release of the DoT document, advances in climate change science have been reflected in revisions to SLR projections, such as those documented in IPCC's Sixth Assessment Report [AR6] (IPCC, 2021). Current guidance on global SLR projections is derived from Shared Socioeconomic Pathways (SSP), characterising the trajectory of global society, demographics and economics

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over the coming century. Analogous to that used in DoT's (2010) recommendation is SSP5, which forecasts a SLR of 0.94m between 2020 and 2120 (see Figure 5-5).

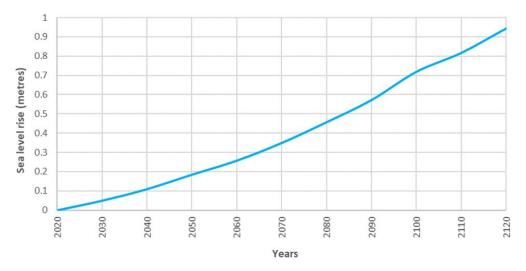


Figure 5-5 Sea level rise allowance for planning in Western Australia (adapted from DoT, 2009 and IPCC, 2021)

5.2.4 Wave Climate

The wave climate in the Town is seasonal, with on average, higher wave energy during the winter months of May to October. Analysis of offshore waverider buoy data indicated the annual wave energy peak occurs between June and September (Damara & CZM 2008).

The two seasonal weather modes described in Section 5.2.2 dominate the local wave climate with locally generated seas from the south, south-west interrupting generally calm conditions during summer. Storms during winter lead to higher energy wave conditions and a greater presence of offshore derived swell, which generally propagates from the southwest, but can also approach from the northwest. Tropical cyclones that develop during the summer months off WA's north-west coast rarely track down to the study area's latitude, however, have been recorded in the area and can cause significant damage to coastal infrastructure.

The study area is afforded protection from offshore wave conditions by Rottnest Island to the west and fringing limestone reef structures scattered adjacent to the coastline. Cottesloe groyne can provide local sheltering from inshore waves, depending on the wave-direction, which varies throughout the year (refer to Figure 7-2 and Figure 7-3).

5.2.5 Sediment Transport

Sediment cells are areas along the coastline which are likely to be connected through processes of sediment exchange. Stul et al. (2015) mapped sediment cell boundaries at three spatiotemporal scales along the Western Australian coastline between Cape Naturaliste and Moore River. The three scales are listed below and depicted for the area relevant to the Town in Figure 5-6.

Primary cells are related to large landforms or land systems over longer coastal management timescales
of more than 50 years. The study area falls in primary cell R06F which spans from the engineered section
of the coast at Fremantle to Pinnaroo Point;

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 Secondary cells incorporate contemporary sediment movement on the shoreface and potential landform responses to inter-decadal changes in coastal processes. The study area is spread across cells 25 and 26. Cell 25 spans from South Mole Fremantle to Mudurup Rocks, cell 26 from Mudurup Rocks to Trigg; and

Tertiary cells are defined by the reworking and movement of sediment in the nearshore and are the most relevant for seasonal to inter-annual changes to the beachface. The study area is spread across cells 25b and 26a. Cell 25b spans from Leighton Salient to Mudurup Rocks, cell 26a from Mudurup Rocks to North Swanbourne pipe.

Longshore sediment transport within the study area has been shown to be mainly northward from September to April, associated with prevailing currents over the summer period. A southward movement of sediment is usually observed during the winter months of June and July. The result is a net northward movement of material annually (CZM & Damara 2008). Nearshore structures can obstruct this sediment movement. The most notable example of this is the Cottesloe groyne, which exhibits accretion of sediment at its northern side in winter and alternatively erosion at the same site during summer.

Cross-shore sediment movement is also seasonal, with sporadic periods of swell pushing sediment onto the shore, steepening the beach profile. Mid-year, the beach is reformed by the energy of winter storms eroding the beach face and redepositing sediment to form sandbars just offshore. These formations become stable towards the end of winter and act as a buffer, preventing wave breaking at the shore and the substantial shifting of sediment that can cause long-shore transportation and further erosion towards the spring and summer.

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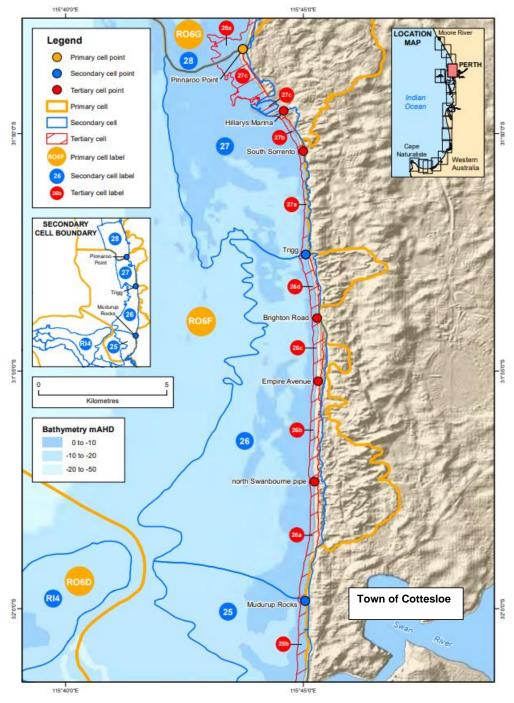


Figure 5-6 Sediment cells relevant to the Study Area (Figure A.15 from Stul et al, 2015)

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6 COMMUNITY AND STAKEHOLDER ENGAGEMENT

Key to the success of the CHRMAP project will be to ensure that the adaptation plan is underpinned by community and stakeholder values and knowledge. To this end, a Community and Stakeholder Engagement Plan has been developed in order to identify relevant stakeholders and determine the structure and pathways for their engagement throughout the CHRMAP process. The plan is intended to be fit-for-purpose, and commensurate with the size and scope of the CHRMAP – so as to avoid consultation fatigue within the community.

Supporting the overall project objectives, the engagement objectives are to:

- Promote knowledge and information sharing to and from community and key stakeholders to support the collection of coastal values, assets and preferred adaptation options, including the planning framework requirements for beneficiaries pays requirements.
 - The benefit distribution analysis will assist in educating the community on the beneficiaries pays principle, as it will define the apportioning of costs for chosen risk management measures.
- Break down complicated and technical information to be easy to understand.
- Aim to reach a diverse range of community members and key stakeholders through various methods.
- Offer accessible and convenient engagement activities for the community and stakeholders to attend.
- Keep the community interested and engaged throughout the project timeline with carefully timed communications and engagement events.

Table 6-1 summarises the engagement tools used to date; more detail is provided in the Interim Engagement Outcomes Report (refer Appendix B).

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Table 6-1 Summary of engagement activities

Activity	Timeline	Participants	Key Finding
Targeted Stakeholder Conversations	2022	6	The importance of the environment in its natural state was a theme, and the ability to use the area to recreate was highly valued. Clubs with members particularly valued social aspects since members use the area as a connection, enhancing health and wellbeing. Iconic nature, heritage, cultural features were identified as values for the area. Erosion is identified as a concern, since beach sand is important, for recreational use, 'Sculptures by the Sea', surf clubs.
Aboriginal Engagement Session	14 September 2022	4 cultural representatives	Mudurup Rocks were seen as a very important historical, heritage, cultural site to local Aboriginal people, a place where ceremonies are held. It was felt rock area should not be interfered with.
Pop-up Information Session	17 September 2022, 21 September 2022	68	Information sessions included displays about the project and affected areas, people viewed the information and chatted to the project team to gather more information about the project.
Coastal Values Survey	1 September 2022 to 16 October 2022	131	Most appreciated the natural assets associated with the beach. Important places within the coastline are identified as Main Beach, North Cottesloe Beach, coastal paths, Cottesloe Groyne, dining out venues, cafes, Grant Street Beach. North beach zone identified as more active compared to south zone. Walking and swimming, being in nature were the most valued activities, and were valued as either very important or important for health and wellbeing. Sand erosion exposing rocks were identified as concerns.

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7 EXISTING CONTROLS

7.1 Existing Planning Controls

Planning in Western Australia is guided and regulated by the State Planning Framework, which includes strategic and statutory planning functions set out in the Planning and Development Act 2005. The planning system is hierarchical, requiring increasing levels of detail as a proposal progresses through the state and local planning systems, including subdivision and development of individual sites. The relationships of the various policies are presented in Figure 7-1.

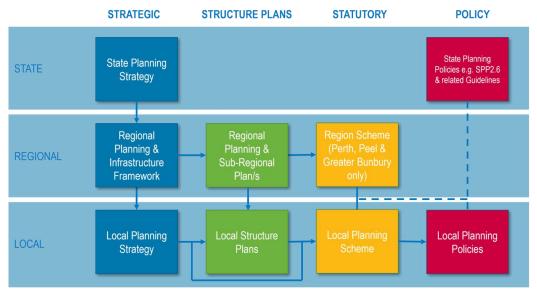


Figure 7-1 State Planning Framework for Western Australia

This section reviews the planning documents within this Framework which are relevant to coastal hazard planning in the project area; additional information is provided in Appendix A. This review will help to: assess the adequacy of the existing planning documents for addressing coastal hazards; identify gaps that need to be addressed through the CHRMAP process (such as planning controls that are required or need amending to enable implementation of CHRMAP recommendations); identify any potential planning issues that may constrain the CHRMAP process; and ensure that the adaptation plan aligns with state, regional and local planning frameworks.

A summary of information from the planning documents relevant to the coast is included in Table 7-1 below and in Appendix A. This will all be considered as part of the vulnerability / risk assessment and development of adaptation options for the CHRMAP, with appropriate text included in the relevant planning documents as required. The implementation plan will identify these adaptation measures and include proposed wording, implementation methods/process and supporting information.

Presently there are Town-wide coastal hazard controls in place in the study area. For context, available planning controls adjustments for addressing coastal hazards within the Town are presented in Table 7-2. together with their advantages and disadvantages. These will be discussed in more detail in later stages of the project.

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Table 7-1 Summary of relevant planning framework

Framework function	Document	Purpose
Relevant Planning Legislation	Planning and Development (Local Planning Schemes) Regulations 2015	Regulations introduced by the State government to ensure a consistent structure, format and approach to local planning schemes and planning mechanisms across the state of Western Australia.
State Planning Framework	WA Coastal Zone Strategy	Integrated framework for collective action to manage and adapt to threats and pressures along the coast. The fundamental aim of this strategy is to ensure that coastal development is sustainable in the long term and meets community, economic, environmental and cultural needs.
State Planning Framework	State Planning Policy 2.6: State Coastal Planning and Guidelines	Guides decision making in relation to planning along the state's coastline and stipulates the requirement for the preparation of this CHRMAP.
State Planning Framework	Coastal hazard risk management and adaptation planning guidelines	Guide for decision-makers to develop and implement effective coastal hazard risk management and adaptation plans.
State Planning Framework	State Planning Policy 3.4: Natural Hazards and Disasters	Guide to ensure that land use planning appropriately considers the risk of natural hazards and disasters.
State Planning Framework	Metropolitan Region Scheme	Defines the future use of land through zones and reservations.
State Planning Framework	Perth and Peel @3.5 million and Sub-Regional Planning Framework	Framework to deliver four sub-regional strategies to guide future growth and development across Perth and Peel metropolitan area through to the year 2050. The framework identifies the need to adapt to the impacts of climate change with the impacts of rising sea levels.
Local Planning Framework	Town of Cottesloe Local Planning Strategy	Local Planning Strategy sets out the long-term planning directions of the Town over a 10 to 15 year timeframe. Considering the outcomes of CHRMAP, Local Planning Strategy should include a provision for all SPP 2.6 requirements to be met at the earliest stage possible.
Local Planning Framework	Town of Cottesloe Local Planning Scheme No.3 (LPS 3)	The principal statutory planning document which applies land use and development controls within the Town at a local level.
Local Planning Framework	Local Planning Policy No.2 – Wearne Redevelopment, Lot 87 (8) Warton Street, Cottesloe (LPP2)	Relates to a site located adjacent to the foreshore reserve. The setback provisions contained within LPP2 could be amended to respond to coastal hazards, as identified in the CHRMAP. However, will have limited effectiveness in response to the hazards identified in the CHRMAP given it only applies to a single site which is currently being developed. There are more effective planning mechanisms that will be considered in the CHRMAP.
Local Planning Framework	Restricted Foreshore Centre Zone Design Guidelines for Setbacks	Zone contains sites adjacent the foreshore reserve. The setback provisions could be amended to respond to coastal hazards, as identified in the CHRMAP. However, effectiveness is considered limited given the relatively small number of sites within the Zone. There are more effective planning mechanisms that will be considered in the CHRMAP.
Local Planning Framework	Cottesloe Foreshore Masterplan	The Cottesloe Foreshore Masterplan comprises of land zoned 'Parks and Recreation' and 'Urban' under the MRS. As such, the Town's local planning framework has limited application over the use and development of MRS zoned land. The CHRMAP will build on the previous coastal studies undertaken as part of the Cottesloe Foreshore Masterplan, including hazard issues, asset identification and recommendations. However, the Cottesloe Foreshore Masterplan will not be relied upon as a planning mechanism to responds to coastal hazards given it has no statutory weight from a local planning perspective.
		Future works within the foreshore reserve as identified in the Cottesloe Foreshore Masterplan shall have due regard to the outcomes of the CHRMAP.

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Table 7-2 Possible planning controls for the Town

Statutory Measure	Advantages	Disadvantages
Structure Plan / Activity Centre Plan	Can address location specific issues i.e. identification of foreshore physical setbacks and areas affected by erosion and inundation.	 Does not have the force and effect of the local planning scheme. Decision makers to have due regard only. Structure Plan cannot specify / enforce built form requirements. Location specific only and therefore cannot address hazard issues on a broad scale. Generally, requires the land to be appropriately zoned to require the preparation of a structure plan.
Local Development Plan	 Can specify built form requirements to address location specific hazard issues i.e. increased setbacks, minimum habitable floor levels, etc. Has statutory weight of the local planning scheme. Can vary 'deemed-to-comply' development requirements. 	Location specific only and therefore cannot address hazard issues on a broad scale.
Local Planning Policies and Design Guidelines	 Can address hazards and risk issues at a district (broad) level and/or at a location specific level. Can include mapping of hazard issues with flexibility to update Mapping as and when amendments are required to be undertaken. Can vary 'deemed-to-comply' development requirements. Can be amended relatively quickly (compared to local planning scheme amendment). 	Is only a 'due regard' document and does not have the full force and effect as provisions contained in a local planning scheme.
Special Control Area (SCA)	 SCAs may establish specific provisions to address a specific issue such as erosion and inundation. SCAs can broadly address unique issues that extend across multiple zones and/ or reserves. SCAs can be used to require development approval for otherwise normally 'exempted' development. In this regard, SCAs are the preferred mechanism to identify where and what type of development requires development approval to allow for appropriate consideration of the risk of erosion and inundation. 	 A scheme amendment would potentially need to be progressed every time mapping of the coastal issue is amended and/or updated. This may be avoided if the Special Control Area refers to a separate Local Planning Policy which may contain reference of mapping of hazards.
General Development Provisions of LPS3	 Can establish provisions which broadly address hazard issues. Can introduce provisions which relate to a local planning policy addressing hazard issues and which may contain hazard mapping. 	Given the specific nature of erosion and inundation issues, including the varied locational extent to which it may affect land within a district, specific development requirements would more appropriately be established within a SCA as opposed to general provisions within a local planning scheme.
Supplemental Provisions to Schedule 1 and 2 of the Regulations	May be used to supplement the standard scheme provisions set out in Schedule 1 and 2 of the Regulations to address specific hazard issues.	Given the specific nature of erosion and inundation issues, including the varied locational extent to which it may affect land within a district, specific development requirements would more appropriately be established within a SCA as opposed to supplemental provisions of a local planning scheme.

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7.2 Existing Physical Controls

Existing controls should be identified while establishing the CHRMAP context, as recommended in the CHRMAP Guidelines (WAPC, 2019). In the context of coastal processes, controls are physical and include structures that currently interact, or have the potential to interact in the future, with oceanographic conditions and coastal processes. Such structures include seawalls, groynes and breakwaters. Controls also include ongoing management/intervention activities, such as beach nourishment, dredging and sand by-passing. The existing physical controls identified for the study area are outlined in Table 7-3 below. It should be noted that the downstream effects of the nourishment at Port Beach are yet to be determined nor is it known if the nourishment program will continue into the future.

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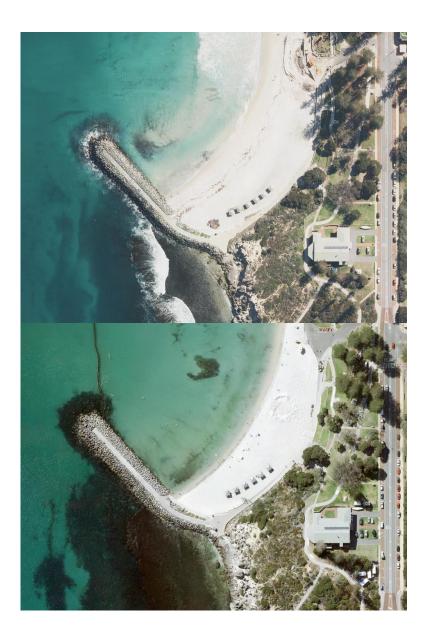


Figure 7-2 Cottesloe Groyne – October 2020 (top) and March 2021 (bottom) (Metromap)

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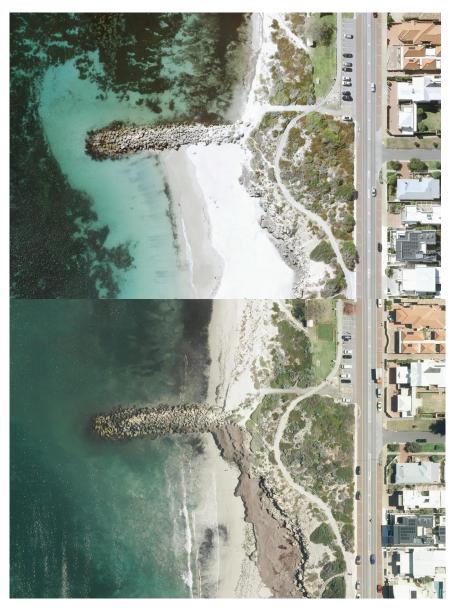


Figure 7-3 Beach Street Rock Groyne – March 2021 (top) and November 2021 (bottom) (Metromap)

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Table 7-3 Summary of existing physical controls in the study area

Control	Location	Purpose	Year Implemented	Assumed design life/management timeframe
		'Hard 'engineering contro	ls	
Cottesloe Groyne at Mudurup Rocks (Figure 7-2)	Mudulup rocks, 100 m south of Forrest Street	Interrupt southwards transport of sediment during winter storms to maintain a sandy beach	1960s (refurbished 2007)	50 years
Beach Street Groyne (Figure 7-3)	Adjacent to Beach Street	Stabilisation of adjacent beaches	1960s	40 years
Cottesloe concrete seawall	Between Forest St and Warnham Rd	Protection for development at Cottesloe Beach including Indiana Teahouse and carpark	1930	50 years
Cables Artificial Surf Reef	Offshore of Cable Station Beach	Improve surf conditions	1999	50 years
'Soft' management controls				

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Control	Location	Purpose	Year Implemented	Assumed design life/management timeframe
Nourishment at Port Beach (City of Fremantle)	Approximatel y 2 km south of Town of Cottesloe	To replenish the beach at Port Beach, protecting assets and preserving sandy beach. Nourishment may shift north into the Town.	2022	TBD

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8 SUCCESS CRITERIA

The values collated from the engagement to date have been used to generate preliminary success criteria for the risk assessment component of the CHRMAP. These will be key to the whole CHRMAP as it is these that will ultimately drive the selection of adaptation options. It is important that a comprehensive approach be applied at this stage of the project, in order to provide a CHRMAP applicable to the Town and stakeholders.

The 'success' of the CHRMAP will be determined by the assets identified through the CHRMAP process continuing to provide their present function, services and values (or an accepted version of it as determined by community and stakeholders).

Therefore, the success criteria will be determined by the values collected in this part of the engagement process. The preliminary success criteria are outlined in Table 8-1 below and will be updated as the engagement progresses; particularly after the community workshops in Stage 5 of the CHRMAP.

Table 8-1 Preliminary success criteria

- Preserve and protect the Town's beaches and natural assets such as vegetation and dunes.
- Ensure the natural environment is protected and sustained in its current condition or an improved condition.
 - o Maintaining the natural state of any underdeveloped areas is important.
 - o Preserve and consider the cultural significance of Mudurup Rocks.
- Preserve the function and opportunity for all types of water-based and land-based activities, particularly those that help to improve the health and well-being of people.
- Preserve and accommodate the existing surf lifesaving clubs as these facilities were seen as a hub
 of water and land-based activities that also helped to improve social connection and mental
 wellheing
- Continue to provide public amenities at the coast, such as parks, restrooms parking and access paths.
- Ensure that areas for community events and access to remain within the coastline. Provide and maintain spaces and infrastructure for community events, arts and entertainment.
- Minimise impacts on existing private property.
- Consider treatments for coastal areas that have current inundation and erosion issues. Preserve the current uses of the beach areas
- Develop solutions to coastal processes that are sustainable (financially, socially and built form) and locally responsive.
- Revisit regularly with community and key stakeholders their values in relation to development adjacent the foreshore.

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9 REFERENCES

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APPENDIX A
SUPPORTING PLANNING CONTROLS /
INFORMATION





Town of Cottesloe CHRMAP

Existing Planning Controls

28 June 2022

Document ID: 22-030				
Issue	Issue Date		Prepared by	Approved by
			Name	Name
1	28 June 2022	Draft	Dylan Wray	Matt Raymond
				-

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Stage 1, Task 1 – Establish the Context

Policy Framework Overview

Western Australia's planning framework includes strategic and statutory planning functions set out in the *Planning and Development Act 2005*. The planning system is hierarchical, requiring increasing levels of detail as a proposal progresses through the state and local planning systems, including subdivision and development of individual sites. The relationships of the various policies are presented in Figure 1.



Figure 1 - Western Australian planning hierarchy (State Coastal Planning Policy Guidelines, 2020)

This CHRMAP provides the overarching blueprint for the Town's local planning framework to deliver the requirements of State Planning Policy 2.6 State Coastal Planning Policy (SPP 2.6).

SPP 2.6 considers the impacts of coastal related processes along the coastline and outlines requirements for appropriate land use and development within the coastal zone in conjunction with the ongoing provision of a coastal foreshore reserve. SPP 2.6 provides the basis for coastal planning and seeks to ensure coastal hazard risk management and adaptation planning is established to guide the location and form of future development along the coast. SPP 2.6 is applicable to every stage of the planning process and provides a range of policy measures to consider in the decision-making process.

This section reviews the existing planning framework relevant to coastal processes along the coastline within Town of Cottesloe, with a detailed review provided in Appendix 1. The primary aim of this review is to:

- Ensure the CHRMAP aligns with aims and objectives of the relevant state and local planning frameworks
- Assess the adequacy of the existing planning framework and controls for addressing hazard issues
- Identify any potential constraints and/or opportunities with the existing planning framework, including controls for addressing hazard issues.

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Stage 4, Task 9 – Review of Existing Planning Controls

Summary of Available Planning Controls

There are various planning controls that will be considered in the CHRMAP process and recommended for implementation, where appropriate. The statutory planning mechanisms that may be available to address coastal hazards within the Town are considered in Table 1 with an assessment of the advantages and disadvantages of each option.

Table 1 - Available Planning Mechanisms

Statutory Measure	Advantages	Disadvantages
Structure Plan / Activity Centre Plan	Can address location specific issues i.e. identification of foreshore physical setbacks and areas affected by erosion and inundation.	 Does not have the force and effect of the local planning scheme. Decision makers to have due regard only. Structure Plan cannot specify / enforce built form requirements. Location specific only and therefore cannot address hazard issues on a broad scale. Generally, requires the land to be appropriately zoned to require the preparation of a structure plan.
Local Development Plan	Can specify built form requirements to address location specific hazard issues i.e. increased setbacks, minimum habitable floor levels, etc. Has statutory weight of the local planning scheme. Can vary 'deemed-to-comply' development requirements.	Location specific only and therefore cannot address hazard issues on a broad scale.
Local Planning Policies and Design Guidelines	Can address hazards and risk issues at a district (broad) level and/or at a location specific level. Can include mapping of hazard issues with flexibility to update mapping as and when amendments are required to be undertaken. Can vary 'deemed-to-comply' development requirements. Can be amended relatively quickly (compared to local planning scheme amendment).	Is only a 'due regard' document and does not have the full force and effect as provisions contained in a local planning scheme.
Special Control Area (SCA)	SCAs may establish specific provisions to address a specific issue such as erosion and inundation.	A scheme amendment would potentially need to be progressed every time mapping of the coastal issue is amended and/or updated.

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Statutory Measure	Advantages	Disadvantages	
	 SCAs can broadly address unique issues that extend across multiple zones and/ or reserves. 	This may be avoided if the Special Control Area refers to a separate Local Planning Policy which may contain reference to mapping of hazards.	
	 SCAs can be used to require development approval for otherwise normally 'exempted' development. 	Totololo to mapping of nazardo.	
	 In this regard, SCAs are the preferred mechanism to identify where and what type of development requires development approval to allow for appropriate consideration of the risk of erosion and inundation. 		
General Development Provisions of LPS1	 Can establish provisions which broadly address hazard issues. Can introduce provisions which relate to a local planning policy addressing hazard issues and which may contain hazard mapping. 	Given the specific nature of erosion and inundation issues, including the varied locational extent to which it may affect land within a district, specific development requirements would more appropriately be established within a SCA as opposed to general provisions within a local planning scheme.	
Supplemental Provisions to Schedule 1 and 2 of the Regulations	May be used to supplement the standard scheme provisions set out in Schedule 1 and 2 of the Regulations to address specific hazard issues.	Given the specific nature of erosion and inundation issues, including the varied locational extent to which it may affect land within a district, specific development requirements would more appropriately be established within a SCA as opposed to supplemental provisions of a local planning scheme.	

Existing Controls Relevant to the CHRMAP

The following documents have been considered in the review contained in Appendix 1.

- Relevant Legislation:
 - o Planning and Development (Local Planning Schemes) Regulations 2015
- State Planning Framework:
 - o Perth and Peel @3.5 million and Sub-Regional Planning Framework
 - o Metropolitan Region Scheme
 - o WA Coastal Zone Strategy
 - o State Planning Policy 2.6 State Coastal Planning and Guidelines
 - o Coastal hazard risk management and adaptation planning guidelines
 - State Planning Policy 3.4 Natural Hazards and Disasters
- Local Planning Framework:
 - o Town of Cottesloe Local Planning Strategy
 - o Town of Cottesloe Local Planning Scheme No.3 (LPS 3)
 - Local Planning Policy No. 2 Wearne Redevelopment, Lot 87 (8) Warton Street, Cottesloe
 - Restricted Foreshore Centre Zone Design Guidelines for Setbacks
 - Town of Cottesloe Foreshore Mater Plan

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Based on the Town's existing planning framework and the available controls outlined in Table 1, a Special Control Area in conjunction with a Coastal Local Planning Policy is considered the most appropriate mechanism available to the Town. These recommendations will be discussed in greater detail in Chapter 5 – Risk Treatment.

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Appendix 1 – Review of Existing Controls

The existing planning controls applicable to land use and development within the Town have been reviewed with a particular focus on planning and management of hazard issues affecting the Cottesloe coastline. The following state and local planning frameworks will inform the identification of issues and opportunities relating to the preparation of this CHRMAP.

Relevant Legislation

Planning and Development (Local Planning Schemes) Regulations 2015

The *Planning and Development (Local Planning Schemes) Regulations 2015* (the Regulations) were introduced by the State government to ensure a consistent structure, format and approach to local planning schemes across the state of Western Australia.

The Regulations contain 'deemed provisions' under Schedule 2 which apply automatically to all local government planning schemes throughout the state and supersede corresponding provisions of these schemes.

Schedule 2 of the Regulations contain provisions relating to various planning mechanisms which have varying degrees of application to implementing adaptation approaches for coastal processes. The planning mechanisms available in the Regulations are examined below.

Local Planning Policies

Part 2: Division 2 of the deemed provisions relates to the preparation of local planning policies. A local planning policy may apply generally to the Scheme area or deal with specific matters.

In making a determination under the scheme, the authority responsible for determining a planning application must have due regard to each relevant local planning policy, to the extent that the policy is consistent with the scheme. In addition to introducing new policy measures, a local planning policy may also vary existing deemed-to-comply provisions of the Residential Design Codes, where it is considered appropriate. In the context of foreshore hazards and risk planning, a local planning policy could introduce additional design requirements for development, such as elevated finished floor levels, additional setback requirements and other relevant matters to ensure coastal hazards are appropriately responded to within the planning framework.

Structure Plans / Activity Centre Plans

Part 4 of the deemed provisions relates to the preparation of Structure Plans while Part 5 relates to the preparation of Activity Centre Plans. A Structure Plan or Activity Centre Pan may be prepared for a specific area if:

- (a) The area is:
 - All or part within a zone that is identified by the scheme as being suitable for urban or industrial development; and
 - ii. Identified in this scheme as an area requiring a structure plan to be prepared before any future subdivision or development is undertaken; or
- (b) A State Planning Policy requires a structure plan to be prepared for the area; or
- (c) The Commission considers that a structure plan for the area is required for the purposes of orderly and proper planning.

The relevant decision maker of subdivision and development applications within a structure plan area must have due regard to but is not bound by a structure plan. A structure plan therefore does not have the full force and effect of the scheme. Once adopted, a structure plan which identifies

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zoning and land use permissibility, would need to be normalised within a scheme by way of a scheme amendment, if the zoning and land use permissibility is to have statutory weight.

Local Development Plans

Part 6 of the Regulations provides for the preparation of Local Development Plans (LDP), which states:

'A local development plan in respect of an area of land in the Scheme area may be prepared if -

- (a) The Commission has identified the preparation of a local development plan as a condition of approval of a plan of subdivision of the area; or
- (b) A structure plan requires a local development plan to be prepared for the area; or
- (c) An activity centre plan requires a local development plan to be prepared for the area; or
- (d) The Commission and the local government considers that a local development plan is required for the purposes of orderly and proper planning.'

It is considered that the LDP as a statutory instrument will have limited application within the Town for responding to coastal hazards and that there are more appropriate mechanisms available (i.e. Scheme provisions and/or local planning policy) to address such matters.

Special Control Areas

Special Control Areas (SCA) may be established as set out within Part 5 of the model scheme provisions (Schedule 1 of the Regulations). SCAs are typically put in place to establish special provisions to target a single issue or related set of issues often overlapping zone and reserve boundaries. The provisions of an SCA would establish the purposes and objectives of the SCA, specific development requirements and, if applicable, referral requirements to relevant agencies. A SCA could therefore be established within a scheme to comprehensively address the specific development issues associated with land prone to coastal hazards.

A SCA would be delineated on the scheme maps by way of line work, which could follow the extent of mapped areas known to be prone to erosion and inundation.

General Development Provisions

Part 4 (Clause 32) of the model scheme has provisions for the establishment of additional site and development requirements in addition to those set out in the R-Codes, structure plans, activity centre plans, local development plans or State and local planning policies. General development provisions could technically set out general development requirements relating to areas subject to coastal hazards.

Given the specific nature of erosion and inundation and the varied locational extent to which it may affect land within a district, specific development requirements would more appropriately be established through a Structure Plan or within a Special Control Area as opposed to general provisions within the scheme.

Supplemental Provisions

The Regulations provide for local planning schemes to establish provisions that supplement the provisions set out in Schedule 1 and 2 of the Regulations, or provisions that vary a provision established in Schedule 1. Such supplemental provisions are typically contained within a Schedule within the scheme. This section could be used to introduce additional provisions and requirements in relation to erosion and inundation hazards.

Exemptions from planning approval

Regulation 61 of the deemed provisions specifies development and land uses that are exempt from the requirement to obtain development approval.

This is an important consideration of the CHRMAP process, as the specified exemptions may provide for situations where certain development may be established within an area affected by erosion or inundation hazards without the requirement to obtain planning approval. However, there are ways of addressing this issue. For instance, a local planning policy or local development plan

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could vary the deemed-to-comply requirements of the R-Codes to put in place additional design requirements that may trigger the requirement for planning approval.

Secondly, a SCA could be established over land affected by inundation or erosion, which would trigger the requirement for planning approval to be obtained from the responsible authority, including development that would otherwise be exempt under the Regulations.

State Planning Framework

Perth and Peel @ 3.5 million and Sub-regional Planning Framework

Perth and Peel @ 3.5 million was released by the State government in 2018 and provides the overarching framework to deliver four sub-regional strategies to guide future growth and development across the Perth and Peel metropolitan area through to the year 2050. The framework identifies the need to adapt to the impacts of climate change with the impacts of rising sea levels exacerbating coastal erosion and the impact of storm surges which will affect coastal communities, infrastructure and ecosystems.

Cottesloe is located within the Central sub-regional area which envisages an additional 213,130 infill dwellings by 2050. The Town will need to ensure future infill development along the coast considers and addresses the risks identified in this CHRMAP.

Metropolitan Region Scheme

The Metropolitan Region Scheme (MRS) is the principal region scheme which applies to the study area. The MRS defines the future use of land through zones and reservations.

The extent of the coastal foreshore is reserved 'Parks and Recreation' under the MRS with the exception of the Beehive Montessori School site which is reserved for 'Public Purpose – Special Uses'. Properties situated to the east Marine Parade are zoned 'Urban' under the MRS which is intended for residential, commercial, recreational and light industrial activities.

WA Coastal Zone Strategy

The WA Coastal Zone Strategy provides an integrated framework for collective action to manage and adapt to threats and pressures along the coast. The WA Coastal Zone Strategy supplements SPP 2.6 and provides a framework to ensure development within coastal environments are sustainable in the long term and meet community, economic, environmental and cultural needs. The key objectives of the WA Coastal Zone Strategy are to:

- Conserve the State's natural coastal values and assets through sustainable use.
- Ensure safe public access to the coast and involve the community in coastal planning and management activities.
- Provide for the sustainable use of natural coastal resources.
- Ensure the location of facilities and infrastructure in the coastal zone is sustainable and suitable.
- Build community confidence in coastal planning and management.

The WA Coastal Zone Strategy is particularly important to this CHRMAP as it provides the integrated framework for coastal planning and management across all levels of government.

State Planning Policy 2.6 State Coastal Planning

SPP 2.6 and associated guidelines have been prepared to guide decision making policy in relation to planning along the State's coastline. SPP 2.6 provides guidance on the determination of an appropriate foreshore reserve, which acts as a natural buffer to accommodate coastal processes.

SPP 2.6 seeks to ensure coastal hazard risk management and adaptation planning is established to guide the location and form of development along the coast. The policy establishes a hierarchy for undertaking coastal hazard and risk adaptation planning. The adaptation measures of Avoid,

element.

Planned or Managed Retreat, Accommodate and Protect are to operate on a sequential and preferential basis as part of the coastal hazard risk management adaptation planning process.

State Coastal Planning Policy Guidelines

The State Coastal Planning Policy Guidelines were introduced to provide guidance on the application of SPP 2.6. These guidelines identify a range of ongoing risk management and adaptation planning measures that may be considered in the assessment of development proposals located within an area known to be subject to erosion or inundation hazards. The guidelines establish a process for undertaking CHRMAP, as follows:

- 1. Establish a context;
- 2. Undertake a risk vulnerability assessment;
- 3. Determine the likelihood of the hazard occurring;
- 4. Determine the consequences;
- 5. Evaluate the risks;
- 6. Set in place adaptation management measures; and
- 7. Undertake monitoring and review.

Adaptation planning may be implemented through a range of planning mechanisms including decision-making on zoning, structure plans, subdivision and development applications.

Coastal Hazard Risk Management and Adaptation Planning Guidelines

The CHRMAP Guidelines provide guidance for decision-makers to develop and implement effective coastal hazard risk management and adaptation plans. The Guidelines outline the implementation of a policy of planned or managed retreat, applicable to 'Brownfield' and 'Infill' development, as it is these locations that are currently, and increasingly, vulnerable to coastal hazards with limited opportunities to introduce less vulnerable forms of use or development through planning controls.

The CHRMAP Guidelines are based on the principles of social, environmental and economic sustainability and adheres to objectives set out in SPP 2.6. The approach ensures ongoing protection and provision of a coastal foreshore reserve, beach amenity and public access. The policy directly references the completion of a comprehensive CHRMAP process, in order to achieve the strategic directions outlined in the WA Coastal Zone Strategy and SPP 2.6.

The key principles of the CHRMAP Guidelines are as follows:

- To ensure land in the coastal zone is continuously provided for coastal foreshore management public access, recreation and conservation;
- To ensure public safety and reduce risk associated with coastal erosion and inundation;
- To avoid inappropriate land use and development of land at risk from coastal erosion and inundation; and
- To ensure land use and development does not accelerate coastal erosion or inundation risks; or have a detrimental impact on the functions of public reserves.

The CHRMAP Guidelines outline the approach for implementing the Planned or Managed Retreat Policy, outlining planning mechanisms and their associated levels, including structure planning, local planning scheme amendments and land acquisition.

Structure Planning:

Structure planning is identified as the first mechanism, requiring the consideration of risks identified in the CHRMAP process to feed into subdivision conditions of coastal areas where some degree of comprehensive redevelopment of land remains an option.

Local Planning Scheme Amendment:

A local planning scheme amendment is the second mechanism and is required to give statutory weight to the proposed Planned or Management Retreat Policy.

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A scheme amendment is to be informed by SPP 2.6 and such an amendment should classify areas vulnerable to coastal processes within a SCA. The SCA may establish specific land use and development controls which may include preventing certain land use and development in areas at risk of coastal processes, incorporating adaptation development requirements (i.e. finished floor levels above the known storm surge level) or requiring development to retreat from the risk at specific trigger points.

Taking of Land:

Taking of land is the third planning mechanism and occurs when it is assumed that land has not been transferred or committed to the public realm through structure planning processes, and that coastal processes have advanced to the point where there is no further economic or social utility in land due to coastal changes.

Where land is reserved under the relevant planning scheme, options to move this land from private holdings to the public realm include:

- Purchase of the land by the responsible authority if the owner is willing to sell it by ordinary sale pursuant to s190 of the PD Act; or
- Compulsory taking by the responsible authority without agreement pursuant to s191 of the PD Act

If land cannot be acquired under the above options, it can be argued that the land is acquired for a 'public work' (that is, for the protection of foreshores). Options available for acquiring land for a 'public work' include:

- Taking by agreement under the Land Administrative Act 1997 (LA Act); or
- Compulsory acquisition by the Minister for Lands for the purpose of a 'public work' under the LA Act.

It is the preferred approach that the land be purchased by the responsible authority by agreement under the above relevant acts.

State Planning Policy 3.4: Natural Hazards and Disasters

State Planning Policy 3.4: Natural Hazards and Disasters (SPP 3.4) has been prepared to ensure that land use planning appropriately considers the risk of natural hazards and disasters. It addresses hazards applicable to the CHRMAP, including storm surge flooding.

SPP 3.4 requires the following to be considered in respect to storm surge flooding:

- Where storm surge studies have been undertaken and show inundation may occur, new
 permanent buildings should be constructed to take account of the effects of storm surge
 (including wind and wave set up).
- In areas where storm surge studies have not been undertaken, but evidence is available to
 demonstrate vulnerability to inundation, any development proposals should be supported by
 studies that demonstrate inundation will not occur.

The preparation of this CHRMAP will assist the Town in the application of SPP 3.4 through the identification of properties that may be vulnerable to coastal inundation.

Local Planning Framework

Local Planning Strategy

The current Local Planning Strategy was endorsed in 2008 and sets out the long-term planning directions for the Town over a 10 to 15 year timeframe. The Town is currently reviewing the Local Planning Strategy which will examine the current demographics and economic, environmental and transport conditions of the Town.

The Local Planning Strategy should consider the outcomes of the CHRMAP and include a provision for all SPP 2.6 requirements to be met at the earliest stage possible, including the requirements for

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the ongoing provision of a coastal foreshore reserve. Properties at risk of coastal processes as identified through the CHRMAP should not be identified for further development, intensification or rezoning.

Local Planning Scheme No.3

Local Planning Scheme No. 3 (LPS3) is the principal statutory planning document which applies land use and development controls within the Town at a local level. The recommendations of this CHRMAP will align with the aims and objectives of LPS3, specifically:

- Facilitate implementation of the State Planning Strategy and relevant regional plans and policies, including the Metropolitan Region Scheme, by coordinating the Scheme with such plans and policies;
- Promote the Local Planning Strategy;
- Protect the integrity, amenity and scenic quality of the coastal landscape; and
- Ensure that development and the use of land within the district complies with accepted standards and practices for public amenity and convenience.

Scheme Provisions

Part 10.2.2 of LPS3 require the Town to consider whether properties are suitable for future development through an assessment of risks, including flooding, tidal inundation, subsidence, landslip, bushfire, etc. However, LPS3 does not contain provisions that would adequately respond to coastal hazards such as erosion and inundation.

The Town can introduce development provisions into LPS3 to address a specific area of a range of issues. Amendments to LPS3 may be a suitable approach to introduce adaptation mechanisms in response to the coastal hazard issues identified within the CHRMAP.

Heritage List

The Regulations require the Town to establish and maintain a heritage list which is administered under LPS3. The Town has adopted a heritage list which aims to identify places within the scheme area that are of cultural heritage significance and worthy of conservation under LPS3.

The Town's heritage list is relevant to this CHRMAP given the foreshore reserve contains assets of cultural heritage significance. The CHRMAP will consider the impacts on local heritage assets when developing appropriate adaptation and management options.

Local Planning Policies / Design Guidelines

The Town has adopted various local planning policies (LPPs) and design guidelines relating to a number of matters, including procedures, land uses, development requirements and design guidelines. The existing LPPs and design guidelines that could be utilised to respond to coastal hazards within the CHRMAP study area have been summarised in Table 3.

Table 3 - Town of East Fremantle Local Planning Policies / Design Guidelines

LPP / Guideline	Purpose and Relevance to the CHRMAP	
Local Planning Policy No.2	Objectives:	
Wearne Redevelopment,Lot 87 (8) Warton Street,Cottesloe (LPP2)	 Responds sensitively to interface issues, particularly between existing residential development adjacent to the site and the subject land; 	
	 Delivers an optimal residential aged care facility having regard to the statutory and operational requirements of such a facility; 	
	 Improves the existing movement network including site access; 	
	 Defines appropriate building envelopes, typologies, form and heights having specific regard for existing and surrounding development; 	
	 Identifies the amount, locations for and functions of key open spaces and considers the opportunity for public realm for aged care, independent living and communal spaces; and 	
	Is implementable in the context of a phased project delivery.	

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LPP / Guideline	Purpose and Relevance to the CHRMAP
	Project Relevance:
	LPP2 relates to a site located adjacent to the foreshore reserve. The setback provisions contained within LPP2 could be amended to respond to coastal hazards, as identified in the CHRMAP.
	However, LPP2 will have limited effectiveness in response to the hazards identified in the CHRMAP given it only applies to a single site which is currently being developed. There are more effective planning mechanisms that will be considered in the CHRMAP.
Restricted Foreshore	Objectives:
Centre Zone Design Guidelines for Setbacks	To prescribe setback requirements for development in the Restricted Foreshore Centre Zone to ensure appropriate development
	Project Relevance:
	The Restricted Foreshore Centre Zone contains sites adjacent the foreshore reserve. The setback provisions contained within the Design Guidelines could be amended to respond to coastal hazards, as identified in the CHRMAP.
	However, the effectiveness of the Design Guidelines is considered limited given the relatively small number of sites within the Restricted Foreshore Centre Zone. There are more effective planning mechanisms that will be considered in the CHRMAP.

Non-Statutory Documentation

The Town has endorsed various masterplans, management plans and technical studies that do not have statutory weight from a planning and land use perspective. However, the documentation identified in Table 4 is of relevance to this CHRMAP given they recommend future development within the foreshore reserve which may be at risk of coastal hazards.

Table 4 - Non-Statutory Documentation

Document	Purpose and Relevance to the CHRMAP
Cottesloe Foreshore	Objectives:
Masterplan	 Develop a foreshore master plan that builds on the previous consultation and work completed to date.
	 Engage with the community to develop a long-term vision and design principles for the foreshore and key project sites.
	 To preserve and improve Cottesloe's natural and built environment and beach lifestyle by using sustainable strategies in consultation with the community.
	 Identify a series of public realm upgrades that can be progressively implemented as funds become available.
	 Develop a plan that captures the unique character of Cottesloe and the surrounding community.
	Project Relevance:
	The Cottesloe Foreshore Masterplan comprises of land zoned 'Parks and Recreation' and 'Urban' under the MRS. As such, the Town's local planning framework has limited application over the use and development of MRS zoned land.
	The CHRMAP will build on the previous coastal studies undertaken as part of the Cottesloe Foreshore Masterplan, including hazard issues, asset identification and recommendations. However, the Cottesloe Foreshore Masterplan will not be relied upon as a planning mechanism to responds to coastal hazards given it has no statutory weight from a local planning perspective.
	Future works within the foreshore reserve as identified in the Cottesloe Foreshore Masterplan shall have due regard to the outcomes of the CHRMAP.





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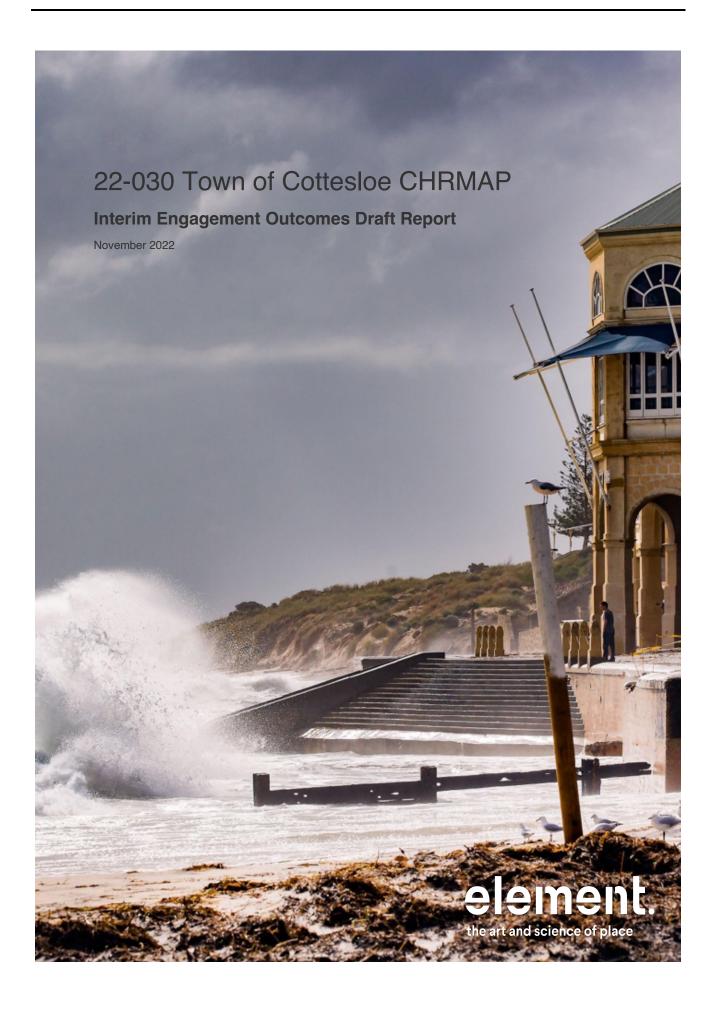
Town of Cottesloe | 11 November 2022 Chapter Report: Establish the Context





APPENDIX B INTERIM ENGAGEMENT OUTCOMES REPORT





Docum	ent ID: 21-601 D	ocuments / 04 Rep	orts			
Issue	Date	Status	Prepared by		Approved by	
			Name	Initials	Name	Initials
1	7.11.2022	Draft	Misha White	MW	Cath Blake-Powell	CBP
			Yasmine Mnahy	YM		

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Executive Summary

In 2021, the Town of Cottesloe engaged the project team of Watertech, Cardno-Stantec and **element** to provide specialist land use planning, community engagement and coastal engineering consultants to produce a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP). The CHRMAP will be prepared in accordance with the CHRMAP Guidelines and State Planning Policy 2.6, adopted by the Town of Cottesloe and used to guide future decision making for vulnerable assets in its coastal area.

An important part of this study is speaking with the community and key stakeholders to identify their values and aspirations for the foreshore. The engagement for this project will be primarily spread across two key stages in the project lifecycle: Stage 1: Establish the Context and Stage 5: Risk Treatment.

In Stage 1 of the project, we engaged with over 141 people across 3 activities and promoted the project through an awareness campaign. The purpose of engagement in Stage 1 was to understand coastal values, aspirations, visitation and usage of the coastline. Below is a summary of the key findings.

- The community valued the 'natural environment' most about their foreshore, with 'access to water-based activities' and 'opportunities for health and well-being' also highly valued.
- The Cottesloe foreshore is well utilised with a range of land and water-based activities occurring frequently in the area.
- Whilst a smaller proportion of respondents noted that they were undertaking activities in the area
 because 'I can't do this activity elsewhere, it is unique to this area', a vast many felt that their lives
 would be impacted adversely if they were unable to undertake these along the Cottesloe foreshore.
- The community were concerned about erosion and inundation along the coast, particularly in relation
 to sand erosion and the potential to expose rocks. This was also noted by the key stakeholders are
 being an important issue that influenced the use of Cottesloe beach.

This report will be updated after the Community Workshops in Stage 5, which will be held in early 2023.

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1. Introduction

1.1 Project Overview

In 2021, the Town of Cottesloe (ToC) appointed the project team of Water Technology, Cardno and **element** to produce a Coastal Hazard Risk Management Adaptation Plan (CHRMAP) consistent with Western Australian Planning Commission (WAPC) 2019 guidelines. The Cottesloe CHRMAP will be used guide future decision making for vulnerable assets in its coastal zone.

A Stakeholder and Community Engagement Strategy (SCEP) was prepared to guide the engagement process and ensure that the community and stakeholders were effectively and actively involved in the CHRMAP preparation process.

The SCEP outlines how the community and stakeholder participation, and engagement process aligns within the inform, consult and involve levels of IAP2 Public Participation Spectrum. The goals of each level of engagement are described in the table below.

Table 1: Levels of Engagement for the Project (based on IAP2 Public Participation Spectrum)

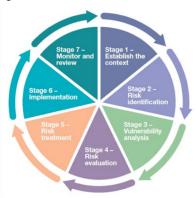
Goal	To provide balanced and objective information in a timely manner.	To obtain feedback on analysis, issues, alternatives and decisions.	To work with the public to make sure that concerns and aspirations are considered and understood.
Promise	"We will keep you informed."	"We will listen to and acknowledge your concerns."	"We will work with you to ensure your concerns and aspirations are directly reflected in the decisions made."

The engagement objectives and the engagement tools are summarised in the sections that follow based on the information in the SCEP.

The CHRMAP process is being completed in 7 stages, where the community will review the draft prepared at the end of each stage. In this way, community and stakeholder involvement will guide the preparation process. See the diagram overleaf for a breakdown of the 7 stages.

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Figure 1 Diagram of the CHRMAP stages



This report is a summary of the community engagement undertaken during Stage 1 of the CHRMAP process. This report will be updated as the engagement progresses throughout the CHRMAP project.

Establishing the context of the CHRMAP is the critical task, which will provide the foundation for the project, which covers the purpose, objectives, scope, study area, community and stakeholder engagement, values, existing controls and success criteria.

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1.2 Project Scope

The subject area, is located on Whadjuk Noongar land within the Town of Cottesloe. The approximate 4 km of coastline contains some of Perth's most iconic and popular beaches and lies between North Street and just South of the Vlamingh Memorial. Bordered by the residential suburb of Cottesloe, the coastal foreshore area has interactions with many landmarks and recreational features including Cottesloe main beach recreation area, Cottesloe Surf Lifesaving Club, North Cottesloe Surf Life Saving Club, The Cottesloe Sundial, Indiana Tearooms, South Cottesloe Beach exercise park, South Cottesloe playground, Cottesloe Nature discovery Space, the Vlamingh Memorial, several public beaches, and hospitality venues, as well as the Cottesloe and Beach Street Groynes.

The project site also includes the Cottesloe foreshore masterplan concept and redevelopment area. The study area was split into 2 zones north and south of the main groyne, shown in the Figure X below;





Figure 3: Study area South of Cottesloe Groyne



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1.3 Project Objectives

The objectives of the CHRMAP are to:

- improve understanding of coastal features, processes and hazards in the study area;
- identify significant vulnerability trigger points and respective timeframes to mark the need for immediate or medium-term risk management measures;
- identify assets (natural and man-made) situated in the coastal zone and the services and functions they provide;
- gain an understanding of asset vulnerability;
- identify the value of the assets that are vulnerable to adverse impacts from coastal hazards;
- determine the consequence and likelihood of coastal hazards on the assets, and assign a level of risk;
- identify possible (effective) risk management measures (or 'actions') and how these can be incorporated into short and longer-term decision-making; and
- engage stakeholders and the community in the planning and decision-making process.

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2. Engagement Methodology

2.1 Purpose and Objectives of Engagement

The purpose of the engagement during Stage 1 of the CHRMAP process was to raise project awareness, engage with Aboriginal representatives and collect community coastal values including social, economic and environmental values, including which coastal foreshore assets the community hold important.

As such, the objectives of the engagement were to:

- Utilise reliable communication channels to ensure information is shared with interested stakeholders.
- Identify stakeholders and understand the nature of their interest and potential to contribute towards success of the project or otherwise.
- Establish early in the project opportunities to have authentic conversations with people. Particularly
 those most affected by potential change from future coastal adaptation measures.
- Inform key community member and stakeholders to develop understanding and alignment with the goals of coastal hazard risk assessment within the Cottesloe community.
- Ensure adjacent neighbours (residents and businesses) to the project site are kept informed and are invited to undertake targeted engagement as required, giving sufficient notice to do so.
- Inform, consult and involve the community in identifying suitable adaptation options
- Collect and collate the community and stakeholders' coastal values and aspirations for the long term.
- Understand the level of tolerance of specific risks within the community for specific assets, or groups of assets.
- Develop a shared vision between the Town, landowners and surrounding community for the future CHRMAP recommendations.

A number of communication channels and engagement tools have been used throughout Stage 1 of the CHRMAP project process, these are identified below.

2.2 Engagement Tools

2.2.1 Targeted Stakeholder Conversations

Understanding project stakeholders is a critical consideration of any engagement and communications program. By understanding who these groups or individuals are, we may better understand and analyse their degree of influence and interest, and therefore the involvement they are likely to request and require.

To ensure that key stakeholders were able to provide input into the project element held interviews with strategic landowners or primary lessees and user groups along the foreshore, as identified by the Town of Cottesloe.

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2.2.2 Aboriginal Engagement Session(s)

Aboriginal engagement is to occur alongside the broader community engagement activities at key stages of the CHRMAP process. This engagement is to provide input into the Cottesloe CHRMAP by providing Aboriginal cultural values and knowledge about the coastline and its natural assets specifically re values and ensuring that responses to potential hazards incorporates this viewpoint.

Aboriginal engagement will consist of 2 meetings with appropriate cultural representatives which will be facilitated by an Aboriginal engagement specialist and will which be aligned with;

Stage 1 - Establishing the context

Stage 5 - Risk Treatment

2.2.3 Pop-up Information Sessions

Two pop-up information sessions were held to introduce the CHRMAP process and provide information about the project including;

- Why does a CHRMAP need to be prepared
- Outline of foreshore zones to be included in the study
- Identification of coastal assets
- Explanation of coastal hazards
- · Overview of management options

These were attended by the project team and Town staff who were available to explain the process and answer any questions

2.2.4 Coastal Values Survey

The Coastal Values survey ran was composed of 22 questions and considered the Cottesloe coastal area in the context of North and South of the Cottesloe Groyne (see Figure 2 and 3) and was hosted online via the Town's webpage.

An outline of the questions in the Coastal Values survey is shown in Table 1 below.

Table 1 Coastal Values Survey Questions Overview

No.	Question		
About you	u – Respondent Demographic Information		
1	Roughly how close do you live to the Cottesloe CHRMAP project area?		
2	What suburb do you live in?		
Connection	Connections with the Coastline		
What is your connection to the Cottesloe Coastline (between North Street and Vlamingh Memorial)? Select all that apply.			
4	Thinking about your interactions and experiences at the Cottesloe Foreshore what are three words that come to mind?		
Values and Activities			

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element.

5	Which locations, places or experiences are most important to you within the Cottesloe CHRMAP area. Write in up to 5.
6	Please indicate what activities you or your family undertake along the Cottesloe coastline and where you undertake them (tick all that apply).
Activities	in the North Zone
7	How often do you participate in these activities in the North Zone?
8	Why do you choose to undertake these activities in the North Zone as opposed to other nearby areas? (Choose all that apply).
Activities	in the South Zone
9	How often do you participate in these activities in the South Zone?
10	Why do you choose to undertake these activities in the South Zone as opposed to other nearby areas? (You may select more than one option).
Site Impa	cts
11	If you were unable to do these activities along the Cottesloe coastline, how much would this impact your life?
12	Why do you chose to undertake these activities along the Cottesloe coastline compared to other coastal areas in Perth?
13	Below is a list of values that can apply to a variety of coastline and foreshore environments. Please tell us how important each value is to you in the context of the Cottesloe coastline.
Impact of	Hazards
14	How concerned are you about coastal erosion and/or inundation in the Cottesloe coastal area?
15	From your experience within the project area, have you noticed any areas along the foreshore that may be affected by, or increasingly impacted by inundation and/or erosion hazards over the past 5 years? Please tell us more below, including the location/s of concern.
Other der	nographics and comments
16	We will be conducting further workshops early next year about mitigation strategies. If you would like to be invited to this or kept up to date with the project please let us know.
17	Please provide your name and email address below. This information will be used for project communications for the Cottesloe CHRMAP only and will remain confidential.
18	How young are you?
19	What is your gender?
20	Are you of Aboriginal and/or Torres Strait Islander descent?
21	Please tell us how you heard about this survey.
22	Do you have any further questions or comments about the project for the CHRMAP Team?

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2.3 Communication Channels

Project information, updates and invitations to participate in engagement opportunities were distributed to the community in the following ways.

Table 2 Communications Methods

Project website	Project webpages were hosted via the ToC webpage,
	https://www.cottesloe.wa.gov.au/services/environment-and-
	sustainability/coastal-hazard-risk-management-and-adaptation-plan-
	chrmap.aspx
	These contained all project information including; FAQ's, project background,
	engagement event information and project contact.
Project flyer	A project flyer was distributed to nearby residents and businesses.
	*This flyer also contained information regarding the ToC Heritage Strategy
Project emails/ e-	Emails were sent out via the ToC to community members as a call to action for
newsletters	engagement opportunities.
Posters and signage	Posters were erected at local businesses and signage at key locations along
	the coast directing people back to webpage.
Social media	Established social media channels for the ToC were used to provide
	information and direct people to the webpage

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3. Key Findings

3.1 Stakeholder Conversations

A total of 6 interviews were conducted out of a possible 10 stakeholders identified. The stakeholder groups represented a variety of views from key stakeholders in the area and their members/associates.

Of those that did not participate 1 refused and 3 did not respond to multiple requests to meet.

The six stakeholder groups interviewed were;

- Cottesloe Coastcare
- North Cottesloe Surf Life Saving Club
- Cottesloe Surf Life Saving Club
- Fiveight
- Sculptures by the Sea
- Cottesloe Longboard Club

Each stakeholder provided insight from the perspective of their relevant group regarding the Cottesloe CHRMAP process.

Values

The Cottesloe coastline was valued for a variety of reasons by the key stakeholders.

The importance of the environment in its natural state both in and around the water was a common theme. The ability to use the area to recreate via water-based and land-based activities was highly valued.

In addition to this the clubs with members particularly valued the social aspects of the beach and being part of a group that utilised the area to connect to one another. This was also seen as having flow on effects to mental wellbeing and a healthy lifestyle.

Given the iconic nature of Cottesloe and its existing heritage and cultural features, these were also seen as bringing value for the area.

Activities

In terms of the activities that were noted by stakeholders, these were varying from club specific activities to individual pursuits in and out of the water, with and without equipment. However, from all accounts the Cottesloe coastline is heavily utilised, by a variety of people for an extensive range of sports and activities. Not surprisingly this is more apparent during winter

Assets

The beach sand itself was seen as an important asset – as without it there would be limited beach-based activities and reduced access to the ocean. For the surf clubs and 'Sculptures by the Sea' without this asset their reason for being would disappear.

Cottesloe main beach and foreshore was seen as an important coastal area due to its heritage and social value. Within this were several notable landmarks including the Indian Tearooms. The facilities on the coastal

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element.

side of Marine Parade were also noted as being at risk and particularly the surf clubs that had facilities close to the beach.

Erosion and inundation

Erosion was seen as the main concern along the Cottesloe coast, particularly that the beach sand disappeared at times and exposed limestone rocks that interfered with recreational use. Another issue was maintaining access via beach paths. Stormwater run-off was also noted as being erosive.

Those areas closer to the groynes were seen as less likely to suffer the effects of erosion.

The erosion of sand around the NCSLC ramp was seen as an ongoing issue.

Inundation was seen as a part of winter storm events, but otherwise it was seen as a slow process that there would be time to prepare for. The most viable short-term mitigation strategy for built form assets was adapting them to allow storm inundation to wash through.

3.2 Aboriginal Engagement

An initial meeting with 4 cultural representatives was held 14 September at the Council offices.

The discussion focussed around the importance of the natural environment and specifically around Mudurup Rocks. It is noted that Mudurup Rocks is registered as Site ID 435 at the Department of Aboriginal Affairs, Heritage and Culture Division, Perth.

Some of the comments raised during this meeting were that:

- The Mudurup rocks were seen as a very important site to local Aboriginal people. It holds importance
 due to the fishing and swimming that happened there. A lot of whiting are in the area. It was also seen
 as a place where ceremonies were held.
- There are connections to Aboriginal people coming from Rottnest Island who visited the coast at
 Mudurup rocks for fishing. One of the members claimed to have a bloodline connection to Johnny
 Kudjal who is said to have used a cave within the Rocks and turned into a crow.
- There were some thoughts about the different ways that the name was spelt and pronounced.
- This area is also known as a place inhabited by the spirit of the crow man, with many crows being
 present in the area. This was verified by a direct descendant connection deemed as a custodian of
 the rock.
- The natural environment is important to Aboriginal culture, including that along the coastline, and a desire that it should be enjoyed in its natural state.
- It was felt that the rock area should not be interfered with, and that nothing should be placed on it.
- Although there was a desire to protect it they did not want it fenced but felt that it should be acknowledged.
- There were some comments regarding the active protection of the rocks or allowing them to succumb
 to nature due to sea level rise.

A secondary meeting will be held early 2023.

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3.3 Pop-up Information Sessions

Two pop-up information sessions were held on Saturday 17 September at the Main Cottesloe Beach foreshore (near II Lido) from 9am – 12pm and 21 September from 4.30pm to 6.30pm at the Cottesloe Civic Centre, 109 Broome Street.

The 2 sessions were visited by 68 people who came to view the information and chat to the project team to gather more information about the project.

The information session included static information displays about the project and affected area and was attended by the following project team members:

- Cardno-Stantec coastal engineering specialists
- · element, planning and engagement specialists
- · Town of Cottesloe officers

A handout was also provided with a QR code for the coastal survey.

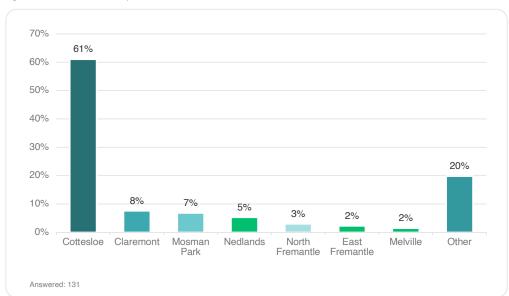
3.4 Coastal Values Survey

The main tool for collecting community feedback was through a Coastal Values survey which ran from to 1 September to 16 October 2022. A total of 131 respondents undertook the Coastal Values survey however not all questions were answered by everyone participating.

3.4.1 Who did we reach

As seen in figure 4, the majority (61%) of respondents were residents within Cottesloe. The remainder of respondents came from a range of other suburbs, with Claremont (8%), Mosman Park (7%) and Nedlands (5%) having the most involvement. A small number of respondents were from nearby suburbs including; Swanbourne, Peppermint Grove, Mount Claremont, South Fremantle, Fremantle, Subiaco, Clackline, Shenton Park, Lower King, Beckenham, Hamilton Hill, Churchlands, Attadale, Joondanna, Dalkeith, South of the River.

Figure 4: Q2 - What suburb do you live in?



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Over half (56.5%) lived within 1km of the site, while a further (26%) lived up to 5km away. The remainder lived more than 5km away.

The two most common age ranges were 45-54 and 65-74, making up 50% of total participants combined.

Most respondents were male (53.70%). However the number of female participants (41.67%) was not significantly less.

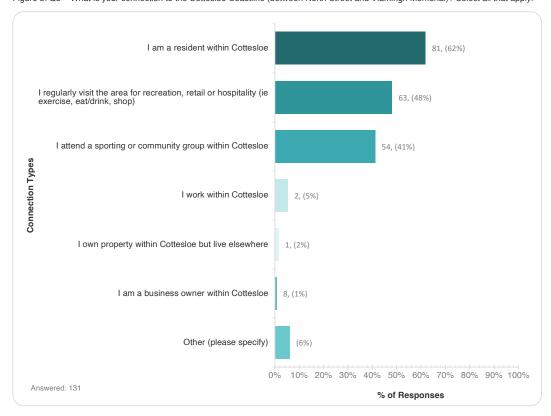
Graphs for the demographics can be found in Appendix A.

3.4.2 Connections with the Coast

The majority of respondents (62%) taking part in the CHRMAP survey reside within Cottesloe. Others regularly visit for recreation, retail or hospitality (48%) or attend a sporting/community group within Cottesloe (41%).

Out of the 8 responses that made up the 'other' category, 3 mentioned an activity that were applicable to other answers (e.g. swimming, surfing, walking the dog). 1 responder mentioned the spiritual and cultural values associated with the coastline and another mentioned the site's aesthetic value.

Figure 5: Q3 - What is your connection to the Cottesloe Coastline (between North Street and Vlamingh Memorial)? Select all that apply.



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3.4.3 Perceptions and Importance of the foreshore area

Respondents were asked about what three words they associated with the Cottesloe foreshore based on their experiences and interactions. A lot of the descriptions related to water and land-based activities that occurred as well as an appreciation of the natural assets associated with the coast.

A fifth of respondents (23%) mentioned 'Swimming' as what came to mind. 'Clean' was mentioned by 15%, with walks/walking mentioned by 12%, along with 'Beach' (11%), 'Natural' (10%) and 'Nature' (9%). The Surf Clubs were also mentioned specifically be 9%.

The image below shows a graphical representation of the word descriptions that were used

Figure 6: Q4 – Thinking about your interactions and experiences at the Cottesloe Foreshore what are three words that come to mind?



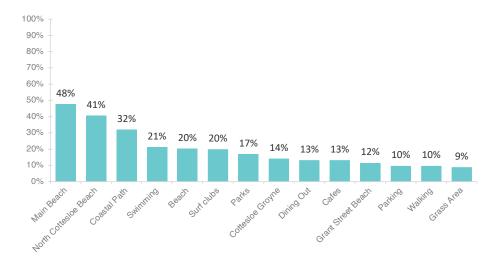
Respondents were asked about the most important aspects of the Cottesloe coast. As seen in figure 7 below, specific locations within the coastline that were frequently mentioned included the Main Beach (mentioned by 48%) and North Cottesloe Beach (41%). Also seen as important were the Coastal Paths along the coastline (32%), swimming (21%) which also covered the shark nets and the Beach/sand.

Other locations mentioned frequently included the Cottesloe Groyne, Dining out venues, cafes, Grant Street Beach and the grassed areas along Cottesloe.

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element.

Figure 7: Q5 – Which locations, places or experiences are most important to you within the Cottesloe CHRMAP area. Write in up to 5.



3.4.4 Activities

Respondents were asked to indicate what activities they did in each zone. People may have participated in the same activity across both zones. Therefore, the results below indicate how many people took part in activities for each zone – rather than a % of total participation in an activity.

Based on the data collected and results shown in Figure 8 overleaf, the North Zone generally appears to be more active. Notable activities that respondents prefer to do in the North include swimming (n=106 people), visiting a restaurant or café (n=103), walking (n=101) outdoor events (n=98), socialising and picnics (n=91), and being in nature (n=88).

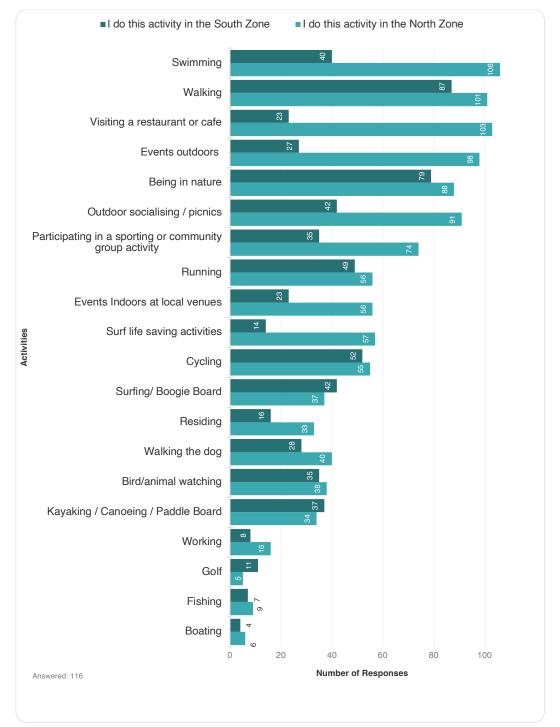
The top activities in the South zone included Walking (n=87) being in nature (79) and cycling (n=52), walking (n=109 combined) and visiting a restaurant/café (n=106 combined).

Boating and fishing were the least popular activity for both zones.

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Figure 8: Q6 – Please indicate what activities you or your family undertake along the Cottesloe coastline and where you undertake them (tick all that apply).



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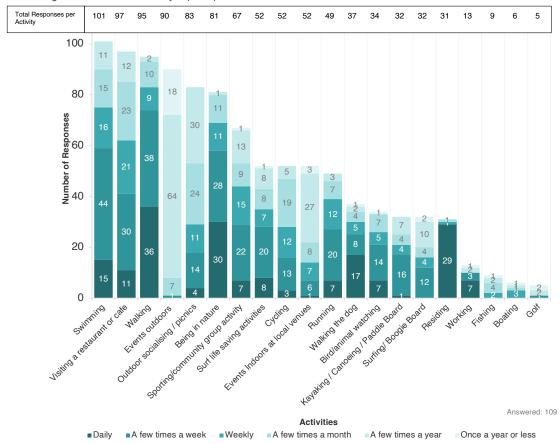
3.4.5 North & South Zone Activities

For each zone, respondents that participated in an activity were asked how frequently they undertook that. This is shown in Figure 9 (North Zone) and Figure 10 (South Zone) below, based on the number of respondents who undertook that activity.

North Zone

- The activities that respondents undertook in the North zone most frequently (at least once a week) were walking, swimming, being in nature and visiting a restaurant or café.
- Swimming was mostly done on a few-times-per-week basis (n=44). Although swimming is overall the
 most popular activity, walking is done most frequently on a daily basis
- Visiting a restaurant of café is mostly done on a few-times-per-week basis (n=30),
- · Walking is mostly done on a few-times-per-week basis (38),
- Those activities that were undertaken the least frequently in the North zone (a few time a year or less) were events (outdoor and indoor) and outdoor socialising/picnics.
- Although outdoor events are generally popular (n=90), they are the most infrequent activity. Outdoor
 events are mostly attended on a few-times-a-year basis (n=64).



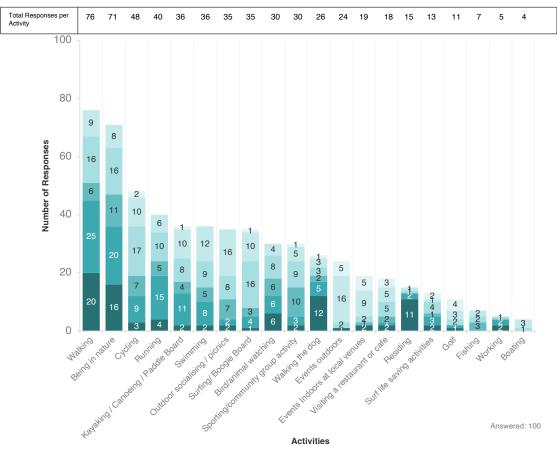


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South Zone





■ Daily ■ A few times a week ■ Weekly ■ A few times a month ■ A few times a year ■ Once a year or less

As seen in figure 10, the top forms of activity are ranked according to what respondents undertake most in the South Zone:

- However, the activities that respondents undertook in the South zone most frequently (at least once a week) were walking, being in nature and running.
- Walking is mostly done on a few-times-per-week basis (n=25).
- Being in nature is mostly done on a few-times-per-week basis (n=20).
- Running is mostly done on a few-times-per-week basis (n=15).
- Although one of the most popular activities, cycling is mostly done on a few-times-per-month basis (n=17).
- Not only is walking the most popular activity, it is also done most frequently on a daily basis (n=20).
- Walking the dog was also one of the activities most frequently on a daily basis (n=12)

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element.

3.4.6 Reasons for undertaking activities

People were asked to indicate why they chose to undertake an activity in an area rather than elsewhere based on the following choices;

- I can't do this activity anywhere else, it is unique to this area
- I've always done the activity here, it's what I know and like
- I live nearby so it is more convenient for me
- I like the quality of the public facilities
- I feel a social connection with others who do this same activity
- Proximity to an attractive, natural setting

The results are shown in Figure 11 and 12 overleaf. Note that more than one reason could be provided for each activity in each zone.

North Zone

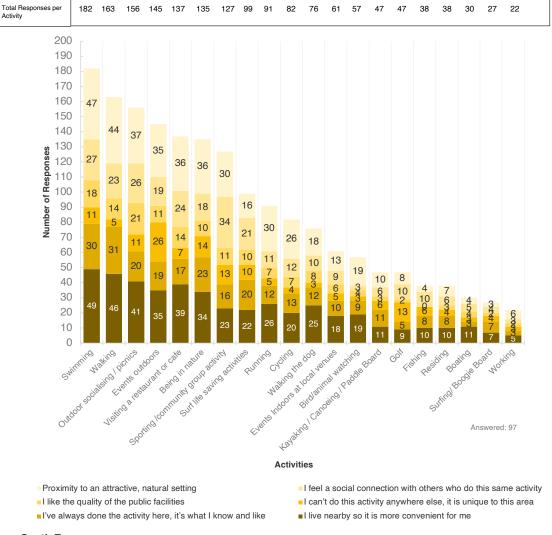
When asked why the North Zone was so desirable for their preferred activity, respondents expressed:

- Overall, the North Zone was generally appealing because respondents live nearby and it being convenient. This was the was the biggest reason for those who walked their dog.
- The second statement that respondents resonated with most was 'Proximity to an attractive, natural setting'.
- The 'proximity to an attractive, natural setting' was especially important when people were
 undertaking swimming, walking, outdoor socialising/picnics, visiting a restaurant or being in nature.
- Being 'considered unique to the area' was the least chosen reason along with the 'quality of the public facilities'.
- Those who participated in group sporting activities were more likely to do because they 'felt a social connection with those who do the same activity'.

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Figure 11: Q8 – Why do you choose to undertake these activities in the North Zone as opposed to other nearby areas? (Choose all that apply)



South Zone

When asked to assign why they undertook activities in the South Zone, respondents expressed:

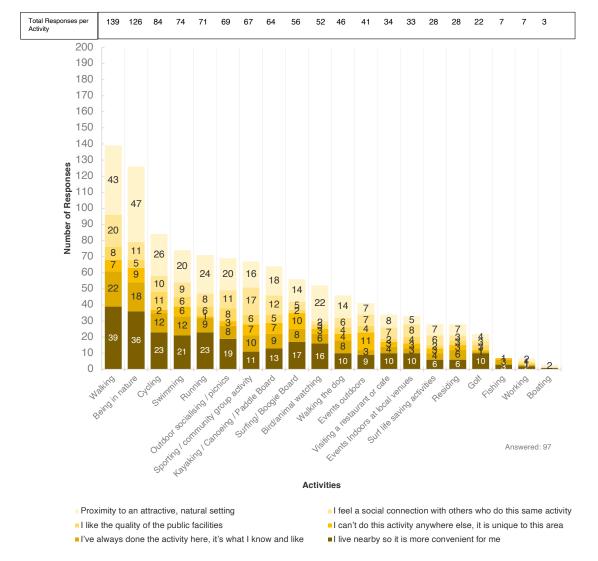
- The South Zone is generally appealing due to 'proximity to an attractive, natural setting', particularly for walking and being in nature.
- The second statement that respondents resonated with most was 'I live nearby so it is more
 convenient for me'. This was the was the biggest reason for those who undertook surfing/boogie
 boarding.
- Similar to the North Zone, being 'considered unique to the area' was the least chosen reason along with the 'quality of the public facilities'.

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 Those who participated in group sporting activities were more likely to do because they 'felt a social connection with those who do the same activity'.

Figure 12: Q10 – Why do you choose to undertake these activities in the South Zone as opposed to other nearby areas? (You may select more than one option).



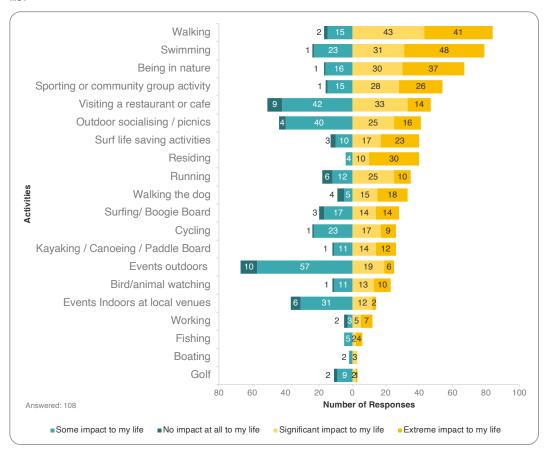
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3.4.7 Impact of Activities

Each of the respondents that indicated they participated in a particular activity, were subsequently asked 'If you were unable to do these activities along the Cottesloe foreshore, how much would this impact your life?'. Respondents then rated the impact on their lives from no impact, some impact, significant impact and extreme impact.

Figure 13: Q11 – If you were unable to do these activities along the Cottesloe coastline, how much would this impact your life?



When asked to evaluate how much of an impact the listed activities had on their lives, participants:

- Found walking to be the most valued activity (n=84 having an significant or extreme impact).
- Swimming (n= 79) and being in nature (n=67) were other activities that would have an impact on people's lives if they could no longer participate in them at Cottesloe.
- Not being able to attend outdoor events and visiting a restaurant/café were seen as having the least impact if they were unable to participate in them.

Respondents were also asked 'Why do you chose to undertake these activities along the Cottesloe coastline compared to other coastal areas in Perth?' A total of 88 respondents provided a response to this question.

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element.

Of the 88 people who answered this question, the main reasons as to why the Cottesloe coastline was seen as unique was due to respondents either living in, or being proximate to, the area (66%). The specific beauty of the coastline (19%), and the underdeveloped/ natural state of the area (18%) were also popular reasons.

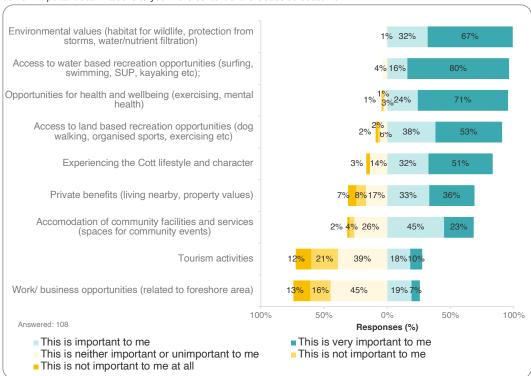
Further to this other mentions were; having specific connections to the area (ie through specific clubs or activies), feeling safe, the public amenities available and being able to connect to others.

3.4.8 Cottesloe Values

There are a range of values that can apply to the Cottesloe coastal area. Respondents were asked to rate the following values to determine which were most important to them.

- Access to water based recreation
- Access to land based recreation
- Private benefits
- Environmental values
- · Opportunities for health and wellbeing
- · Accommodation of community facilities and services
- Work/business opportunities
- Tourism activities
- Experiencing the Cott lifestyle and character

Figure 14: Q13 – Below is a list of values that can apply to a variety of coastline and foreshore environments. Please tell us how important each value is to you in the context of the Cottesloe coastline.



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Environmental values and access to water-based recreation opportunities and were the most appreciated with 99% and 96% indicating that they were either very important or important. Neither of these categories were recorded as unimportant.

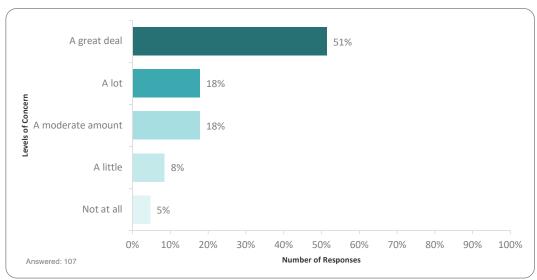
Opportunities for health and wellbeing came a close third (95% very important or important) and experiencing the Cott lifestyle and character also ranking highly (91%).

Tourism activities and work/business opportunities were least valued.

3.4.9 Impact of Hazards

Respondents were asked 'how concerned are you about coastal erosion and/or inundation in the Cottesloe coastal area?'. The majority (51%) answered 'a great deal'. 'A lot' and 'a moderate amount' were both equally the second most popular answer, with 5% responding 'not at all'.

Figure 15: Q14 How concerned are you about coastal erosion and/or inundating the Cottesloe coastal area?



Respondents were also asked 'From your experience, within the project area have you noticed any areas along the foreshore that may be affected by, or increasingly impacted by, inundation and/or erosion hazards over the past 5 years.' A total of 78 respondents provided a response to this question.

Of those who answered the question, sand erosion and the exposing of rocks along the beach was noted most with 24% mentioning it. Further to this the erosion of the dunes (17%) was an area of concern. Other locations where Coastal hazards were noticed were Cottesloe Main Beach (10%), the Northern Beaches (9%) and the Indiana Tearoom facilities/building (8%).

In addition to this 17% of respondents noted that they had not seen any notable change over time and there was a cyclical nature to the movement of sand in the area.

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4. Success Criteria

As a result of the engagement findings, we can deduce a preliminary set of criteria which will be used to guide the success of the CHRMAP report. The 'success' of the CHRMAP will be determined by the assets identified through the CHRMAP process continuing to provide their present function, services and values (or an accepted version of it as determined by community and stakeholders).

Therefore, the success criteria will be determined by the values collected in this part of the engagement process. The preliminary success criteria are outlined below and will be updated as the engagement progresses.

- Preserve and protect the Town's beaches and natural assets such as vegetation and dunes.
- Ensure the natural environment is protected and sustained in its current condition or an improved condition.
 - o Maintaining the natural state and underdeveloped nature of the area is important.
 - o Preserve and consider the cultural significance of Mudurup Rocks.
- Preserve the function and opportunity for all types of water-based and land-based activities, particularly those that help to improve the health and well-being of people.
- Preserve or accommodate the existing surf lifesaving clubs as these facilities were seen as a hub of water and land -based activities that also helped to improve social connection and mental wellbeing.
- Continue to provide public amenities at the coast, such as parks, restrooms, parking and access paths
- Ensure that areas for community events and access to remain within the coastline. Provide and maintain spaces and infrastructure for community events, arts and entertainment
- Minimise impacts on existing private property
- Consider treatments for coastal areas that have current inundation and erosion issues. Preseve th current uses of the beach areas.
- Develop solutions to coastal processes that are sustainable (financially, socially and built form) and locally responsive.
- Revisit regularly with community and key stakeholders their values in relation to development adjacent the foreshore.

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5. Next Steps

Coastal engineers will progress with Stages 2, 3, and 4, we will consult with the community and Aboriginal cultural representatives at Stage 5 via workshops and meetings.

The engagement at this stage will identify important assets along the coast and identify the most preferred adaptation options to mitigate the impact of foreshore hazards.

Respondents were interested in being kept up to date on the project with 74% saying they would like to receive updates and 31% willing to participate in further activities.

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6. Appendix A. Demographics

Figure 16: Q18 - How young are you?

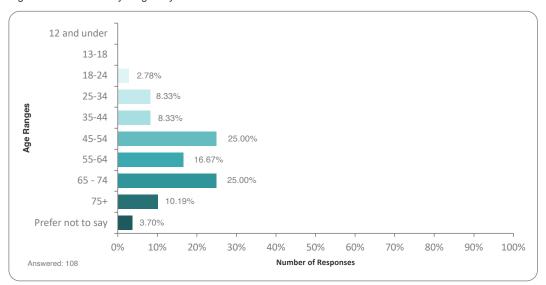
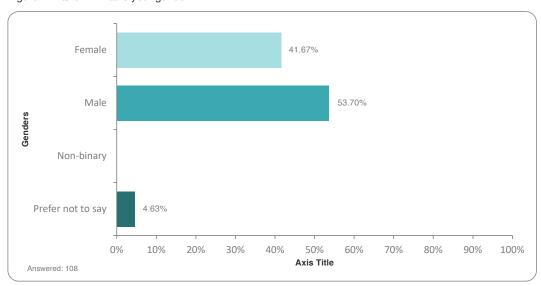
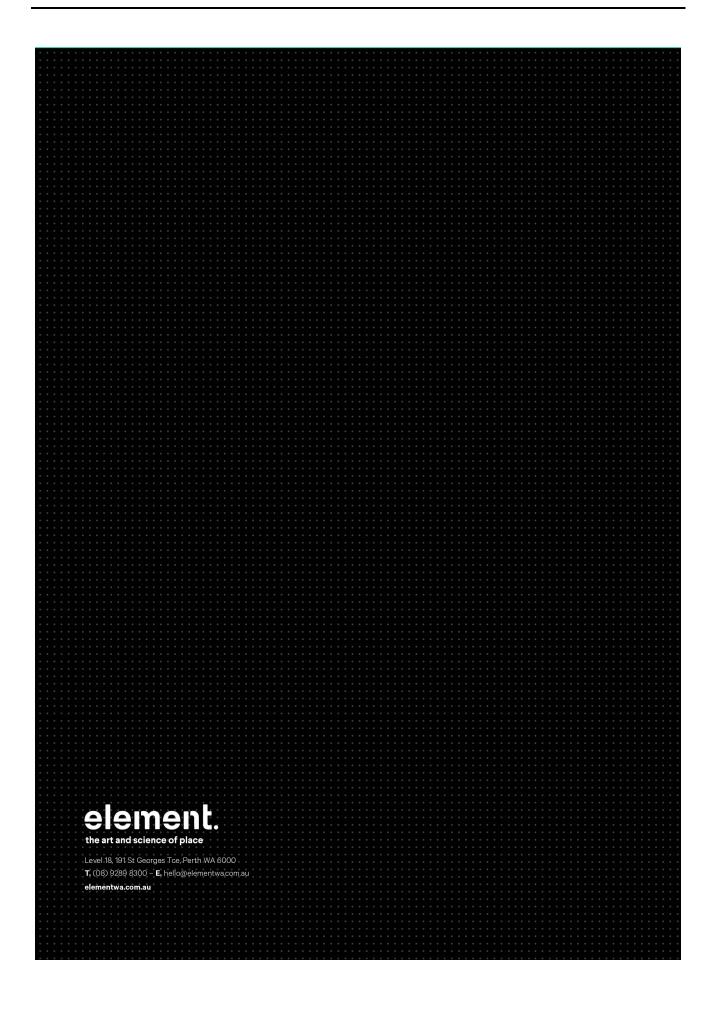


Figure 17: Q19 - What is your gender?



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TOWN OF COTTESLOE



COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN (CHRMAP) STEERING COMMITTEE

ATTACHMENT

ITEM 8.1.1B: R02 RISK ID



Risk Identification Chapter Report

Town of Cottesloe Coastal Hazard Risk Management and Adaptation Plan

Prepared for Town of Cottesloe

May 2023





Revision schedule

Rev No	Date	Description	Signature of Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
Rev A	04/04/2023	Draft	Leo Reith	Daniel Strickland	Daniel Strickland	Daniel Strickland
Rev B	12/04/2023	Draft	Leo Reith	Daniel Strickland	Daniel Strickland / Water Technology	Daniel Strickland
Rev 0	23/05/2023	Final	Leo Reith	Daniel Strickland	Daniel Strickland	Daniel Strickland

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Town of Cottesloe CHRMAP // Risk Identification Chapter Report i

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Quality statement

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Abbreviations

Abbreviation	Full Name			
AEP	Annual exceedance probability			
AHD	Australian Height Datum			
ARI	Average recurrence interval			
CHRMAP	Coastal Hazard Risk Management and Adaptation Plan			
СРТ	Cone penetrometer testing			
CZM	Coastal Zone Management Pty Ltd			
DoT	Department of Transport			
EVA	Extreme value analysis			
FFBH	Fremantle Fishing Boat Harbour			
GIS	Geographical information system			
GPR	Ground penetrating radar			
HSD	Horizontal shoreline datum			
IPCC	Intergovernmental Panel on Climate Change			
JONSWAP	Joint North Sea Wave Project			
MPRA	M P Rogers and Associates			
MSL	Mean sea level			
SBEACH	Storm-induced BEAch CHange			
SLR	Sea level rise			
SPP2.6	State Planning Policy No. 2.6: State Coastal Planning Policy			
SSP	Shared socioeconomic pathway			
SWAN	Simulating WAves Nearshore			
S1	Allowance for the current risk of storm erosion			
S2	Allowance for historic shoreline movement trends			
S3	Allowance for erosion caused by future sea-level rise.			
S4	Allowance for current risk of storm surge inundation			
USACE	United States Army Core of Engineers			
WA	Western Australia			
WAPC	Western Australian Planning Commission			



Town of Cottesloe CHRMAP // Risk Identification Chapter Report 1

1 Introduction

1.1 Overview

The Town of Cottesloe (herein referred to as 'the Town') is situated about 12 km to the west of Perth's city centre in Western Australia (WA) (Figure 1-1). With approximately 4 km of highly developed Indian Ocean coastline ('the study area'), Cottesloe has earned a reputation as one of Australia's iconic beach destinations. Substantial public and private infrastructure exists adjacent to the Town's coastline, holding significant value. This value takes various forms, including private and commercial property, commercial business through several bars, restaurants and shops, public amenity through the beach itself, adjoining walkways and parks, key infrastructure, such as roads, and touristic and historical value. Given the proximity of infrastructure to the shoreline and the inherent value provided by the coast itself, predicted rising sea levels and potential changes to coastal processes in the area pose management challenges for the Town.

The Town is undertaking a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) to provide strategic guidance for coordinated, integrated and sustainable land use planning and management along its coastline. The CHRMAP will inform the Town's future decision-making with respect to areas and assets identified as being at risk of coastal hazards.

1.2 Background

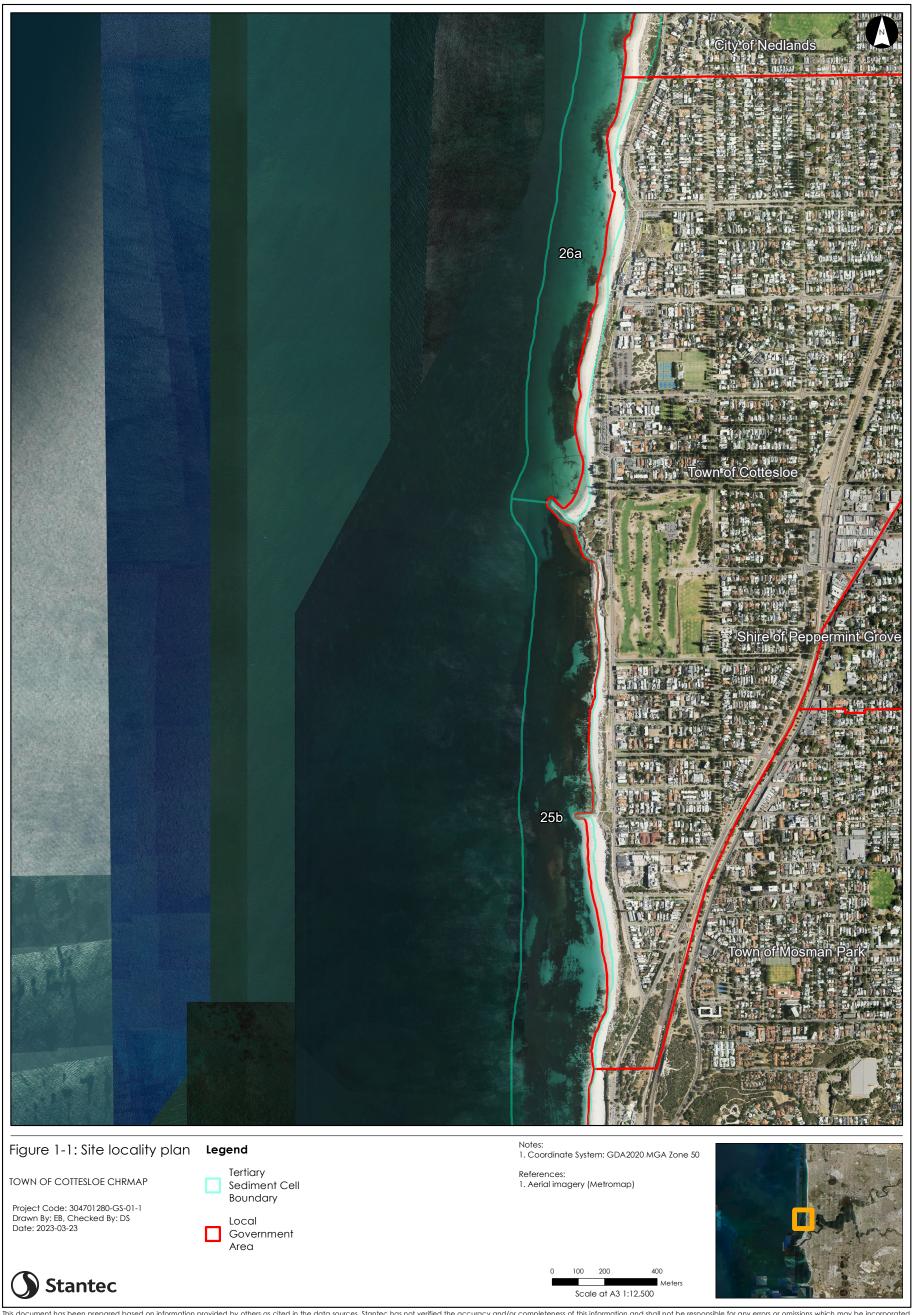
Globally, mean sea level (MSL) has risen since the nineteenth century and is predicted to continue to rise, at an increasing rate, through the twenty first century (Intergovernmental Panel on Climate Change [IPCC], 2021), bringing changes to the WA coastline over the coming decades. To prepare for sea level rise (SLR) induced coastal hazards, such as coastal erosion and inundation, all levels of government are putting processes in place to ensure that communities understand the risks to values and assets on the coast, and to plan to adapt over time.

Changes to MSL over the past century have been observed for the coastline adjacent to the Perth Metropolitan Area. Sea Level Change in Western Australia – Application to Coastal Planning (Department of Transport [DoT], 2010a) reviewed information relating to SLR at a local scale and recommended an allowance for SLR be adopted for planning purposes. Recommendations were based on the upper bound of the global average SLR projections from IPCC's Fourth Assessment Report [AR4] (IPCC, 2007). In the intervening years, following release of the DoT document, advances in climate change science have been reflected in revisions to SLR projections, such as those documented in IPCC's Sixth Assessment Report [AR6] (IPCC, 2021). Current guidance on global SLR projections is derived from Shared Socioeconomic Pathways (SSP), characterising the trajectory of global society, demographics, and economics over the coming century. Analogous to the SSP applied in DoT's recommendation is SSP5, which forecasts a SLR of 0.94m between 2020 and 2120 in the IPCC's 2021 report (Figure 1-2).

The Town has a mixed sandy and rocky coastline, featuring sandy beaches, coastal dunes, nearshore reef platforms, visible rocky cliffs, and subsurface rock formations. For areas with visible or subsurface rock, special consideration of the height and integrity of the rock formations is required to ascertain the level of erosion protection that the rocky features will afford adjacent areas. In areas where rock is absent or discontinuous, increases in local MSL generally result in shoreline recession, with a "rule of thumb" often applied, that a 1 cm rise in MSL will result in 1 m of landward recession of the shoreline. It should be noted that this is based on the "Bruun Rule" (Brunn, 1962) which is generally considered a conservative (and simplified) approach (Rosati et al, 2013; Cooper & Pilkey, 2004).

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Town of Cottesloe CHRMAP // Risk Identification Chapter Report 2



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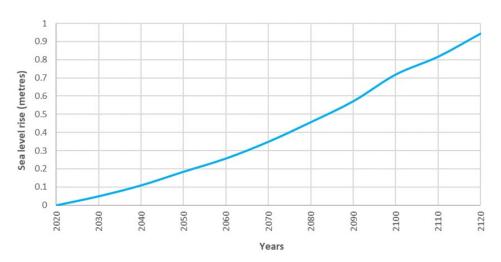


Figure 1-2 Projected SLR for planning purposes in WA (based on IPCC, 2021 & DoT, 2010a).

1.3 Overview of the CHRMAP process

The key policy governing coastal planning in WA is the *State Planning Policy No. 2.6: State Coastal Planning Policy* (Western Australian Planning Commission [WAPC], 2013) (SPP2.6). SPP2.6 recommends that management authorities develop a CHRMAP, using a risk mitigation approach to planning, that identifies the hazards associated with existing and future development in the coastal zone. SPP2.6 and the *State Coastal Planning Policy Guidelines* (WAPC, 2020) contain prescriptive details, for example in relation to scales of assessment, storm event types and SLR allowances.

The WAPC (2019) has also developed the *Coastal hazard risk management and adaptation planning guidelines* (CHRMAP Guidelines) which are less prescriptive in terms of technical assessment of coastal processes but are aimed to ensure that planning is carried out using a risk-based approach. This includes paying due regard to stakeholder engagement, community consultation and education, and requires that a full range of applicable adaptation options are considered. An overview of the typical CHRMAP process and staging is shown in **Figure 1-3**.

Coastal planning in accordance with SPP2.6 also needs to take into consideration the requirements of other planning policies, including Statement of Planning Policy No. 2: Environment and Natural Resources Policy (WAPC, 2003) and Statement of Planning Policy No. 3: Urban Growth and Settlement (WAPC, 2006).

1.4 Purpose of this report

The Town's CHRMAP is being developed in a staged approach, with each stage documented in a standalone chapter report. The chapter reports will be summarised and used to underpin the final CHRMAP document. The purpose of the chapter reporting is to document technical detail, with the final CHRMAP presenting a more accessible and community-friendly document. The chapter reports being prepared as part of the Town's CHRMAP include:

- Stage 1 Establish the Context,
- Stage 2 Risk Identification (this Chapter Report),
- Stages 3 & 4 Risk Analysis and Evaluation,
- Stages 5,6 and 7 Adaptation Planning, and
- Stage 8 Final CHRMAP

This document presents the 'Risk Identification' stage (Stage 2), detailing the coastal hazards identified for the present day (2022), 2032, 2047, 2072 and 2122 planning timeframes. This report includes coastal hazard allowance mapping and the identification of assets that may be impacted by these hazards over the next 100 years.



Town of Cottesloe CHRMAP // Risk Identification Chapter Report 4

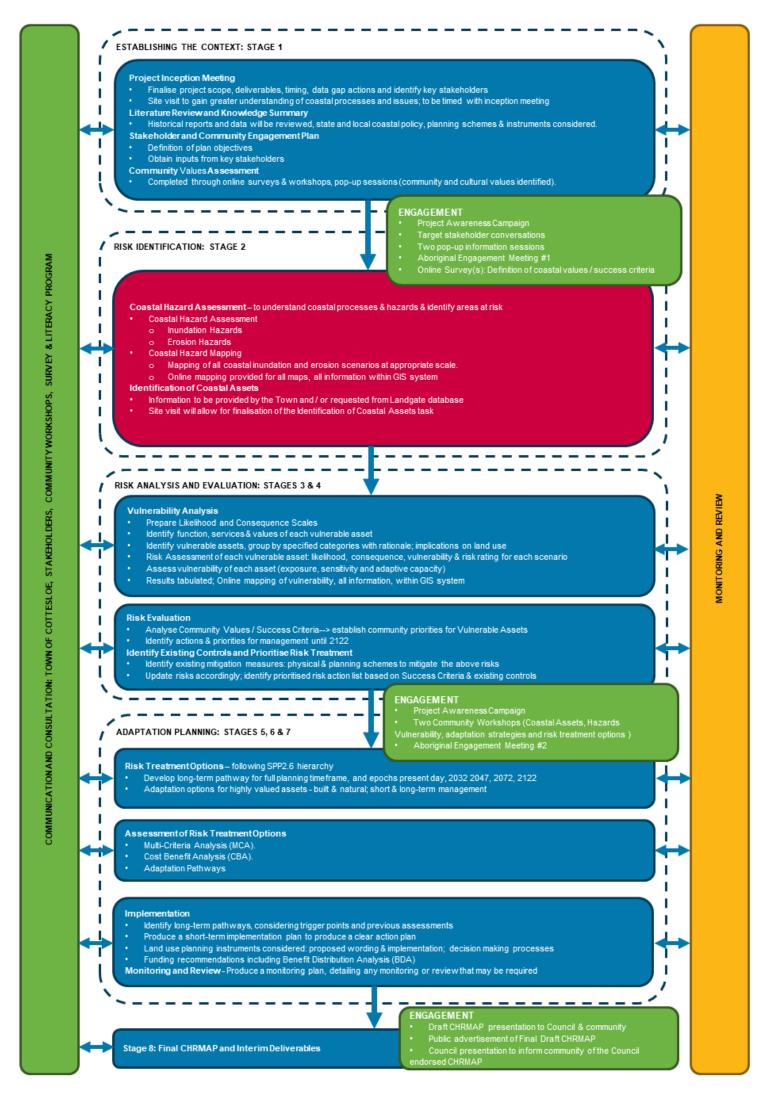


Figure 1-3 Key stages forming the CHRMAP process (Water Technology, 2023).

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Town of Cottesloe CHRMAP // Risk Identification Chapter Report 5

2 Study approach

2.1 Coastal Foreshore Reserve

SPP2.6 provides policy and guidance on the planning principles and guidelines required for coastal development in WA. A key policy objective of SPP2.6 is the provision of a coastal foreshore reserve. The coastal foreshore reserve is essentially a 'space' between the ocean and private land. It should accommodate a range of functions and values such as geomorphological integrity, biodiversity, heritage, public ownership, and access.

Schedule One of SPP 2.6 provides guidance for calculating the coastal foreshore reserve to allow for coastal processes, incorporating acute (storm-based) erosion, historical shoreline movement trends, the future effects of sea level rise and storm tide inundation. The coastal foreshore reserve should be determined on a case-by-case basis and include allowances for additional functions provided by the coastal foreshore region associated with environmental, social, and indigenous values.

The component of the coastal foreshore reserve to allow for coastal processes should be sufficient to mitigate the risks of coastal hazards by allowing for landform stability, natural variability, and climate change. The coastal foreshore reserve is a critical input into the coastal hazard risk management and adaption planning framework outlined in SPP 2.6. The assessment considers allowances for coastal erosion and storm surge inundation in parallel.

2.2 Coastal erosion

2.2.1 Sandy coasts

The natural coastline is, in general, very responsive to the climate and any changes that occur. The allowance for erosion on sandy coasts is calculated as the sum of the S1, S2 and S3 Erosion allowances, plus a 0.2 m per year allowance for uncertainty:

- S1 Erosion: Allowance for the current risk of storm erosion,
- S2 Erosion: Allowance for historic shoreline movement trends, and
- S3 Erosion: Allowance for erosion caused by future sea-level rise.

The erosion allowances are applied from a horizontal shoreline datum (HSD), defined by the active limit of the shoreline under storm activity, at present day (2022). The HSD should be determined against the physical and biological features of the coast.

2.2.2 Rocky coasts

Rocky coasts are defined as comprising a continuous rocky substrate which extends to an elevation above the active limit of the shoreline. In most instances this elevation should be defined at least one metre above the HSD.

Portions of the Town's coastline would be classified as weakly lithified sedimentary rock coast (i.e., limestone), see **Figure 3-8** and **Figure 3-9**. These coasts comprise poorly cemented or semi-lithified, discontinuous, relatively soft, or highly weathered, weak rock. They typically feature low steep cliffs which are easily undercut, often forming wave cut platforms (e.g., Mudurup Rocks). Shoreline retreat is comparatively rapid compared to other types of rocky coasts and generally occurs by slumping, rock-falls, or slab collapse. It has been assumed that, on average, the Town's rocky coastline will recede by 5 cm/year.

2.2.3 Mixed sandy and rocky coasts

Coasts with discontinuous or low elevation rock shall be classified as mixed sandy and rocky coasts. This is the case for most of the Town's coastline, which would be described as rocky platforms. These coasts comprise discontinuous subtidal or intertidal rock on a predominantly sandy shoreline. The subtidal rock may be present as a pavement or discontinuous outcrops of reef close to the shore. Erosion of such coasts are to be considered on a case-by-case basis.



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2 3 Coastal inundation

The allowance for the extent of coastal inundation is calculated as the maximum extent of storm inundation, defined as the peak steady water level, plus wave run-up, for 500-years average recurrence interval (ARI) storm event. Consideration must be given to the likelihood of breaching any manmade structures such as seawalls, or natural barriers such as dune systems. Inundation due to tsunami events should also be assessed and allowed for if an area is prone to such events.

2.4 Climate change considerations

For the Town, the relevant effects of climate change at the coast are predicted to be an increase in MSL, as well as possible minor changes to storm frequency, direction and intensity, changes to precipitation patterns and increased temperatures (CSIRO & BoM, 2022 & 2015; IPCC, 2021). For this CHRMAP, only potential effects due to SLR are considered, including the higher wave energy that this will allow to reach the shoreline.

Adhering to the requirements of SPP2.6, this study will consider the present-day timeframe, as well as the years 2032, 2047, 2072 and 2122 planning timeframes/horizons. Previously recommended allowances for SLR, to be adopted for planning purposes in WA (DoT, 2010), have been updated to reflect advances in climate change science (as recommended by that report). The allowances adopted in this study are provided in **Table 2-1** and have been informed by IPCC (2021). To comply with SPP2.6, the upper bound of the SSP (SSP5-8.5) predictions has been adopted, analogous to that used to inform DoT (2010).

Table 2-1 Sea level rise allowances adopted for this study.

Timeframe	Present day (2022)	2032	2047	2072	2122
Sea Level Rise (m)	0.00	0.05	0.15	0.35	0.94

2.5 Historical data and previous investigations

2.5.1 Vulnerability assessment

The Vulnerability of the Cottesloe Foreshore to the Potential Impacts of Climate Change study was carried out for the Town by Damara WA Pty Ltd (Damara) and Coastal Zone Management Pty Ltd (CZM) in 2008. The main aim of the study was to establish potential risk to existing key coastal infrastructure under a range of future climate scenarios, up to the year 2070. The steps carried out to achieve this aim were:

- Analysis of contemporary coastal conditions (environmental conditions and resultant coastal change),
- · Determination of scenarios for future climate change,
- Prediction of impacts on the physical coastal environment,
- Assessment of implications of physical change for existing infrastructure, and
- Development and assessment of strategic adaptation options.

The study was carried out using a risk-based approach that aligned with international best practice at the time and assessed the most up-to-date climate science. The process was comparable to that of a CHRMAP, for which policy and guidelines had not yet been formed, including three main work phases of risk identification, risk assessment, and risk treatment

With respect to the guidance and information available for this CHRMAP, the study's outcomes and findings are considered to have been restricted by:

- · A lack of local policy and guidance which is now in place,
- Less advanced climate science including various emissions and SLR scenarios,
- Not having data pertaining to subsurface coastal geology, for which it recommended the studies discussed in Section 2.5.2, and
- A lack of quality historical monitoring data specific to coastal hazard risk (see Section 2.5.3).



Town of Cottesloe CHRMAP // Risk Identification Chapter Report 7

2.5.2 Geophysical investigations

The Town commissioned GPGMAPS to undertake geophysical surveys in 2010 and 2011 to address some key knowledge gaps related to the study area's local geology, identified by Damara & CZM (2008). The findings were reported in:

- · Geophysical Investigation for Subsurface Lithology Along the Foreshore of Cottesloe Beach (GBGMAPS, 2010), and
- Ground Penetrating Radar Investigation for Subsurface Lithology along Marine Parade, Cottesloe Western Australia (GBGMAPS, 2011), respectively.

The geophysical surveying included longshore and cross-shore ground penetrating radar (GPR) transects along the coastline between North Street and south of Sydney Street. Cone penetrometer testing (CPT) was undertaken along these transects to validate and help confirm the presence of rock. Based on the longshore segment between Curtin Avenue and North Street, the depth between ground level and bedrock ranged between approximately 5 metres and greater than 10 metres. Between just south of Curtin Avenue and Gibney Street this bedrock was mainly at or above mean sea level (MSL). Other sections of the survey showed that bedrock was below MSL, by greater than 2 metres in places. The compaction of beach sediment was found to be variable with depth along the tested segment, with generally poor compaction in the first 5 metres below the surface. Testing along the transects perpendicular to the shoreline revealed high variability in the depth from surface to bedrock; ranging from 2 metres to greater than 10 metres. Historical geophysical transect locations are shown in **Figure 2-1** and **Figure 2-2**.

Results of geophysical investigations have been interpreted to establish barriers to coastal erosion and, subsequently, inform the calculation of hazard allowances (see **Section 4.5**).

2.5.3 Coastal monitoring

The Town of Cottesloe's Coastal Monitoring Program commenced in November 2014 and has been ongoing since this time, being now in its ninth year. The primary components of the monitoring program are:

- 6-monthly beach profile surveys at, originally 39, now 40 locations along the entire extent of the Town's shoreline.

 These extend from the top of primary dune or fixed infrastructure to the approximate depth of closure offshore,
- Remote shoreline imagery collected every hour (during daylight hours) from, originally 2, now 3 vantage points, and
- Sporadic storm monitoring of Cottesloe Main Beach, including:
 - Additional beach profile surveys collected before and after storm events,
 - Beach sediment samples collected for analysis of particle size distribution (PSD) before and after storm events,
 and
 - The installation of an additional remote imagery camera for one of the winter storm monitoring periods.

The monitoring has been reported on in:

- Cottesloe Coastal Monitoring: Five Year Summary Report April 2014 to March 2019 (Cardno, 2019), and
- A series of annual monitoring reports up to Cottesloe Coastal Monitoring: Annual Summary Report: Year 6 April 2019 to March 2020 (Cardno, 2020).

Recent years of monitoring (beyond year 6) have involved the same data collection without ongoing summary reporting as the Town has elected to report on the data every 5 years.

The monitoring program was designed, and is being undertaken, as a long-term exercise with a key focus on better understanding the Town's exposure to natural coastal variability and hazards, as well as to detect any ongoing climate change effects that may be occurring. The data collected to date has been analysed to inform the risk identification stage of the CHRMAP, including:

- The use of beach profile monitoring data to:
 - Extract the most up to date HSD from which coastal erosion allowances are measured (see Section 4.1.2),
 - Determine the current beach and foreshore topography to underpin coastal inundation allowance mapping (see Section 4.7).
 - Extract appropriate beach profiles for use in Storm-induced BEAch CHange (SBEACH) erosion modelling along the Town's coastline (see Section 4.2.4), and
 - Comparison of both pre- and post-storm profiles, as well as adjacent 6-monthly profiles, to validate the S1 erosion allowance distances derived from coastal erosion hazard modelling.

3

Town of Cottesloe CHRMAP // Risk Identification Chapter Report 8

 The use of remote imagery data, with associated automated shoreline detection, to discern variability and trends in shoreline movement for the locations of capture. This is useful to inform and validate both short-term (S1) and ongoing (S2) erosion allowances that are derived from the risk identification process (see Section 4.2 and Section 4.3, respectively),

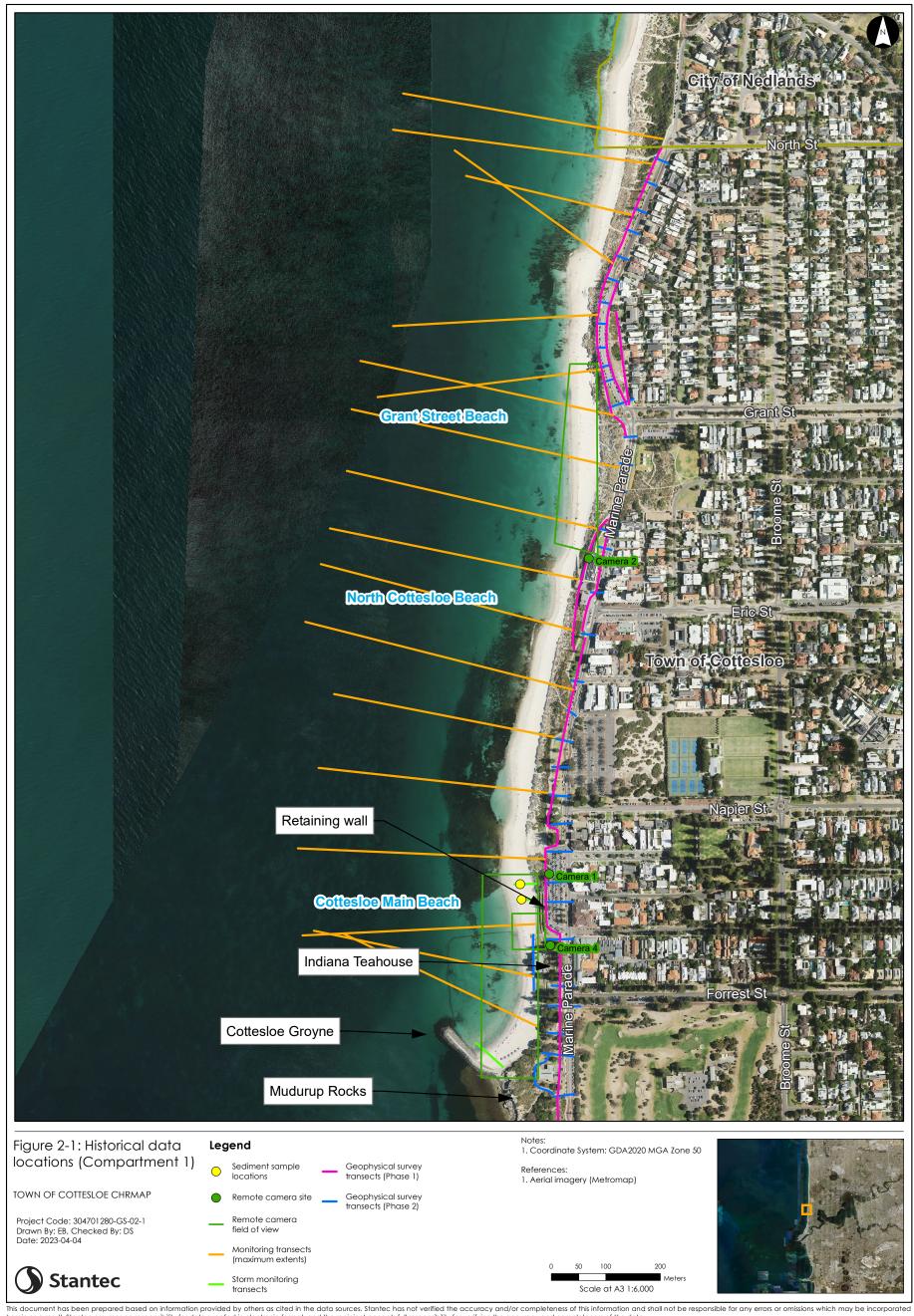
- The use of sediment sample data as a key input to SBEACH storm erosion modelling (see Section 4.2.4), and
- The general assessment of monitored storm events to help inform selection of appropriate conditions for the rare coastal hazard storm events stipulated in SPP2.6.

Historical monitoring locations are shown in Figure 2-1 and Figure 2-2.



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NOVEMBER 2024 ATTACHMENTS



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3 Site description

3.1 Bathymetry and Topography

The bathymetry offshore of the study area includes various limestone reefs and islands, the largest of these being Rottnest Island to the west of the Town. The presence of these rock structures provides some level of protection against the direct impact of offshore wave conditions to the Town's coastline. The shelf adjacent and offshore of these bathymetric features is relatively gentle, with the -30 m AHD depth contour approximately 10 km offshore (DoT, 2010b). Regional bathymetry and topography for the study area is shown in **Figure 4-4** of this report.

In the nearshore area the bathymetry is relatively consistent across the study area. The cross-shore profile slopes gently downwards to the approximate closure depth (i.e., where the profile becomes flat) between -5 and -8 m AHD, approximately 300 m from the shoreline. Immediately adjacent the shoreline, sandbars can become established during periods of elevated wave conditions (Short, 2006). While interrupted by commercial and public development, the dune system remains present across much of the study area, with the primary dune reaching a height of 15 m AHD in some areas.

3.2 Geology and Geomorphology

The geology and geomorphology of the Town's coastline has been described in BMT Oceanica (2015) as follows:

Cottesloe lies on the western part of the Swan Coastal Plain, which extends from the north of Perth to Dunsborough in the south, and from the Darling Scarp in the east to the Indian Ocean in the west (WAPC 1999). The local geology consists mainly of Holocene sands overlying Pleistocene Tamala Limestone, which rests on older sandstone, siltstone, claystone and shales. The Tamala Limestone is calcarenite and forms small rocky headlands and nearshore reef platforms (Searle & Semeniuk 1985; Sanderson et al., 2000).

The beaches comprise a limestone bedrock shelf overlain in most areas by unconsolidated beach sediments. The results of a geotechnical survey undertaken along shore-parallel transects in 2010 between Curtin Avenue and North Street (GPGMAPS, 2010) indicated that that the depth of the limestone bedrock varies alongshore from 5 m to >10 m below the ground surface. Between south of Curtin Avenue and Gibney Street, the bedrock elevation was mainly above or near mean sea level. The bedrock elevation in other areas was below present mean sea level, in some places >2 m below present mean sea level. The survey also indicated variability in sand compaction with depth below the ground surface and distance alongshore, with poor sand compaction most common in the top 5 m (GPGMAPS, 2010).

The results of a second geotechnical survey undertaken along shore-perpendicular transects in 2011 between Curtin Avenue and North Street (GPGMAPS, 2011) indicated that there is a high level of cross-shore variability in the depth of the limestone bedrock, ranging from ~2 m to >10 m below the ground surface. Localised high and low points in the limestone bedrock were observed and may relate to karstic features such as pinnacles and depressions (GPGMAPS, 2011). Section 2.2 provides further discussion on how this geotechnical information may affect coastal vulnerability.

Cottesloe has been classified as a reef-protected, reflective sandy beach with strong currents, and North Cottesloe has been classified as a reflective (steep) beach (Velardo 1998, in Stul 2005). The beaches are backed by calcarenite dunes in most areas, except along a stretch of beach between Warnham Road and the Cottesloe Surf Lifesaving Club that is backed by concrete seawalls, paved pathways and terraced lawns.

3.3 Oceanography

3.3.1 Wind

The study area is located within the greater Perth Metropolitan Region and experiences the typical meteorological conditions of the region. It is influenced by two dominant seasonal weather patterns. The summer period is characterised by south to south-westerly sea breezes that generally increase through the afternoon and can be very strong at times, reaching up to 50km/hr. The winter period is characterised by intermittent storms attributed to mid latitude low pressure systems, bringing more west to north-westerly wind conditions that can exceed 75 km/hr during storms (Bureau of Meteorology, 2022).



Town of Cottesloe CHRMAP // Risk Identification Chapter Report 12

3.3.2 Water Levels

The Town's coastline is located within a predominantly diurnal, microtidal environment. The tidal range varies from approximately 0.3 m during neap tides to 0.7 m during springs. The latest astronomical tidal planes (DoT) at Fremantle Fishing Boat Harbour (FFBH) are provided in **Table 3-1**.

Table 3-1 Astronomical tide regime at FFBH (DoT, 2017)

Tidal Water Levels	m AHD	m CD
Highest Astronomical Tide (HAT)	0.63	1.40
Mean High Water Spring (MHWS)	0.38	1.15
Mean High Water Neap (MHWN)	0.27	1.04
Mean Sea Level (MSL)	0.00	0.81
Mean Low Water Neap (MLWN)	-0.20	0.57
Mean Low Water Spring (MHWN)	-0.30	0.47
Highest Astronomical Tide (LAT)	-0.51	0.26

3.3.3 Currents

The small tidal movement at the study area allows wind to be the major driver of currents, particularly within the nearshore zone. Longshore currents correspond to seasonal wind and wave conditions, predominantly propagating northward during summer and to the south briefly during winter. The interaction of these currents with shoreline features can form local eddy and rip currents, particularly when swell is present driving substantial water movement perpendicular to the shore (Pattiaratchi et al., 1997).

3.3.4 Wave Climate

The regional offshore wave climate is bimodal with respect to period and direction. A persistent background swell is present all year round from the Indian and Southern Oceans. This swell is predominately from the south to south-west, with an increased westerly component during the winter period (Lemm et al., 1999).

Superimposed on the swell regime is a highly-variable, locally generated sea climate attributed to the seasonal wind patterns that characterise the region. The winter period waves are driven by west to north-westerly conditions, associated with intermittent mid-latitude low pressure systems. The summer period waves are driven by a frequent and strong southwesterly sea breeze, attributed to pressure differences between the ocean and land (Lemm et al., 1999).

Tropical cyclones that develop during the summer months off WA's north-west coast rarely track down to the study area's latitude but have been recorded in the region (Tropical Cyclone Alby and Ned for example) and can cause significant wave conditions over relatively short durations (MPRA, 2018).

The Town is afforded some protection from offshore wave conditions by Rottnest Island offshore to the west and, closer to shore, by discontinuous limestone reef structures scattered adjacent to the coastline. The depth of the reef structures play a significant role in dissipation of wave energy reaching the shoreline. This dissipation is expected to lessen in the future as mean sea level rises.

3.4 Sediment transport

The sediment transport regime along the Town's coastline has been described in BMT Oceanica (2015) as follows:

Beach sediments at Cottesloe, as with most beaches along the Perth Metropolitan Coast, are comprised mainly of quartz sands of both marine and terrestrial origin, and calcareous material of biogenic origin (Stul, 2005). The calcareous sand is a mixture of fresh skeletal material derived from offshore seagrass banks and reefs, and reworked shell fragments derived from erosion of the Tamala Limestone at the coastline and nearshore area (Sanderson et al., 2000).



Town of Cottesloe CHRMAP // Risk Identification Chapter Report 13

The longshore sediment transport at Cottesloe has been observed to be predominantly northward for ~8 months of the year (September to April) and predominantly southward for ~2 months (June and July), with an annual net sand movement northward (Kempin, 1952). The reef and the rock groyne at Mudurup Rocks act as a barrier to longshore sediment transport, largely blocking southward sediment transport in the winter and northward sediment transport in the summer. This reportedly causes accretion at Cottesloe beach north of Mudurup Rocks in winter and erosion in summer (Kempin, 1952; cited in CZM & Damara, 2008). The shoreline south of Mudurup Rocks has very little sand cover, which may be due to the combined effect of southwards sand transport into the 'shadow area' behind Fremantle North Mole and scouring of the beach by northerly currents (Kempin 1952). Low-lying offshore reefs present along some parts of the Cottesloe coastline can dissipate a large proportion of incident wave energy, but they do not tend to block longshore sediment transport and can instead accelerate it because of the wider surf zone they generate (Silvester, 1961).

The seasonal pattern of cross-shore sand movement at Cottesloe is characterised by the movement of sediment shorewards by summer swell to construct a steep beach profile (Silvester, 1961). The first winter storms then erode the steeply sloped beach to form an offshore sand bar. Erosion then tends to slow or cease when this sand bar is sufficiently high to cause breaking of incident waves (Silvester, 1961).

3.5 Sediment Cells

Sediment cells are areas along the coastline which are likely to be connected through processes of sediment exchange. Stul et al. (2015) mapped sediment cell boundaries at three spatiotemporal scales along the Western Australian coastline between Cape Naturalist and Moore River. The three scales are described below and depicted for the area relevant to the Town in **Figure 3-1**:

- Primary cells are related to large landforms or land systems over longer coastal management timescales of more than 50 years. The study area falls in primary cell R06F which spans from the engineered section of the coast at Fremantle to Pinaroo Point
- Secondary cells incorporate contemporary sediment movement on the shoreface and potential landform responses
 to inter-decadal changes in coastal processes. The study area is spread across cells 25 and 26. Cell 25 spans from
 South Mole Fremantle to Mudurup Rocks, cell 26 from Mudurup Rocks to Trigg, and
- Tertiary cells are defined by the reworking and movement of sediment in the nearshore and are the most relevant for seasonal to inter-annual changes to the beach face. The study area is spread across cells 25b and 26a. Cell 25b spans from Leighton Salient to Mudurup Rocks, cell 26a from Mudurup Rocks to North Swanbourne pipe.



Town of Cottesloe CHRMAP // Risk Identification Chapter Report 14

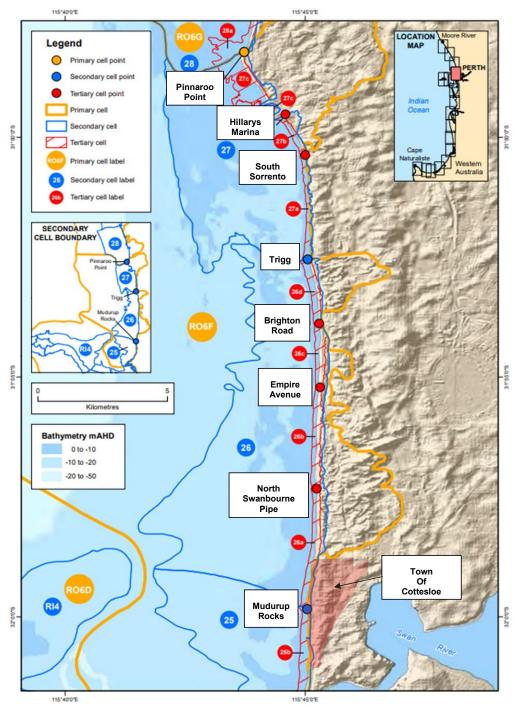


Figure 3-1 Coastal sediment cells relevant to the study area presented in Stul et al. (2015).



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3.6 Coastal controls

3.6.1 Overview

Existing coastal controls should be identified and incorporated in the coastal hazard identification and risk assessment, as recommended in the CHRMAP Guidelines (WAPC, 2019). In the context of coastal processes, controls are physical and include structures that currently interact, or have the potential to interact in the future, with oceanographic conditions and coastal processes. Such structures include seawalls, groynes and breakwaters. Controls also include ongoing management/intervention activities, such as beach nourishment, dredging and sand by-passing. The existing physical controls identified for the study area are outlined in **Table 3-2** below and discussed further in the below sub-sections.

Table 3-2 Summary of coastal controls

Table 3-2 Summary of coastal controls					
Control	Location	Purpose	Year implemented	Assumed remaining design life / management timeframe	
		'Hard' engineering controls			
Cottesloe Groyne at Mudurup Rocks (Figure 3-2)	Mudurup rocks, 100 m south of Forrest Street	Interrupt southwards transport of sediment during winter storms to maintain a sandy beach	1960 (refurbished 2007)	25 years	
Beach Street Groyne (Figure 3-3)	Adjacent to Beach Street	Stabilisation of adjacent beaches	1960s	25 years	
Cottesloe beach retaining wall (Figure 3-2 and Figure 3-5)	Between Forrest St and Warnham Rd	Protection for development at Cottesloe Beach including Indiana Teahouse and carpark	1930	10 years	
Cables Artificial Surf Reef	Approx 300 m offshore from Vlamingh Memorial	Creation of a more consistent surf spot in the Perth metro area	1999	20 years	
'Soft' management controls					
Nourishment at Port Beach (City of Fremantle)	Approximately 2 km south of Town of Cottesloe	To replenish the beach at Port Beach, protecting assets and preserving sandy beach. Nourishment material may shift north into the Town's coastal areas.	2022 - 2023	Unknown	
Dune management / protection	Various locations along Cottesloe coastline	Protect dunes and their vegetation from being degraded.	Various	Likely to be present into the future.	
Dune restoration / revegetation	Various locations along Cottesloe coastline	Restore, enhance and consolidate dunes.	Various	Likely to be present into the future.	



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3.6.2 Groynes

The Cottesloe Groyne at Mudurup Rocks and to the south of the main beach at Cottesloe was constructed in 1960 and refurbished in 2007 (**Figure 3-2**). The groyne is comprised of granite armour stones. The Beach Street Groyne was constructed in the 1960s and is comprised of limestone armour rock (**Figure 3-3**). Such structures are generally designed (and refurbished) on the basis of a 40- to 50-year design life. However, the structures often remain in place and functional well beyond these periods.

Groynes provide no direct barrier to coastal erosion (except to areas directly landward), but rather affect/control the shoreline either side of their position by interrupting longshore sediment transport. They can also create a localised barrier to wave energy when waves approach them at an angle, encouraging more sediment to reside in the lee of this direction of approach. This is the case for the Cottesloe Groyne and main beach, with respect to south-westerly waves. Conversely, they can also create reflection and scour of the beach on the side that waves approach from.

The hazard identification process assesses erosion that is predominantly associated with cross-shore processes (e.g., via SBEACH and the simplified Bruun Rule). Acute erosion (i.e., intra-annual) that can be more pronounced due to groynes interrupting longshore sediment transport is not a process that is properly assessed by the risk identification (see **Section 4.2**) as this would require complex sediment transport modelling. To incorporate any coastal control exerted by a groyne in the assessment process, two key factors have been considered:

- Has the coastline adjacent the groyne reached dynamic equilibrium? When a coastal structure is installed, the coastline around it will gradually adjust for its presence, due to a changed local metocean and sediment transport regime. This process can take decades, depending on the location and size of the structure. The coastline adjacent the Town's groynes is considered to be in dynamic equilibrium, given the long-term presence of the structures and no discernible net trend of change detected for beaches adjacent the groynes (by ongoing beach profile surveys), and
- The term 'dynamic equilibrium' was used above as the beaches adjacent groynes often demonstrate more
 pronounced seasonal changes than those without nearby coastal structure (e.g., Cottesloe Main Beach vs North
 Cottesloe Beach). Given the higher variability in shoreline and beach form, it is important that this is considered when
 determining the beach profile from which coastal hazard allowances are measured (i.e., at what time of year). This
 consideration is described further in Section 4.1.2.

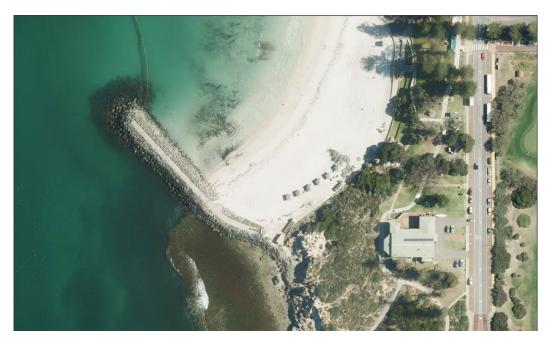


Figure 3-2 Cottesloe Groyne and portion of retaining wall (Metromap, 2022).

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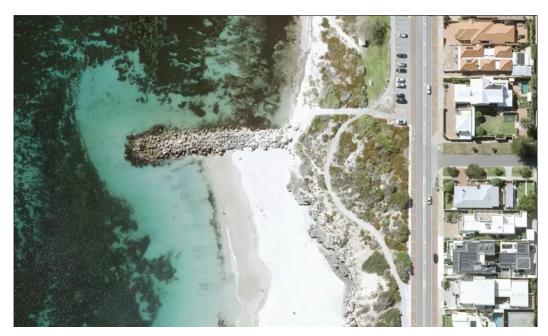


Figure 3-3 Beach Street Groyne (Metromap, 2022).

3.6.3 Cottesloe Beach retaining walls

Retaining walls have been constructed at the back of the beach along Cottesloe Main Beach, including in front of the Indiana Tea House. It is unlikely that these structures have sufficient foundation scour protection or can withstand the direct impact of wave action in the way an engineered seawall/revetment can. As such, they are not included as formal barriers to coastal erosion in the calculation of hazard allowances, although they are likely to restrict erosion landward of their location, to some extent. This effect should be considered as part of the risk assessment process. A remaining design life of 10 years has been assumed, though they are likely to be in place beyond this.

3.6.4 Nourishment activities

There are no ongoing nourishment programs within the Town and there are no recent, historical nourishment activities on record. A significant nourishment program is underway at Port Beach, approximately 2 km to the south of the Town. The project plans to add up to 150,000 m³ of sediment to Port Beach, sourced by dredging from Fremantle Port's Deepwater Channel. Through the process of longshore drift, this program may also affect the Town's coastline. As the effect on the Town's coastline is uncertain and it is unknown if such dredging and nourishment will continue into the future, it has not been incorporated for the purpose of controlling coastal hazard allowances.

3.6.5 Dune management / protection

Fences have been installed by the Town at popular beach access tracks through the dunes and either side of vegetated foredunes. This limits pedestrian access, promoting coastal dune restoration and, potentially, growth over time. These are critical natural barriers to erosion, so the practice is a form of coastal protection. The effect of these works are captured in the hazard identification process, indirectly, through calculation of S1 and S2 erosion allowances (see **Section 4.2** and **Section 4.3**, respectively).

3.6.6 Dune revegetation / restoration

Coastal revegetation and restoration is undertaken throughout the Town's coastline, predominantly by Cottesloe Coastcare. The activities are critical to ensuring the long-term survival of the native flora and fauna and their habitat. Direct planting in combination with soil erosion controls is designed to assist revegetation and enhance the value of coastal reserves. This also helps stabilise coastal dunes and maintain them as natural barriers to coastal erosion. The effect of these works are captured in the hazard identification process, indirectly, through calculation of S1 and S2 erosion allowances (see Section 4.2 and Section 4.3, respectively).

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3.7 Coastline description

3.7.1 Compartment 1 - Sediment Cell 26a

Compartment 1 extends from the Town's northern boundary at North Street to Mudurup Rocks and is classified as a mixed sandy and rocky coastline. The section of coast consists of perched beaches backed by remnant sand dunes. Winter storms often wash away sand at Grant Street Beach, exposing rocky platforms, at, and above MSL (Figure 3-4). Sand generally reaccumulates during spring, burying most of the rock by the summer months. The section of beach adjacent to Overton Gardens also contains rock platforms that often become exposed during winter. The remainder of the segment's rock remains largely buried year-round, including at the iconic Cottesloe Beach.

Cottesloe Groyne is located at Mudurup Rocks, the southern boundary of the compartment. Built in 1960, the groyne was constructed to trap the southwards transport of sediment during winter, preventing rock being exposed, and in turn, increasing the amenity and popularity of the beach.

The compartment includes a number of commercial and residential developments along Marine Parade as well as the Indiana Teahouse, carpark and Cottesloe SLC which lie seaside of Marine Parade. In the north of the compartment is the North Cottesloe SLC and adjoining restaurant and café. A retaining wall exists along the back of the beach between Forrest Street and Warnham Road, running in front of the Indiana Teahouse and southern half of the main carpark. Winter storms coinciding with high water levels and a receded shoreline have resulted in wave action occasionally impacting this wall (**Figure 3-5**), with scour exposing limestone bedrock in front of the Teahouse.



Figure 3-4 Portion of the coastline looking north from North Cottesloe SLC, captured in August 2017, exposed rock can be seen in the top of frame.

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Figure 3-5 Portion of the coastline looking south from Cottesloe Main carpark, captured in May 2018, waves can be seen impacting the southern section of the retaining wall.

3.7.2 Compartment 2 – Sediment Cell 25b

Compartment 2 extends from Mudurup Rocks to Vlamingh Memorial, the southern boundary of the study area. The north of the compartment includes calcarenite cliffs (Mudurup Rocks) fronted by an intertidal rock platform which anchors the beach to its south (**Figure 3-6**). Exposed rock above MSL is present year-round immediately south of Mudurup Rocks and during the winter months the area of exposed bedrock extends over 200 m southward. To the south of this the coastline is classified as mixed sandy and rocky (**Figure 3-7**). Geophysical survey indicates rock exists at, or above, MSL for most of the compartment, with rocky outcrops also visible immediately south of the Beach Street Groyne and adjacent to the Vlamingh Memorial.

A portion of the coastline is compartmentalised by the Beach Street and Cottesloe Groynes, which interrupt the longshore sediment transport regime and can cause the beach to be thinner or wider than its natural state, depending on seasonality and ongoing longshore transport trends. The net effect of the groynes is likely to be an advancement of the shoreline position beyond its natural alignment. Several nearshore reefs result in a reduction of wave energy, providing a level of protection for this section of the Town's coastline (compared to Compartment 1).

The compartment is backed by a thin foreshore reserve with relatively steep foredune, Marine Parade, residential properties, and Sea View Golf Club.



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Figure 3-6 A portion of shoreline to the north of Beach Street Groyne captured in May 2022, Mudurup rocks and Cottesloe Groyne can be seen in the distance.



Figure 3-7 A portion of shoreline to the north of Vlamingh memorial captured in May 2022, Beach Street Groyne can be seen in the distance.

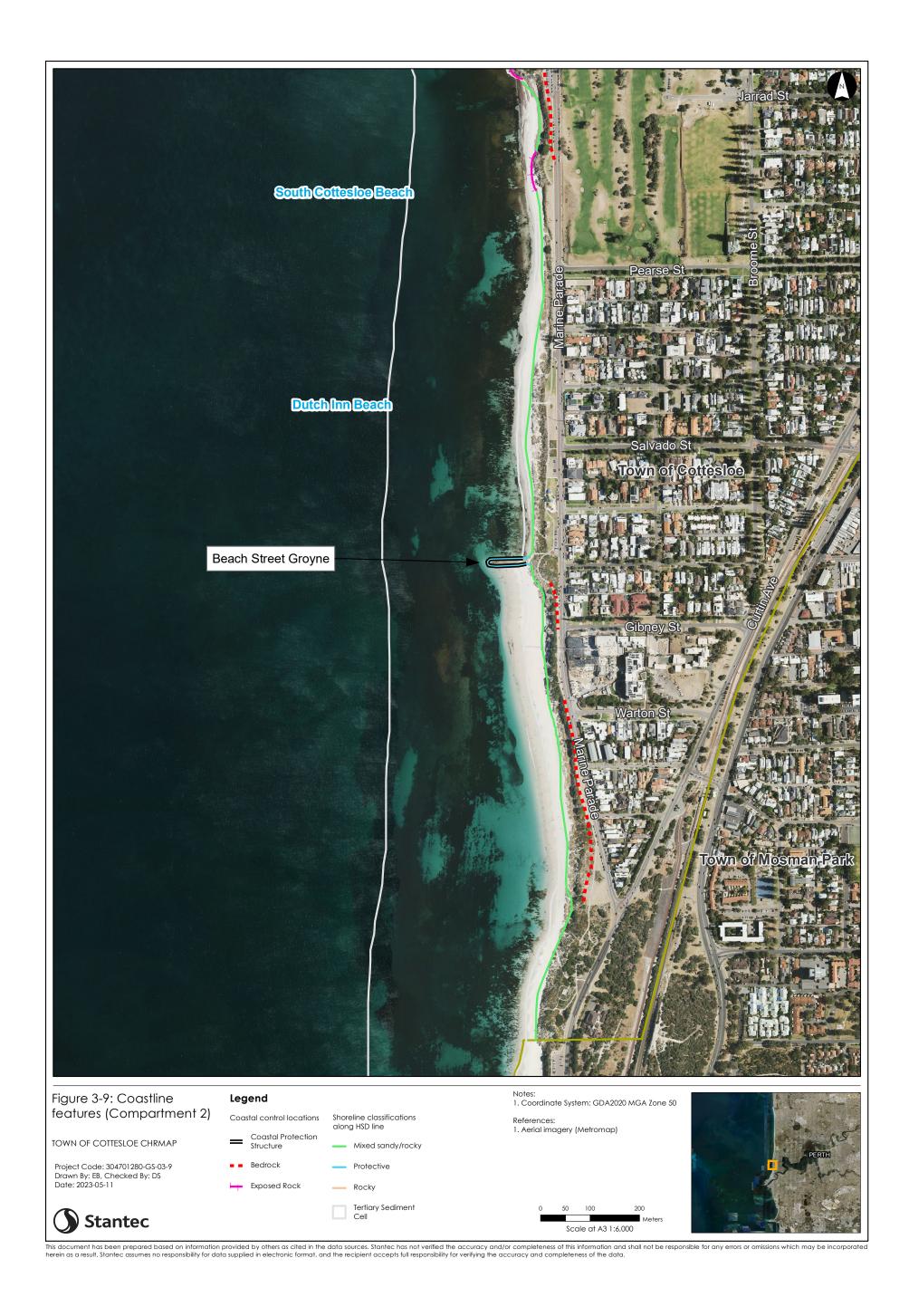
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4 Coastal hazard assessment

4.1 Overview

Present and future coastal hazard allowances for the study area have been defined using available data (described in **Section 2.5**) and adhering to the methodologies specified in SPP2.6 and the CHRMAP Guidelines. This section details the components and calculations of the various coastal hazard allowances, across the 100-year planning time frame, to define the width of the coastal foreshore reserve component that allows for coastal hazards. Key information associated with the coastal hazard assessment has been appendicised as follows:

- Appendix A S1 (SBEACH) erosion modelling outputs.
- Appendix B Coastal hazard allowances summary.
- Appendix C Coastal erosion allowances maps.
- Appendix D Coastal inundation allowances maps.

The calculation of hazard allowance components is described in more detail below. The study area has been divided into four sections for the purpose of mapping hazard allowances, to ensure sufficient resolution and viewability.

4.1.1 Assessment timeframes

The assessment timeframes for which coastal hazard allowances have been assessed, as per the scope of works, are:

- 2022 present day.
- 2032 10-year timeframe.
- 2047 25-year timeframe.
- 2072 50-year timeframe. and
- 2122 100-year timeframe.

4.1.2 Assessment spatial references

Coastal erosion allowances for the CHRMAP are to be extended landward from the present-day (2022) HSD, as per the guidance of SPP2.6. The policy states that the HSD should define the active limit of the shoreline under storm activity and should be defined as the seaward shoreline contour representing the peak steady water level under storm activity, during the adopted 100-year ARI erosion storm event. The HSD has been based upon topography defined by analysis of beach profile monitoring conducted across the past 5 years (2017-2022), to ensure it is accurate and up to date. An average (vertically averaged) pre-winter profile was developed at each of the historical monitoring profile locations, representing the average profile (bathymetry/topography) going into the start of winter. The start of winter is the period in which the most erosive storms have been shown to occur for Cottesloe (Cardno, 2019). Inundation allowances have also been based on averaged monitoring profiles. In areas not captured by monitoring transects, such as coastal structures and exposed rock, LiDAR was used.

Chainage has been defined along the HSD for the study area's coastline, from north to south. Variations in the coastline type, form and exposure lead to variable exposure to coastal hazards. The chainage has been used to describe variations in this exposure along the coastline, where appropriate, for the various hazard allowance components. Specific erosion and water level analysis (see **Section 4.2**) has been undertaken for 17 individual locations along the Town's shoreline. These locations were selected to represents portions of the coastline and account for changes in factors such as exposure to hazards, topography, bathymetry, shoreline orientation, shoreline type and proximity to coastal features. The HSD, chainage, and investigation locations are mapped in **Figure 4-1** and **4-2**.

The coastline has also been compartmentalised as described in **Section 3.7** above. This compartmentalisation is important when determining water level components (e.g., the HSD and allowance for wave set-up), which are generally averaged for modelling results from consistent coastline sections (in terms of bathymetry and exposure).



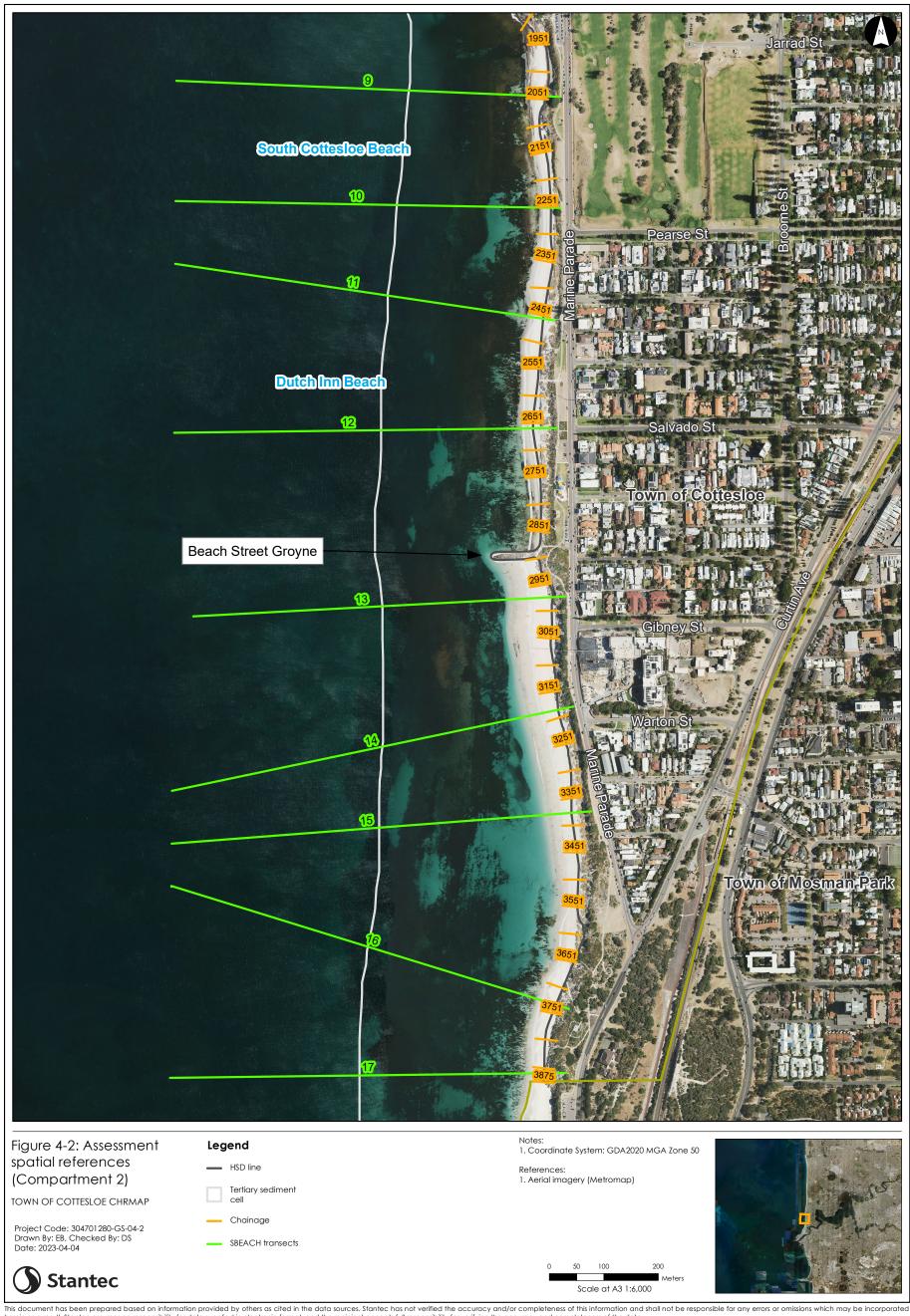
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4.2 Allowance for the current risk of erosion (S1)

4.2.1 Design storm event

Schedule One of SPP2.6 describes four different geographical areas for the definition of the design storm event for the assessment of coastal erosion. The study area lies in area three, which requires the application of a mid-latitude depression or extra-tropical low storm event for coastal erosion. Policy guidance for coastal erosion is that an event corresponding to the 100-year ARI ocean forces and coastal processes should be selected.

For this purpose, the DoT has generated a synthetic design storm sequence based on analysis of actual events for use in the application of SPP2.6 (MPRA, 2018). The storm event applicable to the study area was generated at the location of the Rottnest Wave Buoy, and comprises a large south westerly swell, coinciding with strong south-westerly through to north-westerly winds. Timeseries of the synthetic storm wave and water level conditions at the location of the Rottnest Wave Buoy are presented in **Figure 4-3**.

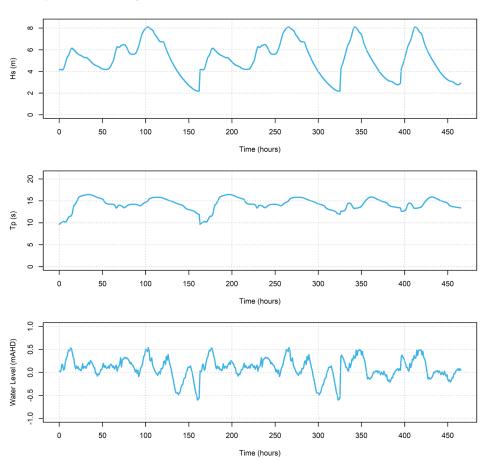


Figure 4-3 Timeseries of design storm wave conditions west of Rottnest Island

Stantec's experience applying the MPRA (2018) design storm, via the SPP2.6 process, to estimate erosion along the Perth Metropolitan Coastline has demonstrated that the synthetic event is not particularly erosive. This is because the study has a heavy focus on assessing extreme wave conditions/energy, with the importance of coinciding water level not properly accounted for. The importance of coinciding water level for cross-shore erosion at Cottesloe has also been demonstrated by dedicated storm monitoring presented in Cardno (2019). This monitoring of six storm events at Cottesloe Main Beach demonstrated that significant erosion did not occur unless the peak storm water level was elevated above 0.8



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mAHD. The peak water level for the synthetic design storm is just above 0.5 m AHD (**Figure 4-3**). As such, the water level time series recommended in MPRA (2018) has been scaled to peak at the 1-year ARI water level at FFBH, to provide a more realistic water level that would be associated with a severe erosion event.

The synthetic design storm represents offshore conditions, specifically at the Rottnest Wave Buoy location. It is not appropriate to directly apply this storm as forcing to coastal erosion models (e.g., SBEACH) from the Rottnest output location, due to the inability of such models to resolve wave shoaling and frictional losses. As such, Stantec have utilised the SWAN (Simulating WAves Nearshore) wave model to transform the synthetic storm conditions to the Town's nearshore zone, prior to simulating the shoreline's response in SBEACH.

4.2.2 Wave transformation modelling

4.2.2.1 Wave Model Description

The SWAN wave model system applied in this study was developed at the Delft University of Technology (Booij et al., 1999), which is incorporated as a module into the Delft3D modelling system. The model can provide third generation full spectral solutions and includes wind input, refraction, diffraction, shoaling, bed friction, white capping, wave breaking, the effect of currents and non-linear wave-wave interaction. It can be applied as a steady-state model for local sea, developed from spatially and temporally variable winds which provides a very reliable basis for generating local sea. The model has been well verified by its authors and is one of the most reliable systems available at present.

4.2.2.2 Wave Grid Setup

The model grid system was prepared with the main objective of providing good resolution near the Town's coastline. Therefore, the SWAN model setup for this study has adopted a nested grid system and is comprised of a fine scale nested grids within outer regional grids. The SWAN model setup consisted of a series of three nested rectilinear grids of increasing grid cell resolution and size (**Figure 4-4**). Cell sizes for each grid are as follows:

- Grid A: Grid cell size is 450m x 450m.
- Grid B: Grid cell size is 150m x 150m.
- Grid C: Grid cell size is 50m x 50m.

4.2.2.3 Bathymetry

The following bathymetric data were used in the wave transformation modelling, in order of preference:

- Two Rocks to Cape Naturaliste LiDAR (DoT, 2016), and
- Geoscience Australia Australian Bathymetry and Topography Grid (Whiteway, 2009).

Figure 4-4 depicts the bathymetry and wave model grid system developed for this study.

4.2.2.4 Boundary Conditions

The offshore open boundary of the coarse grid was forced with the modified synthetic design storm time series (see **Section 4.2.1**) and modelled with a Joint North Sea Wave Project (JONSWAP) spectral shape. As a conservative approach, the synthetic storm was simulated with seven different offshore wave directions (SSW clockwise through to NNW). The direction that resulted in the largest significant wave height at the seaward end of each of the SBEACH profiles (WNW) was applied to the CHRMAP storm time series. The synthetic storm was applied across the western model boundary to bring the storm inshore. Data was extracted at the offshore extents of assessment location profiles for coastal erosion modelling.



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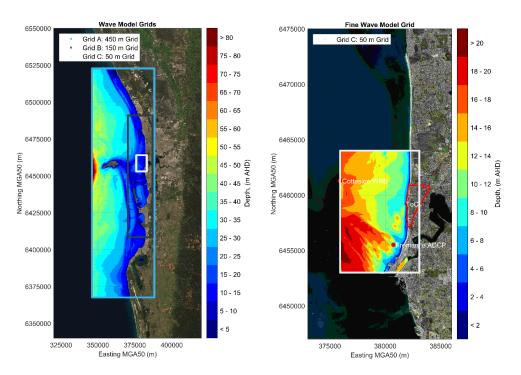


Figure 4-4 SWAN model domain, bathymetry, and calibration data locations

4.2.3 Wave modelling validation

Calibration of the wave transformation model has been undertaken at several locations along the Metropolitan coastline. The two most relevant to the study area are datasets collected by the Cottesloe Waverider Buoy and one of Cardno's short-term ADCP campaigns off Port Beach (see **Figure 4-4** for locations). **Figure 4-5** and **Figure 4-6** demonstrate the model's performance at each location/instrument, respectively.

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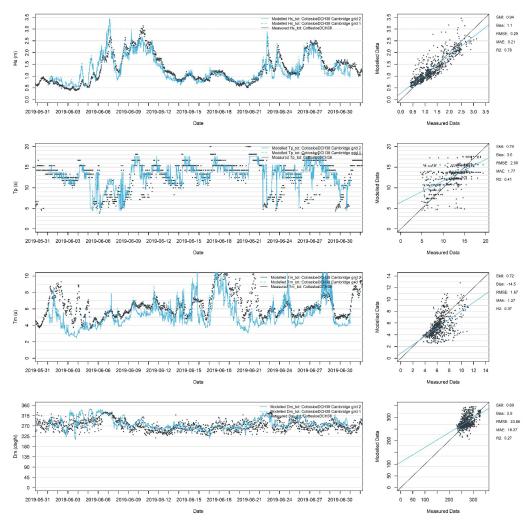


Figure 4-5 SWAN model performance at Cottesloe Wave Buoy

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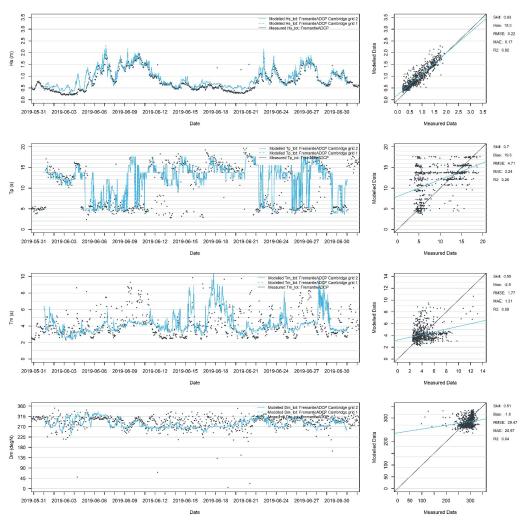


Figure 4-6 SWAN model performance at Fremantle ADCP

4.2.4 Storm erosion modelling

Short-term acute (storm-induced) erosion across the study site was investigated using the SBEACH numerical model, as recommended in SPP2.6, for calculation of the S1 erosion allowance. SBEACH was developed to calculate beach and dune erosion under storm wave action as described in Wise et al. (1996).

A total of 17 shore-normal beach profiles were applied in the simulation of S1 storm erosion, extending offshore to approximately the -10 m AHD contour. The location and length of each profile was based on an assessment of the study area, sediment cells, beach topography, nearshore bathymetry and location of existing monitoring transects for validation. The locations of the 17 SBEACH profiles have been shown above in **Figures 4-1** and **4-2**.

The bathymetric data used for the storm erosion modelling has been primarily derived from survey data collected from 2016 to 2022 as part of the Town's coastal monitoring program, in which 39 beach profiles were surveyed biannually (pre-and post-winter). A mean pre-winter profile was developed at each of the SBEACH transects, representing the average profile going into the start of winter, the period in which the most erosive storms often occur (see also **Section 4.1.2**).

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The median sediment grain size (D_{50}) adopted for the SBEACH modelling north of the Cottesloe Groyne, was based on sediment sampling undertaken during a during storm monitoring between 2017 and 2019 (Cardno, 2019). Grain size south of the Cottesloe Groyne (D_{50}) was chosen based on coastal monitoring undertaken immediately south of the study area (Cardno, 2019). The median diameter (D_{50}) measurements adopted for the SBEACH modelling are provided in **Table 4-1**.

Given the presence of limestone along the Town's coastline, SBEACH modelling has conservatively been undertaken with an assumed presence of bedrock at 0 m AHD landside of the shoreline and at survey level, seaside of shoreline.

The synthetic storm conditions were applied as being perpendicular to the coast at each profile, which is a conservative, however not unrealistic, assumption. The results of the SBEACH simulation for each profile were analysed in order to determine the HSD elevation and the S1 storm erosion allowance for each profile as per SPP2.6. Plots showing the results of the SBEACH simulation for each profile are presented in **Appendix A**.

Table 4-1 Adopted sediment grain sizes (D₅₀)

Transects	D ₅₀ (mm)
1 - 8	0.364
9 - 17	0.467

4.2.5 Erosion modelling validation

The Town of Cottesloe CHRMAP has the benefit of nearly 10 years of continuous historical coastal monitoring data, up to the present data. This dataset has been analysed to validate and, where appropriate, adjust the S1 allowances derived from SBEACH modelling in the following ways:

- Pre- and post-storm monitoring profiles on Cottesloe Main Beach have been analysed to determine erosion distances
 for actual winter storm events. It is noted that these are not necessarily 100-year ARI erosion storm events nor
 sequences, however, the qualitative comparison remains valuable,
- Maximum shoreline erosion between adjacent, 6-monthly beach profile surveys, throughout the whole coastline, have been compared to assess acute effects associated with seasonal changes and/or the effects of a series of storm events (as is the case for pre- and post-winter comparisons), and
- Analysis of images captured by remote cameras have also been used to validate S1 allowances calculated by SBEACH. Years of hourly images were stitched together to form a continuous shoreline width plot in the view of each of the cameras. Winter storms resulting in erosion are then easily identifiable and have been used to check the validity of modelled allowances

4.2.6 Recommended S1 allowances

Adopted S1 allowances at each of the 17 modelled SBEACH transects are tabulated in **Table 4-2**. The modelling validation exercise found SBEACH to be underpredicting erosion south of the Cottesloe Groyne. In such instances, S1 erosion allowances have been based on recorded storm bites (Cardno, 2019).

Table 4-2 Adopted S1 allowances

SBEACH Profile	S1 erosion allowance (m)	Source
1	15	SBEACH
2	12	SBEACH
3	8	SBEACH
4	15	Monitoring
5	13	SBEACH
6	13	SBEACH
7	12	SBEACH
8	22	SBEACH
9	6	Monitoring

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10	6	Monitoring
11	7	Monitoring
12	12	Monitoring
13	20	Monitoring
14	11	Monitoring
15	11	Monitoring
16	10	Monitoring
17	15	Monitoring

4.3 Allowance for historic shoreline movement trends (S2)

An analysis of historical vegetation lines based on aerial photography has been undertaken in order to estimate the historical shoreline movement trends and thus an appropriate S2 allowance, in line with the requirements of SPP2.6. This analysis method assumes the movement of the vegetation line is a valid proxy for shoreline movement.

4.3.1 Analysis of historical vegetation line movements

Analysis of historical shoreline movement included of a review of vegetation lines based on historical aerial imagery for the following years: 1975, 1985, 1990, 1996, 2008, 2016 and 2019. The analysed vegetation lines were chosen due to their coverage of a large proportion of the study area and temporal spacing.

In order to estimate the long-term average shoreline movement rate, the change in shoreline position was analysed between each of the selected years and a baseline time period, nominally 1985, depending on the location. The analysis was undertaken at each 100 m interval along the length of the study area.

Based on analysis of the average rates of shoreline change across the study area, an S2 rate of annual shoreline movement was derived. The selection of this rate has considered the various coastal controls along the length of the Town's coastline. As a conservative approach and in line with the recommendations of SPP2.6, the S2 erosion allowance was selected as zero for all areas where long-term accretion has been observed.

4.3.2 Analysis of historical profile surveys

Eight years of historical profile survey data along the Town's coastline are available. This dataset is not of sufficient length to infer long-term shoreline movement, however, the survey data has been used to validate S2 rates derived from historical vegetation lines. Vegetation lines are often used as a proxy to estimate shoreline change, however, for developed coastlines such as the study area, human activities can often influence their position. Installation of fencing, dune revegetation programs, foot traffic and regular events can all influence vegetation lines. Historical profiles were analysed to check that S2 rates derived through the process referenced in **Section 4.3.1** did not contradict measured data.

4.3.3 Recommended S2 allowances

Analysis of historical vegetation lines and surveys shows the Town's coastline to be relatively stable. Adopted S2 allowances for the study area, differentiated by chainage are tabulated in **Table 4-3**.

Table 4-3 Recommended S2 allowances

Chainage (m)	S2 erosion allowance / year (m)	Chainage (m)	S2 erosion allowance / year (m)
1 to 51	0	1901 to 2151	0.05
51 to 201	0.02	2151 to 2351	0.04
201 to 401	0	2351 to 2551	0
401 to 601	0.11	2551 to 2901	0
601 to 751	0.01	2901 to 3051	0
751 to 901	0	3051 to 3151	0

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901 to 1101	0	3151 to 3301	0
1101 to 1401	0.01	3301 to 3501	0
1401 to 1501	0	3501 to 3651	0.14
1501 to 1701	0	3651 to 3751	0
1701 to 1751	n/a	3751 to 3815	0
1751 to 1901	n/a		

4.4 Allowance for erosion caused by future sea level rise (S3)

In line with the requirements of SPP2.6, for the 2122 planning timeframe, an S3 erosion allowance for projected future sea level rise of 94 m (100 times the recommended sea level rise value of 0.94m) was adopted across the study area. For the intermediate planning timeframes of 2032, 2047 and 2072, values of 5, 15 and 35 m, respectively, were adopted (100 times the adopted sea level rise value at each timeframe).

4.5 Incorporation of coastal rock

Much of the Town's shoreline has been classified as 'mixed sandy and rocky' per the guidance of SPP2.6 (see **Section 2.2.3**). Geophysical survey identified the presence of rock throughout the majority of coastline at varying distances from, and elevation above, MSL and the HSD. If the elevation of visible, competent rock was identified above 2.8 m AHD (one metre above the HSD, in accordance with SPP2.6), or above 3.8 m AHD for subsurface rock inferred by geophysical survey (1 m added due to uncertainty), it has been considered as a barrier to erosion. These areas have subsequently been treated as per the required assessment of 'rocky coasts' in SPP2.6. Protective rock formations were delineated accordingly based on the geophysical survey results and recent aerial imagery, depicted in **Appendix B** mapping.

The allowance for erosion has followed the 'sandy coast' assessment and associated allowances up until a rock barrier is encountered. Beyond the rock barrier, the erosion hazard extent continues inland at a much lower rate. This rate acknowledges the potential for coastal limestone to erode, but considers the gradual mechanisms of limestone erosion. The rates of erosion applied where rock barriers are present are:

- 0.05 m/year where rock is continuous, visible at the surface and has demonstrated good historical longevity, and
- 0.2 m/year where rock has been identified below the ground surface by geophysical survey. The higher rate is a conservative approach, attributed to the uncertainty around the integrity and durability of the sub-surface rock.

Where an alongshore 'gap' in rock above 3.8 m AHD has been inferred by the geophysical survey, this has been assessed on a case-by-case basis, considering the following:

- Length of the discontinuity, and
- Elevation of rock, if present, in this location.

In general, smaller gaps have maintained the rock erosion rate of 0.2 m/year, as the presence of rock either side and below them is likely to control erosion. Maps in **Appendix B** demonstrate the location of identified rock along the Town's coastline.

4.6 Recommended combined erosion allowances

The coastal foreshore reserve allowances without coastal controls, for coastal erosion at present day, 2032, 2047, 2072 and 2122 are summarised in **Table 4-4**. The full results with each component value are presented in **Table 4-5**. The total allowances were calculated as the sum of the S1, S2 and S3 components plus the uncertainty allowance of 0.2 m/year, as per SPP2.6. The significant range in the total allowance across profiles in later timeframes is due to the presence (or lack thereof) of bedrock.

A second set of erosion lines were generated that considered the protective effect of the retaining walls at Cottesloe Beach. As per **Section 3.6.3**, the retaining walls have been assumed to protect against erosion for the next ten years.



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This results in the present day and 2032 hazard lines remaining seaside of the retaining wall, between chainages 1401 and 1701.

Table 4-4 Coastal erosion allowance summary (without coastal controls)

	stal erosion allowa				2422 ()
Chainage (m)	Present Day (m)	2032 (m)	2047 (m)	2072 (m)	2122 (m)
1 to 51	15	22	35	60	129
51 to 151	12	19	33	58	128
151 to 251	12	19	33	58	68
251 to 401	8	15	28	53	122
401 to 575	15	23	38	66	140
575 to 625	13	20	33	59	69
625 to 751	13	20	33	59	128
751 to 901	13	20	33	58	127
901 to 1101	13	20	33	58	127
1101 to 1151	12	19	32	58	68
1151 to 1375	12	19	32	58	127
1375 to 1501	12	19	32	57	67
1501 to 1551	22	29	42	67	77
1551 to 1701	22	29	42	67	136
1701 to 1751	n/a	n/a	n/a	n/a	n/a
1751 to 1901	0	0.5	0.75	1.25	2.5
1901 to 2125	6	14	27	32	42
2125 to 2351	6	13	27	53	124
2351 to 2551	7	14	27	52	121
2551 to 2901	12	19	32	57	126
2901 to 2951	20	27	40	65	134
2951 to 3051	20	27	30	35	45
3051 to 3175	20	27	40	65	134
3175 to 3325	11	18	31	36	46
3325 to 3501	11	18	31	56	66
3501 to 3601	11	19	35	40	50
3601 to 3651	11	19	35	63	139
3651 to 3751	10	17	30	55	124
3751 to 3815	15	22	35	60	129



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Table 4-5 Coastal erosion allowance component breakdown

Shoreline chainage	Compartment / sediment cell	Shoreline classification (SPP2.6)	Relevant coastal controls	Relevant assessment profile (SBEACH)	HSD level (mAHD)	S1 erosion allowance (m)	S2 erosion allowance / year (m)	Timeframe bedrock encountered	S3 erosion allowance / year (m) - rocky coasts	Allowance for uncertainty / year (m)
1 to 51	26a	Sandy/Rocky	n/a	1	1.93	15	0	n/a	n/a	0.2
51 to 151	26a	Sandy/Rocky	n/a	2	1.84	12	0.02	n/a	n/a	0.2
151 to 251	26a	Sandy/Rocky	n/a	2	1.84	12	0.02	2072	0.2	0.2
251 to 401	26a	Sandy/Rocky	n/a	3	1.88	8	0	n/a	n/a	0.2
401 to 575	26a	Sandy/Rocky	n/a	4	1.87	15	0.11	n/a	n/a	0.2
575 to 625	26a	Sandy/Rocky	n/a	5	1.82	13	0.01	2072	0.2	0.2
625 to 751	26a	Sandy/Rocky	n/a	5	1.82	13	0.01	n/a	n/a	0.2
751 to 901	26a	Sandy/Rocky	n/a	5	1.82	13	0	n/a	n/a	0.2
901 to 1101	26a	Sandy/Rocky	n/a	6	1.83	13	0	n/a	n/a	0.2
1101 to 1151	26a	Sandy/Rocky	n/a	7	1.72	12	0.01	2072	0.2	0.2
1151 to 1375	26a	Sandy/Rocky	n/a	7	1.72	12	0.01	n/a	n/a	0.2
1375 to 1501	26a	Sandy/Rocky	Revetment walls	7	1.72	12	0	2072	0.2	0.2
1501 to 1551	26a	Sandy/rocky	Revetment walls	8	1.75	22	0	2072	0.2	0.2
1551 to 1701	26a	Sandy/rocky	Revetment walls	8	1.75	22	0	n/a	n/a	0.2
1701 to 1751	25b / 26a	Protection	Cottesloe Groyne	n/a	1.75	n/a	n/a	n/a	n/a	n/a
1751 to 1901	25b	Rocky	n/a	n/a	1.42	n/a	n/a	n/a	0.05	n/a
1901 to 2125	25b	Sandy/Rocky	n/a	9	1.42	6	0.05	2047	0.2	0.2
2125 to 2351	25b	Sandy/Rocky	n/a	10	1.71	6	0.04	n/a	n/a	0.2
2351 to 2551	25b	Sandy/Rocky	n/a	11	1.71	7	0	n/a	n/a	0.2
2551 to 2901	25b	Sandy/Rocky	n/a	12	1.67	12	0	n/a	n/a	0.2
2901 to 2951	25b	Sandy/Rocky	n/a	13	1.56	20	0	n/a	n/a	0.2
2951 to 3051	25b	Sandy/Rocky	n/a	13	1.56	20	0	2032	0.2	0.2
3051 to 3175	25b	Sandy/Rocky	n/a	13	1.56	20	0	n/a	n/a	0.2
3175 to 3325	25b	Sandy/Rocky	n/a	14	1.6	11	0	2047	0.2	0.2
3325 to 3501	25b	Sandy/Rocky	n/a	15	1.65	11	0	2072	0.2	0.2
3501 to 3601	25b	Sandy/Rocky	n/a	15	1.65	11	0.14	2047	0.2	0.2
3601 to 3651	25b	Sandy/Rocky	n/a	15	1.65	11	0.14	n/a	n/a	0.2
3651 to 3751	25b	Sandy/Rocky	n/a	16	1.62	10	0	n/a	n/a	0.2
3751 to 3815	25b	Sandy/Rocky	n/a	17	1.67	15	0	n/a	n/a	0.2



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4.7 Allowance for current risk of storm surge inundation (S4)

4.7.1 Design storm event

Policy guidance for coastal inundation is that an event corresponding to the 500-year ARI or 0.2% annual exceedance probability (AEP) ocean forces and coastal processes should be selected for assessment. Schedule One of SPP2.6 describes four distinct geographical areas for the definition of the type of design storm event for the assessment of coastal inundation, see **Figure 4-6**. The study area for this CHRMAP lies within Area 3, which indicates that the design storm conditions should be associated with a tropical cyclone storm event.

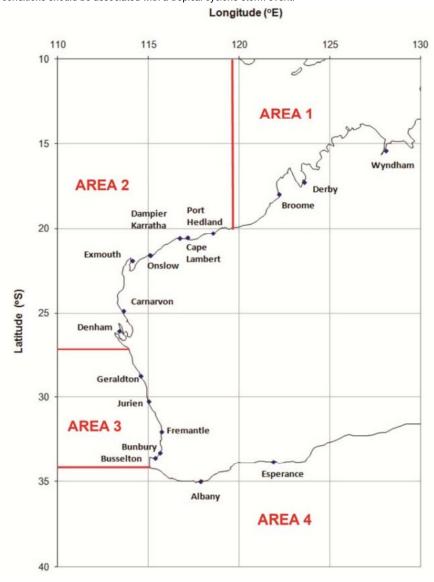


Figure 4-7 Design event coastal areas (extracted from WAPC, 2013)

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4.7.2 Measured water level analysis

The most reliable, long-term water level dataset nearby the study area has been collected at FFBH. Stantec obtained 55 years of quality-controlled water level data (1966-2020) at Fremantle from the DoT. The tide gauge at Fremantle Fishing Boat Harbour is located approximately 5 km south of the southern boundary of the study area. The measured water level record at Fremantle is one of the longest in Western Australia and is still operating, however, DoT have advised that the quality of the data recorded before 19/11/1986 cannot be assured. Accordingly, the measured water level record from 19/11/1986 to 31/12/2022 was analysed as part of this study, which represents a period of approximately 35 years and is essentially continuous with only a small gap in the record in mid-1987. An extreme value analysis (EVA) was carried out on the dataset to estimate a 500-year ARI water level in the region.

4.7.3 Sea level rise detrending

The measured water level record at FFBH was modified to remove the historical sea level rise that is estimated to have occurred over the length of the data record by applying a rate of 2mm/year. This was done such that the measured water level record was made relative to the end date of the record so that the levels from the EVA are relative to the present day (2022).

4.7.4 Extreme value analysis

An EVA was conducted on the top 50%, 40% and 30% of measured water levels above 0 m Australian Height Datum (AHD), with the values associated with the 40% threshold ultimately adopted for the CHRMAP. A 72-hour constraint (1.5 days either side of a peak water level) was applied to ensure all observations used in the EVA were statistically independent. A Weibull EVA was adopted, and the results are presented in **Table 4-6** below.

Table 4-6 EVA analysis results for water levels at FFBH

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ARI (years)		Extreme Water Level at Fremantle (mAHD)	95% Confidence Interval
1		0.96	0.94 - 0.99
	10	1.17	1.10 – 1.23
	50	1.29	1.19 – 1.39
	100	1.34	1.22 – 1.46
	500	1.45	1.29 – 1.61

4.7.5 Wave Setup Allowance

Wave set-up is the increase in ocean water level near to the coast due to wave breaking and the onshore conservation of momentum flux. It is particularly important during extreme events where strong winds can generate large waves. The tide gauge analysed to assess extreme water levels is located in the protected environment of FFBH, and so it is not expected that the measured water level records will properly measure nearshore wave setup, which occurs close to shore due to wave breaking. Thus, it is appropriate and conservative to include an additional allowance for nearshore wave setup on top of the extreme water levels derived by EVA.

The results of the SBEACH modelling (see **Section 4.2.6**) were analysed to determine an estimate for nearshore wave setup at each profile location. The study area has been compartmentalised based on sediment cell classification and general shoreline form and exposure (i.e., north and south of the main groyne). In the northern compartment, SBEACH modelling suggested wave setup could range from approximately 0.8 to 1.0 m and in the southern compartment, between 0.5 and 0.8 m. The average wave setup value encountered in SBEACH modelling for each compartment was adopted (**Table 4-7**).

Table 4-7 Allowances for wave setup

Tubic 4-7 Allowances for wave setup	
Compartment	Wave setup applied (m)
North of Cottesloe Groyne (Sediment Cell 26a)	0.91
South of Cottesloe Groyne (Sediment Cell 25b)	0.68

The calculated wave setup in Cottesloe is comparable to other local government areas along the Perth metro coastline. In the Town of Cambridge, which is a more exposed section of coastline, an average wave setup of 1.08 m was determined during its CHRMAP process (Cardno, 2022a). The City of Stirling's CHRMAP study revealed a wave setup of 1.23 m in



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the higher energy section of the City, south of Trigg Island, and 0.90 m north of Trigg Island due to the presence of nearshore reef systems (Cardno, 2022b).

4.7.6 Wave overtopping and run-up

As specified in SPP2.6 (Schedule One - Section 4.10.1):

On low permeability/impermeable coasts where wave run-up can result in wave overtopping, the coastal foreshore reserve width for this coastal process should be the maximum extent of wave overtopping.

Wave overtopping is important to consider in terms of safety risk, infrastructure damage and potential drainage issues. Due to the height of the dune systems that line much of the Town's coastline, overtopping risk is limited to the access steps/ramp to the Indiana Teahouse.

Wave run-up is defined in SPP2.6 as being the rush of water up a shoreline (or structure) on the breaking of a wave. It is thus only relevant on or immediately behind a beach (or structure) face upon which waves break, where wave run-up might cause water to rush up far enough to inundate an asset or infrastructure located close to the beach (or structure) face

Wave runup and overtopping of the Cottesloe Teahouse access stairs and ramp is expected in later timeframes. The stairs/ramp are backed by a bitumen landing which is sloped back towards the ocean, further retarding flow and allowing drainage. Due to the temporary nature of the flow, an overtopping or runup allowance was not incorporated into inundation hazard lines but will be considered in the risk assessment.

4.7.7 Dune breaching

As specified in SPP2.6 (Schedule One - Section 4.10.1):

Where a continuous barrier dune is present the capacity of the dune to provide protection from inundation should be assessed based on the cross-sectional area of the dune. If the dune reserve, the cross-sectional area of the dune above the peak steady water level, is less than 100 cubic metres, it should be assumed that the dune will be removed during storm activity and the maximum extent of storm inundation should be calculated without the dune.

An assessment of dune topography and capacity was undertaken on this basis throughout the study area. Results indicate that dune breaching is not expected to occur and has, therefore, not been incorporated in hazard allowances.

4.7.8 Tsunami Allowance

SPP2.6 stipulates that an allowance for absorbing the current risk of inundation be adopted based on maximum inundation heights evidenced in tsunami prone areas. The WA coastline is susceptible to tsunami impact from seismic activity, most prominently originating from the Sunda Arc on the southern edge of the Indonesian archipelago. The destructive effects of tsunami across the Indian Ocean were observed during the 2004 Sumatra–Andaman (Boxing Day) event, where maximum run-up height exceeded 30 m on the coastline of Banda Aceh, Indonesia. Along the Perth Metropolitan coastline, the impact of tsunamis is substantially reduced, due to a combination of large propagation distances and offshore bathymetric features (Pattiaratchi, 2020).

Geoscience Australia has recently mapped the offshore tsunami hazard at various depth contours across the Australian coastline (2018). The predicted amplitudes offshore (100 m water depth) from the Town's coastline, for various tsunami ARIs, are provided in **Table 4-8** below. The amplitudes have been predicted based on tsunami propagation of hypothetical earthquakes from major subduction zones around the world. It should be noted that due to limitations in the model resolution, there are inherent uncertainties in the predicted amplitude as the tsunami propagates into shallow water.

Table 4-8 Predicted tsunami wave amplitude above mean sea level at 100m depth contour (Geoscience Australia, 2018)

ARI (years)	Tsunami Amplitude Offshore Study Area (m)	90% Confidence Interval
10	0.04	0.00 - 0.09
25	0.10	0.04 – 0.18
50	0.19	0.07 – 0.30
100	0.27	0.12 – 0.47

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250	0.45	0.22 - 0.83
500	0.64	0.31 – 1.14
1000	0.89	0.39 – 1.48
2500	1.23	0.50 – 1.92
5000	1.53	0.57 – 2.26
10000	1.79	0.63 – 2.71

Given that the Perth Metropolitan coastline is relatively sheltered from the direct impact of tsunami waves originating from the Sunda Arc (Pattiaratchi, 2020), and the relatively high relief topography of the study area, a high-level correlation between the offshore tsunami recurrence interval and the resultant peak water level at the Fremantle Fishing Boat Harbour is considered to be appropriate for this study.

Applying the tsunami propagation equation developed by the United States Army Core of Engineers (USACE) (1989) estimates that the 500-year ARI tsunami would result in an amplitude of approximately 1.15m in 10m of water depth offshore from the study area. This water level would correlate to a recurrence interval between 1 and 10 years for tidal/meteorological water level variation at the FFBH (see **Section 4.7.4**).

The impact of tsunamis on the Perth Metropolitan coastline was recently demonstrated through observations of the peak water level observed as a result of the Sumatra–Andaman (Boxing Day) event in 2004. Using the same equation as above, and the observed peak water level of 0.78 m at the Fremantle Fishing Boat Harbour, it is estimated that the tsunami amplitude was in the order of 0.45m in 100m of water depth offshore from the Study Area, correlating to a tsunami recurrence interval of approximately 250 years.

Given the estimated peak water level in the study area for the 500-year ARI tsunami event is significantly less than the predicted present day 500-year ARI storm induced inundation level, it is reasonable to provide no additional inundation allowance to absorb the current risk of tsunami-induced inundation.

4.8 Recommended inundation allowances

The total steady water levels for storm surge (S4) inundation adopted for this CHRMAP study, which combine extreme water level, nearshore wave setup and future sea level rise, are presented in **Table 4-9** for each of the various planning timeframes. Note that these levels do not include an allowance for the potential effects of wave overtopping and run-up, which may need to be considered for assets and infrastructure located close to the back of the beach face or behind a coastal barrier. Inundation allowances have been used to generate inundation hazard lines for each timeframe, presented in **Appendix C**.

Table 4-9 Adopted S4 inundation allowances across planning timeframes

Table 1 0 Table 0 1 manualism and manual planning annonance							
Compartment	Present Day (2022)	2032	2047	2072	2122		
North of Cottesloe Groyne (Sediment Cell 26a) (m AHD)	2.4	2.4	2.5	2.7	3.3		
South of Cottesloe Groyne (Sediment Cell 25b) (m AHD)	2.1	2.2	2.3	2.5	3.1		



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5 Conclusions and next steps

The coastal hazard assessment conducted along the Town's coastline and the subsequent generation of coastal hazard allowance extents at various timeframes have led to the following conclusions:

- Coastal erosion is the predominant coastal hazard along the Town's coastline, with coastal inundation levels failing
 to breach the Town's dune systems and sections of engineered coastline;
- Historical and ongoing monitoring data has proven valuable for informing model/analysis inputs and validating subsequent outputs and, in some cases, adjusting outputs to ensure risk is properly defined; and
- The establishment of coastal erosion hazard extents is significantly influenced by the presence or absence of limestone bedrock, which exhibits high variability along the Town's coastline.

The next step for the Town's CHRMAP is the asset identification and Vulnerability Analysis (Stage 3), which is documented in the next chapter report. The key activities and outcomes of the next steps include:

- Identification of assets at risk of coastal erosion and inundation by overlaying the hazard allowances over the Town's GIS asset management system.
- Characterising risk for each asset or asset group by combining the likelihood of impact (from the hazard allowances
 presented in this Chapter Report) with the consequence of such impact,
- Determining each asset's adaptive capacity, and
- Assessing overall asset vulnerability by introducing the adaptive capacity of each asset to its risk rating.



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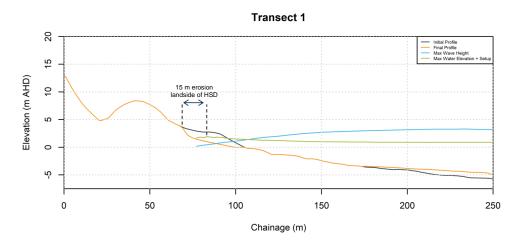


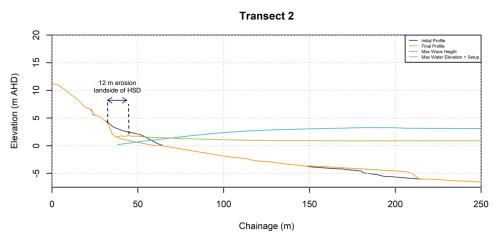
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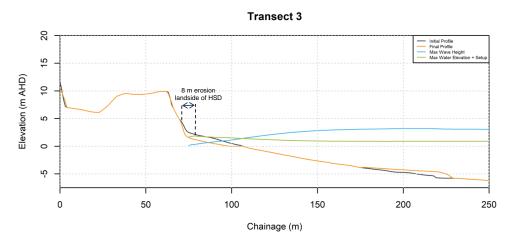
Appendix A SBEACH modelling results

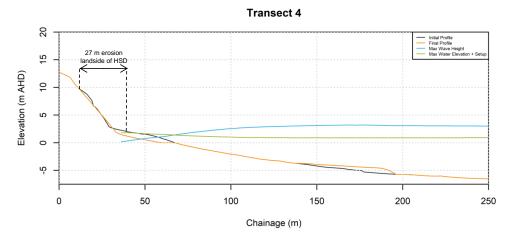


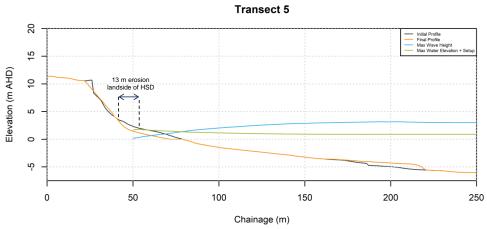
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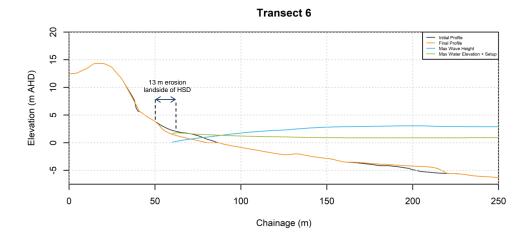


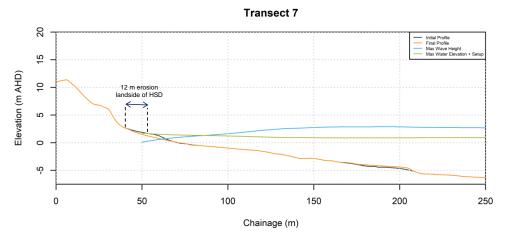


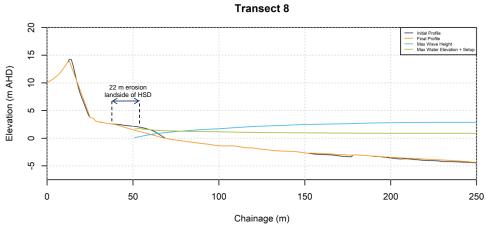


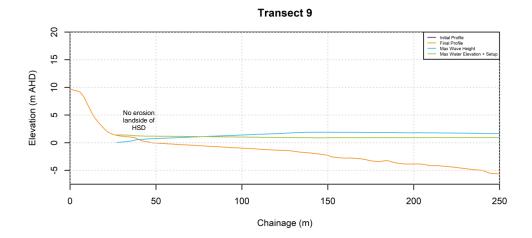


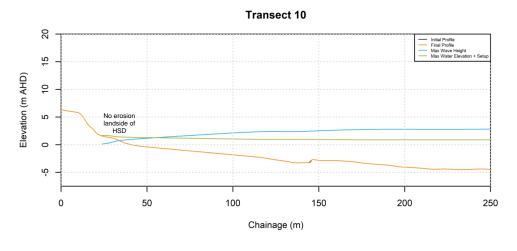


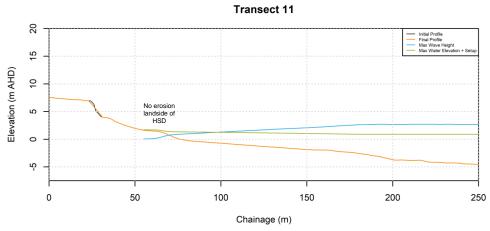


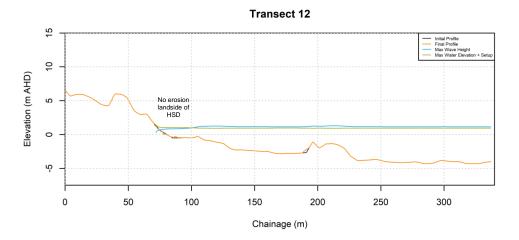


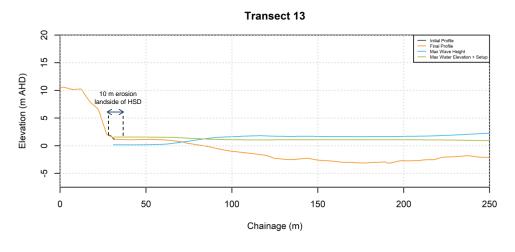


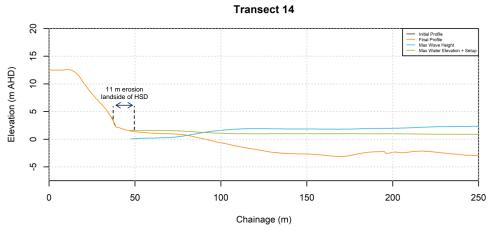


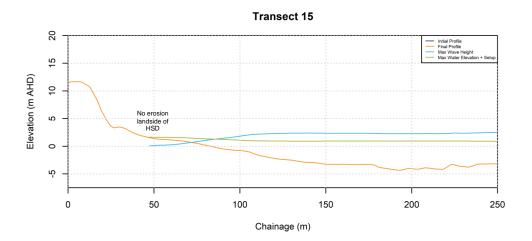


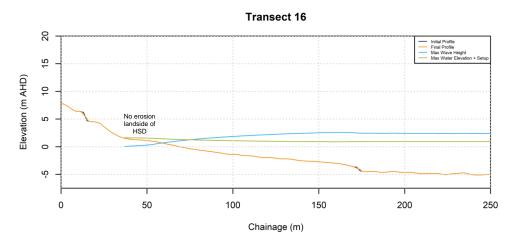


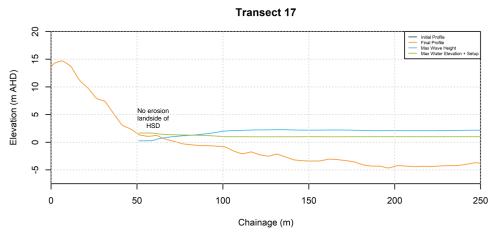












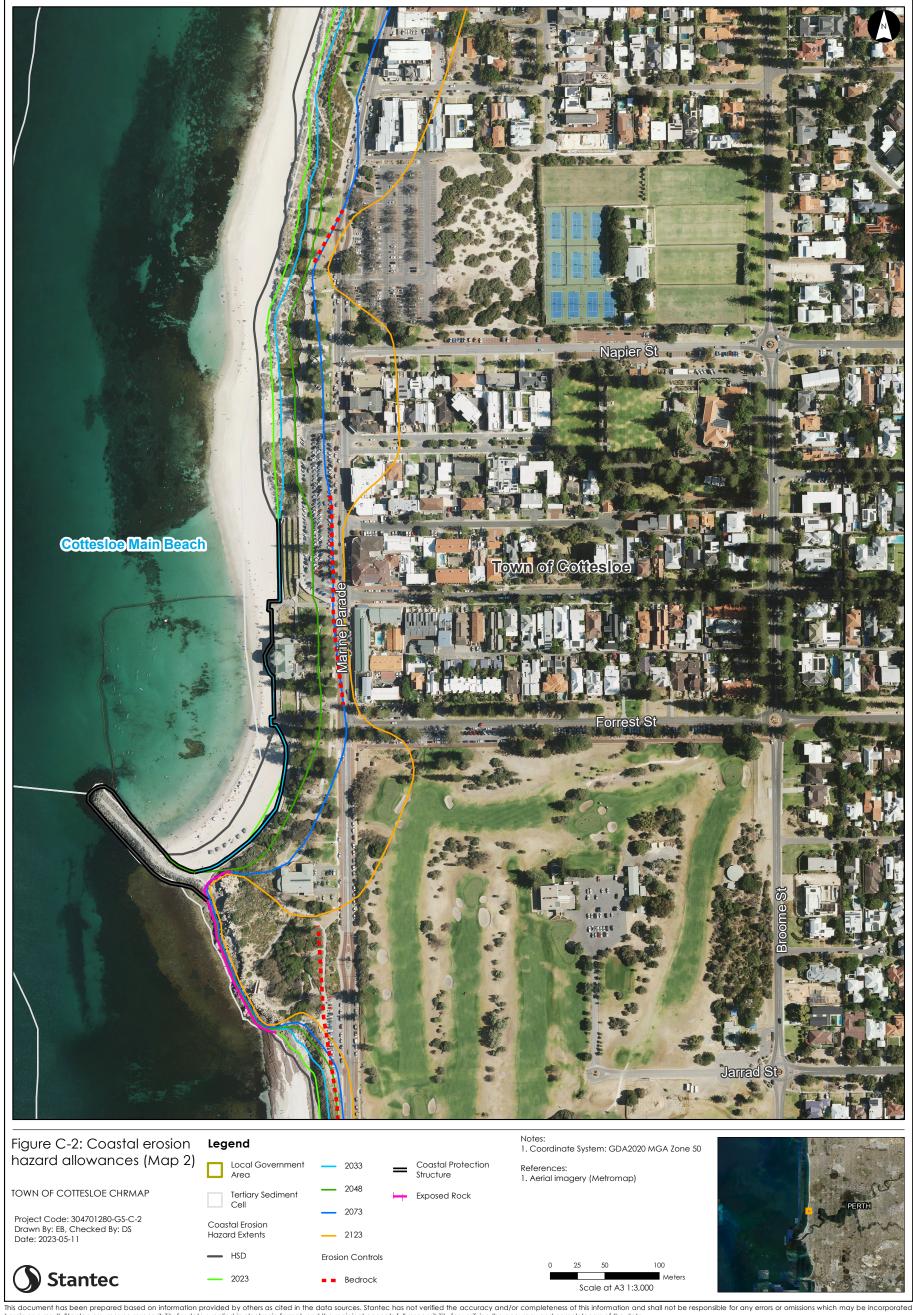
Appendix B Coastal erosion hazard mapping

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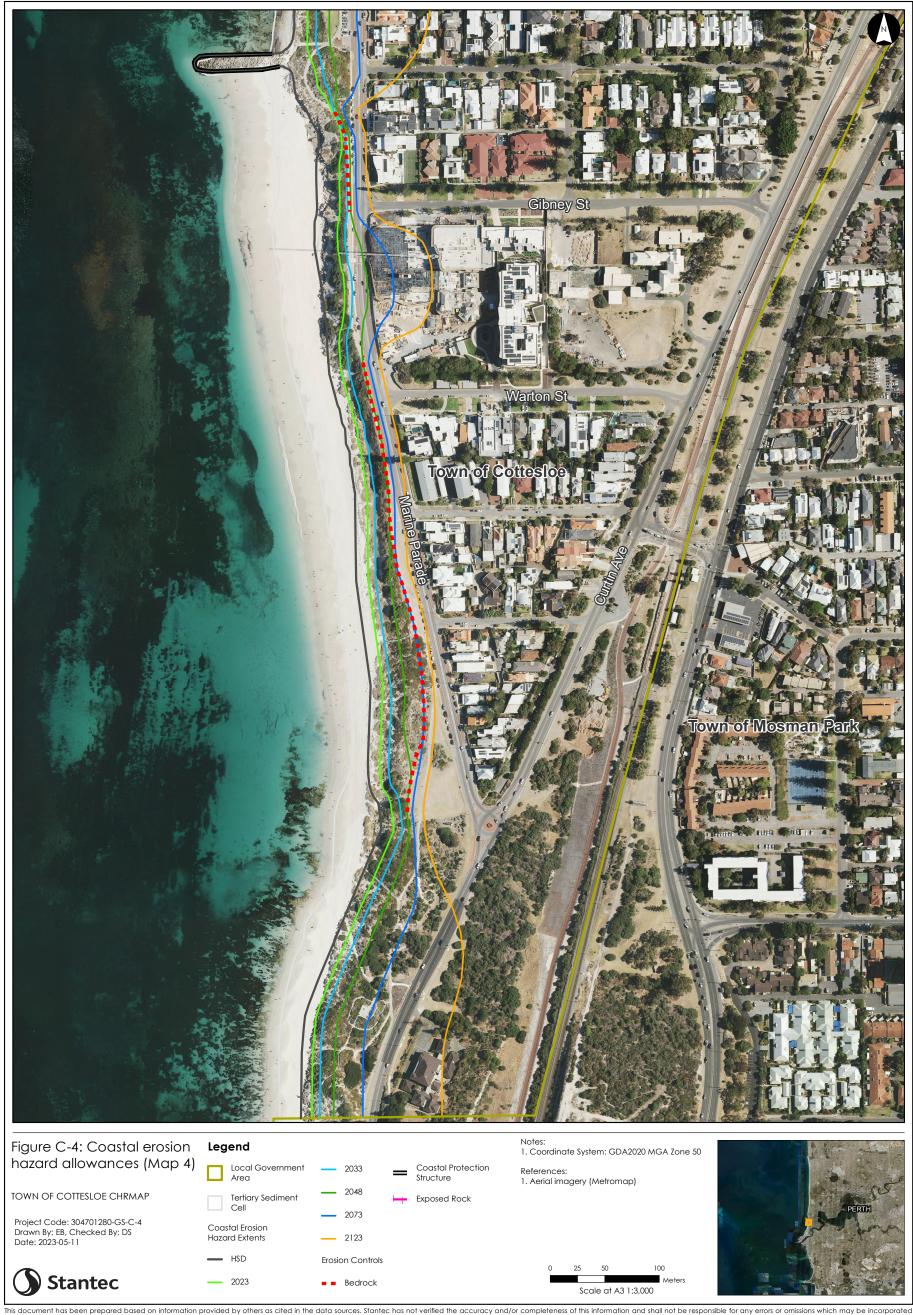
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Appendix C Coastal inundation hazard mapping

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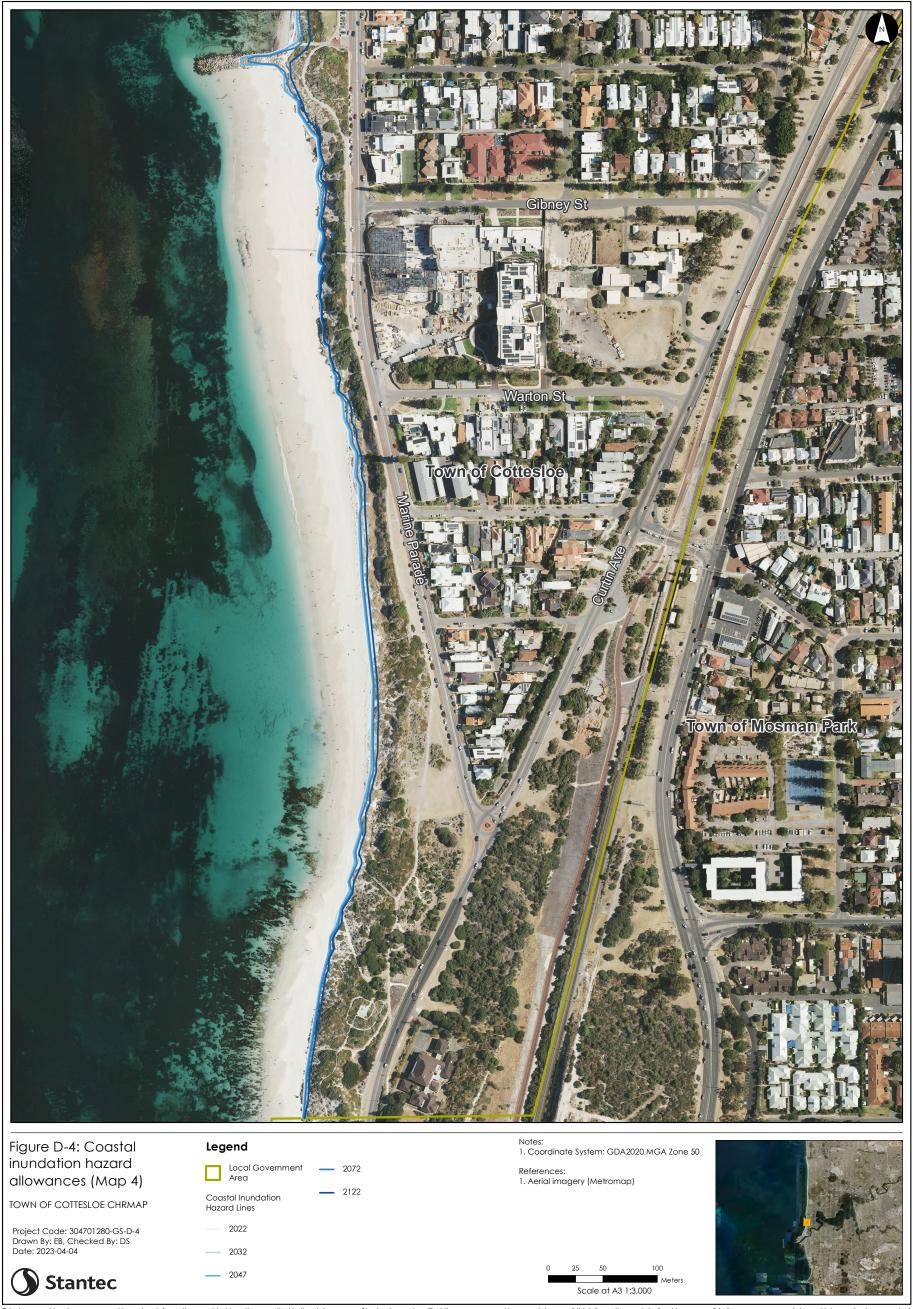
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TOWN OF COTTESLOE



COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN (CHRMAP) STEERING COMMITTEE

ATTACHMENT

ITEM 8.1.1C:
R03 VULNERABILITY ANALYSIS



Town of Cottesloe CHRMAP

Chapter Report: Vulnerability Analysis

Town of Cottesloe

29 September 2023







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1 INTRODUCTION

The international community recognises that the global mean sea level has been rising since the nineteenth century and is expected to rise at an accelerating pace in the future (IPCC, 2021). This will lead to an increased risk of coastal flooding, erosion, and shoreline recession caused by intensifying storms. To address this, state governments in Australia have introduced obligations that require local governments to plan for and consider these hazards. In Western Australia, the State Planning Policy No. 2.6: State Coastal Planning Policy (SPP2.6) recommends that management authorities develop a **Coastal Hazard Risk Management and Adaptation Plan (CHRMAP)** for land use or development that is vulnerable to coastal hazards. The policy also aims to establish coastal foreshore reserves to protect and enhance coastal values. Specific guidelines have been developed to help with this process (WAPC, 2019).

One of the key objectives of SPP2.6 is to establish coastal foreshore reserves which include allowances for the protection, conservation, and enhancement of coastal values across the state. Risk assessment processes are then utilised to identify risks that are intolerable to the community, and other stakeholders such as local governments, indigenous and cultural interests, and private enterprise. Adaptation measures are then developed according to the preferential adaptation hierarchy outlined in SPP2.6.

The study area for this CHRMAP is the entire shoreline within the Town's jurisdiction (see Figure 1-1). Zoomed images of the study area are shown in Figure 1-2 and Figure 1-3 for North and South areas respectively. The study area consists of various shoreline types and many coastal assets, involving multiple stakeholders:

- Physical controls rubble mound rock groynes at Beach Street and Cottesloe Beach; seawalls at Cottesloe Beach
- Sandy pocket and "perched" beaches backed and underlain by rock shelves and adjacent narrow foreshore reserve
- Presence of various rock features including shore-attached reef and rock outcrops and cliffs
- Roads along the shoreline Curtin Avenue and Marine Parade
- Two Surf Life Saving Clubs
- Registered Aboriginal Heritage Site at Mudurup Rocks, south of the Cottesloe Surf Club
- Significant built infrastructure buildings, car parks, shore-parallel dual use path, utilities, playgrounds
- Large number of foreshore amenities such as showers, fencing, information signage, access paths and stairways
- Highly valued recreational assets beach and ocean areas used heavily by locals and visitors for many different pursuits.

This CHRMAP project is expected to increase knowledge and understanding of coastal hazard risks and identify risk management and adaptation measures for implementation. The outcomes will be used to inform local government policies, strategies and plans, including (but not limited to); planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans. The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with the objectives identified by these guidelines and SPP2.6. The project will identify the strategic direction for coastal adaptation scenarios from the present to 2123 (100-year management time frame) and identify an implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway for the region and serve as a key reference for management, planning and policy making for the present day (2023), 2033, 2048, 2073 and 2123 planning timeframes.

Delivery of this project will occur over 8 stages (as summarised in Figure 1-4), each of which represents a key hold point. The staged approached is developed according to the Town of Cottesloe scope and is in line with the CHRMAP Guidelines (WAPC, 2019). This report presents the Vulnerability Analysis Chapter Report, which

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assess the vulnerability of the assets within the coastal hazard zone and details the vulnerability of the at-risk assets using the concepts of sensitivity, exposure, potential impact, adaptive capacity, and vulnerability. The flow chart displayed in Figure 1-4 indicates where this component sits with reference to the greater study; the 'Vulnerability Analysis', shaded in red, corresponds to Stage 3.



Figure 1-1 Study Area

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Figure 1-2 MU 1 – North of Cottesloe Groyne



Figure 1-3 MU 2 – South of Cottesloe Groyne

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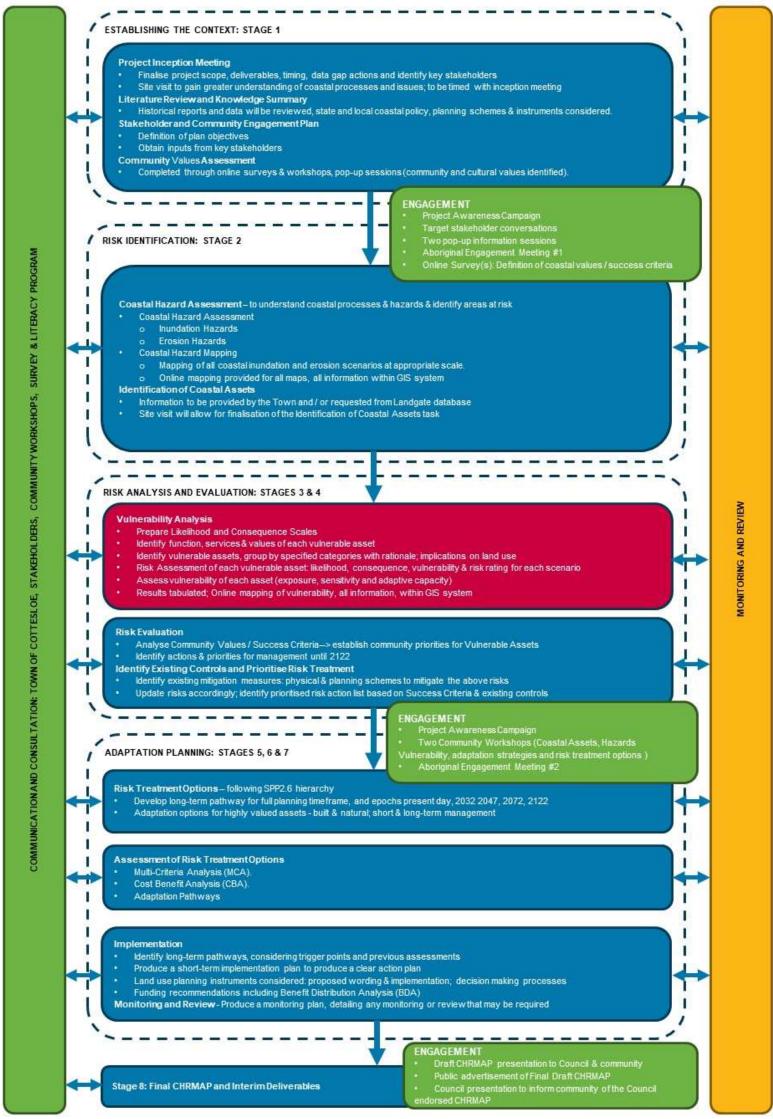


Figure 1-4 CHRMAP Methodology

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2 IDENTIFICATION OF ASSETS

To facilitate the coastal hazard assessment and development of adaptation options, the study area is delineated into two units, MU 1- North of and including Cottesloe Groyne and MU 2 - South of Cottesloe Groyne, based on the coastal process, orientation of the coast, and potential hazard types. Refer to Figure 1-2 and Figure 1-3 for the delineation of these units.

To identify assets at risk of coastal erosion and inundation, recent aerial imagery of Town of Cottesloe was overlaid with the hazard extents and evaluated alongside the Town of Cottesloe Local Planning Scheme No.3. Each asset was then classified to simplify the adaptation planning process in subsequent phases of the project.

Based on the inundation hazard lines, no assets are predicted to be at risk of inundation, please refer Cardno (2023) for further details.

It is important to note that the count of assets includes those partially included within a hazard line.

2.1 Asset Classifications

Assets are grouped according to classification for ease of interpretation. For the purposes of this report, Water Technology has grouped assets into categories: Public and Community, Environmental, Residential, Developed Foreshore Reserve, Commercial, Roads, and Heritage sites.

Public and Community

This includes, Seaview Golf Course, Structures on beach, Cottesloe Groyne at Mudurup Rocks, Beach Street Groyne, Cottesloe concrete seawall, Local Centre, Town Centre, Public purposes – Special Uses.

Environmental

This includes Beach, Foredune, Undeveloped foreshore, Local Parks and Recreation.

Residential

This includes Residential, Residential Office.

Developed Foreshore Reserve

This includes Foreshore Centre, Restricted Foreshore Centre, Public Carparks near coast/beach, Beach access, Local Parks and Recreation near coast/beach, areas of lower-value foreshore amenity such as paths, seating, playgrounds etc.

Commercial

This includes Hotels, Ocean Beach Hotel owned properties, Development.

Roads

This includes Scenic drives along coast, Local Roads, Regional Roads.

Heritage

This includes Aboriginal heritage sites from DPLH database.

2.2 Identified Assets

Table 2-1 presents the identified assets by management unit and category.

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Table 2-1 Summary of Vulnerable Assets, grouped by Management Unit & Planning Horizon.

Planning Horizon	2023 (present)	2033 (+10 years)	2048 (+25 years)	2073 (+50 years)	2123 (+100 years)	
Asset Classification Group	Management Unit 1 – MU1					
Public and Community (Nos)	1	2	2	2	3	
Environmental (m²)	Nil					
Residential (Nos)	0	0	0	0	92	
Developed Foreshore Reserve (m²)	78667	78667	78667	78667	99270	
Commercial (Nos)	1	1	1	1	15	
Roads (m²)	0	0	15928	38628	48835	
Heritage (m²)	33513	33513	33513	33513	33513	
Asset Classification Group	Management Unit 2 – MU2					
Public and Community (Nos)	1	1	3	5	10	
Environmental (m²)	13189	13189	13189	13189	13993	
Residential (Nos)	0	0	0	7	54	
Developed Foreshore Reserve (m²)	61470	61470	63660	63660	63660	
Commercial (Nos)	Nil					
Roads (m²)	40993	40993	40993	53720	60476	
Heritage (m²)	0	0	0	112422	227723	

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Comments:

Public and Community assets (Cottesloe main groyne and the area immediately adjacent to the rear of beach) are vulnerable to erosion at present. The North Cottesloe SLSC building(s) is vulnerable to erosion by 2033 and by 2123 the north-west and south-west corners of the golf club are classed as vulnerable.

Residential assets are not presently vulnerable to erosion. Some Eileen Street properties and those northward of Eric Street in MU1, and similarly, properties fronting Marine Parade between Pearse and Beach Streets in MU2 are shown to be vulnerable to erosion between by 2123 (i.e., the 100-year planning horizon). Of these, properties fronting Marine Parade between Pearse and Deane Streets are classed as vulnerable to erosion by 2073 (i.e., the 50-year planning horizon).

In both Management Unit 1 and Management Unit 2, the developed foreshore reserve (including car parking) is presently classed as vulnerable to erosion, the area increasing between the 2073 and 2123 timeframe by the inclusion of part of the Town of Cottesloe's No.2 Car Park.

Marine Parade generally northward of Napier Street is classed as vulnerable in 2048.

The Indiana Tea Rooms building is presently vulnerable to erosion risk, unless the existing seawall function as expected. Other commercial properties to the east of Marine Parade are shown to be vulnerable to erosion between 2073 and 2123.

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3 VULNERABILITY ANALYSIS METHOD

A vulnerability assessment defines the degree of impact coastal hazards are likely to have on coastal assets over the planning timeframe. The vulnerability of coastal assets to coastal hazards is related to its exposure to the hazard, its sensitivity to that exposure, and the ability of the asset to be modified or adapted to manage this exposure. This is displayed diagrammatically in Figure 3-1; the input components are displayed in blue.

In the sub-chapters below, the asset ratings to the hazards are discussed and a vulnerability rating assigned. As the only asset at inundation risk was the beach, which will be affected by erosion on a greater proportion, only erosion hazards are considered going forward with the Vulnerability Analysis.

The asset ratings are subject to discussion and confirmation with the Steering Committee to ensure they reflect the views of the community.

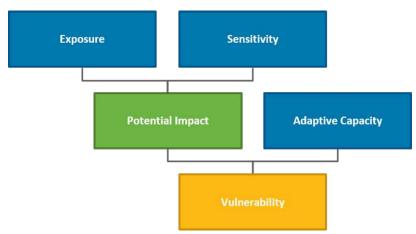


Figure 3-1 Vulnerability Assessment Components (reproduced from Allen Consulting, 2005)

3.1 Exposure/Likelihood Rating

The exposure/likelihood of identified assets represents the likelihood of coastal hazards impacting on an asset. That is, the chance of erosion impacting on existing and future assets and their values (WAPC, 2019). The likelihood scale adopted for this study is presented in Table 3-1.

Table 3-1 Exposure/Likelihood Rating

Likelihood Rating	Description	Annual Exceedance Probability	
Almost Certain	Expected to occur in most circumstances	>90%	
Likely	Impact to asset shoreline for a given planning timeframe is likely	50 - 90%	
Possible	Impact to asset shoreline for a given planning timeframe is possible	10 - 50%	
Unlikely	Impact to asset shoreline for a given planning timeframe is unlikely	1 - 10%	
Rare	May occur in exceptional circumstances	<1%	

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Historically there has been significant variation in defining the likelihood ratings based on coastal hazard assessment outcomes. The erosion hazard lines in this analysis (Cardno, 2023) were developed based on several components, each of which has its own assumptions and degree of uncertainty. For instance, the assessment of S1 erosion risk has considered a few different likelihood storm events which, by themselves, represent their likelihood of occurrence, however such occurrences change over the different planning timeframes. Likelihood of sea level rise (SLR) and historic shoreline movement are very difficult to define quantitatively by scientific terms. It is therefore important to adopt a straight-forward approach to transfer the information presented in the coastal hazard maps into likelihood of impact to assets.

Through internal discussion and review, Water Technology has adopted the approach recommended by WAPC (2019) as demonstrated in Figure 3-2 below for the likelihood of erosion hazard. Table 3-1 determines the likelihood of erosion hazard for the current study.

Calculating the probabilities behind the likelihood ratings is complex, and simplification is necessary for the vulnerability and risk assessments. However, any adaptation measures will consider applying triggers before implementation to reduce the risk of this simplification process. For example, a trigger may be reached if an erosion event with certain consequences occurs twice in any given year.

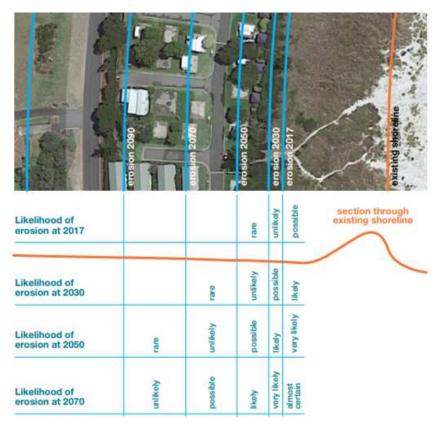


Figure 3-2 Example of Likelihood Rating based on Erosion Hazard Lines (adapted from WAPC, 2019)

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Table 3-2 Exposure / Likelihood of Coastal Erosion Hazards across the Planning Timeframe

Erosion Hazard Line	2023	2033	2048	2073	2123
HSD-2023	Possible	Likely	Almost Certain	Almost Certain	Almost Certain
2023-2033	Unlikely	Possible	Likely	Almost Certain	Almost Certain
2033-2048	Rare	Unlikely	Possible	Likely	Almost Certain
2048-2073	Rare	Rare	Unlikely	Possible	Likely
2073-2123	Rare	Rare	Rare	Unlikely	Possible

3.2 Sensitivity/Consequence

The sensitivity/consequence of coastal assets are important considerations in assessing their vulnerability to hazards. Sensitivity refers to how an asset responds to a hazard, whether gradually or suddenly. It can be applied to the asset itself or to its critical function. Meanwhile, consequence ranks the physical impact of a hazard on the asset as well as its importance according to pre-defined success criteria. These success criteria were generated through stakeholder engagement and consider the environmental and social value of the asset. The sensitivity is an asset's responsiveness to a coastal hazard. This could be a gradual response or a stepped change in response to discrete events (WAPC, 2019). The sensitivity can be applied to the asset itself, or to the asset's function and the criticality of the service it provides (CoastAdapt, 2017).

The consequence ranking presented in Table 3-4 constitutes the physical impact of the event to the asset, as well as that of the values attributed to it by the success criteria defined earlier in the study (replicated below in Table 3-3, for reference). The success criteria were generated (Water Technology, 2022) from the coastal values assessment, which was undertaken by stakeholder and community engagement. Table 3-1 can be interpreted as follows:

The Physical, Financial column considers the physical impact as well as a qualitative assessment of the economic costs associated with the various consequences. These will be assessed in more detail in the cost benefit analysis as part of the adaptation options assessment component of the study (Stage 6 Chapter Report, as per Figure 1-4 CHRMAP Methodology)

The remaining columns include the application of the success criteria. The success criteria highlight the importance of the environment and coastal recreation to the community:

- Environment column considers how the environment may be impacted through an erosion event, including consideration of if a similar habitat may exist elsewhere.
- Community / Social & Cultural column considers how impacts to an asset may affect the community, also allowing for if alternatives assets / functions exist elsewhere. Consideration of community safety is also included.

For each hazard, the consequence is assessed against the criteria qualitatively, based on experience of the impacts of coastal erosion, and the examples presented in the consequence scale. These rankings are intended to aid the adaptation plan, identifying priority areas for adaptation, but should not replace traditional internal risk assessment processes. Local governments will still likely apply their internal risk assessment processes when considering adaptation actions such as the removal or repair of assets.

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Table 3-3 Preliminary Success Criteria

- Preserve and protect the Town's beaches and natural assets such as vegetation and dunes.
- Ensure the natural environment is protected and sustained in its current condition or an improved condition.
 - o Maintaining the natural state of any underdeveloped areas is important.
 - o Preserve and consider the cultural significance of Mudurup Rocks.
- Preserve the function and opportunity for all types of water-based and land-based activities
 particularly those that help to improve the health and well-being of people.
- Preserve and accommodate the existing surf lifesaving clubs as these facilities were seen as a hub
 of water and land-based activities that also helped to improve social connection and mental
 wellbeing.
- Continue to provide public amenities at the coast, such as parks, restrooms parking and access
 paths.
- Ensure that areas for community events and access to remain within the coastline. Provide and
 maintain spaces and infrastructure for community events, arts and entertainment.
- Minimise impacts on existing private property.
- Consider treatments for coastal areas that have current inundation and erosion issues. Preserve the current uses of the beach areas.
- Develop solutions to coastal processes that are sustainable (financially, socially and built form) and locally responsive.
- Revisit regularly with community and key stakeholders their values in relation to development adjacent the foreshore

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Table 3-4 Sensitivity / Consequence Ranking

Consequence Level	Physical, Financial	Environment	Community / Social & Cultural
Insignificant	No or minimal damage, perhaps requiring increased maintenance Financial loss less than \$20,000	Negligible to no impact to environment	Minimal short-term inconvenience to asset, services, and function, <5% of community affected. Many alternatives exist
Minor	Minor damage to assets resulting in restrictions in capability, financial loss of \$20,000 to \$200,000	Short term damage to environment. Recovery will be strong. Local or regional alternate habitat exists	Isolated but noticeable (short term) decline or disruption to asset, services, and function, <10% of community affected. Alternative sites exist
Moderate	Damage to assets resulting in isolated loss of capability, financial loss of \$200,000 to \$2 million	Medium term loss of environmental assets. Recovery is likely. Local or regional alternate habitats exist	Moderate (short to medium term) decline or disruption to assets, services, and function, <25% of community affected. No convenient alternative exists
Major	Significant damage to many assets resulting in very limited capability, financial loss of \$2 million to \$5 million	Long-term damage to environmental assets. Limited chance of recovery. No local alternate habitat(s) exist. Regional habitats exist	Severe (medium-term) decline or disruption to asset, services, and function, <50% of community affected. No convenient alternative exists
Catastrophic	Significant damage to most assets resulting in loss of capability, financial loss of over \$5 million	Permanent damage to environmental assets. No chance of recovery. No alternate habitat(s) exist.	Long term or permanent loss of asset, services, and function >75% of community affected. No alternative exists

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Table 3-5 assigned a sensitivity / consequence rating for each asset category. In the sub-chapters below, the asset ratings to the hazards are discussed and a vulnerability rating assigned. Assets are grouped according to classification for ease of interpretation. All ratings are somewhat subjective. The ratings will be discussed to ensure the ratings are reflective of stakeholder knowledge. The ratings will then be updated in the final report.

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Table 3-5 Sensitivity / Consequence Rating by Asset Category: Erosion

Asset Category	Physical, Financial	Environment	Community / Social & Culture	Overall Rating	
Public and Community	Major	Moderate Moderate		Major	
Environmental	Moderate	Major Major		Major	
Residential	Catastrophic	Minor	Major	Catastrophic	
Developed Foreshore Reserve	Moderate	Moderate	Moderate	Moderate	
Commercial	rcial Catastrophic Minor Ma		Major	Catastrophic	
Roads	Catastrophic	phic Minor Major		Catastrophic	
Heritage	Major	Major	Major	Major	

3.3 Potential Impact (Level of Risk)

To determine the **potential impact** of coastal hazards on assets, we calculate the risk level as the **product** of exposure and sensitivity (refer to Table 3-6). This helps classify the level of risk for identified assets within different planning timeframes. We mainly evaluate the level of risk based on its tolerability, or consequence (definitions available in Table 3-7).

Table 3-6 Risk Level (Potential Impact) Matrix as Product of Sensitivity (Consequence) and Exposure (Likelihood)

Sensitivity /	Exposure / Likelihood									
Consequence	Rare	Unlikely	Possible	Likely	Almost Certain					
Catastrophic	Medium	High	Extreme	Extreme	Extreme					
Major	Medium	Medium	High	Extreme	Extreme					
Moderate	Low	Medium	Medium	High	High					
Minor	Low	Low	Low	Medium	Medium					
Insignificant	Low	Low	Low	Low	Low					

Table 3-7 Risk Profile Definition

Risk Profile	Definition
Low	Tolerable risk. A level of risk that is low and manageable without intervention outside routine asset maintenance.
Medium	A level of risk that may require intervention to mitigate, such as changes to design standards or asset maintenance. Short to medium term action required.
High	A level of risk requiring significant intervention to mitigate in the immediate to short term.
Extreme	Immediate action required to reduce risk to acceptable levels

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3.4 Adaptive Capacity

Adaptive capacity refers to an asset's ability to adjust or adapt to coastal hazards. We determine this based on the potential for the system to be modified to cope with the impacts of hazards. Assets with high adaptive capacity can be easily adapted or have some ability to self-adapt to changing conditions. For example, beach and dune systems generally have greater adaptive capacity than coastal infrastructure and residential land. The scale for adaptive capacity is available in Table 3-8, and ratings are determined by stakeholder and community opinions, as well as the asset or asset group.

Table 3-8 Adaptive Capacity

Adaptive Capacity	Description
No adaptation required	Potential impact has insignificant effect on asset. Controls are reestablished naturally or with ease before more damage would likely occur.
Very High	Good adaptive capacity. Functionality restored easily. Adaptive systems restored at a relatively low cost or naturally over time.
High	Decent adaptive capacity. Functionality can be restored, although additional adaptive measures should still be considered. Natural adaptive capacity restored slowly over time under average conditions
Moderate	Small amount of adaptive capacity. Difficult but possible to restore functionality through repair and redesign.
Low	Little or no adaptive capacity. Potential impact would destroy all functionality. Redesign required.

Table 3-9 presents the assigned adaptive capacity ratings for erosion hazard by category.

Table 3-9 Adaptive Capacity Rating for Erosion by Asset Category

Asset Category	Adaptive Capacity
Public and Community	Low
Environmental	Low
Residential	Low
Developed Foreshore Reserve	High
Commercial	Low
Roads	Low
Heritage	Low

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3.5 Vulnerability

To determine vulnerability, the product of the potential impact (risk level) and adaptive capacity is calculated. This study considered four levels of vulnerability, as outlined by WAPC (2019), and each planning timeframe analysed by the CHRMAP should be assessed accordingly.



Figure 3-3 Vulnerability Relationship

Table 3-10 Vulnerability Matrix as a Product of Risk Level and Adaptive Capacity

Risk Level	Adaptive Capacity									
	Low	Moderate	High	Very High						
Extreme	Extreme	Extreme	High	Medium						
High	Extreme	High	Medium	Medium						
Medium	High	Medium	Medium	Low						
Low	Medium	Medium	Low	Low						

Applying the described methodology, assets in all management units are identified and categorised in the sections below. Exposure level is rated as AC (Almost Certain), L (Likely), P (Possible), U (Unlikely) and R (Rare). Sensitivity is rated as IN (Insignificant), MI (Minor), MO (Moderate), MA (Major) and CA (Catastrophic). Risk / potential impact and vulnerability are rated as EX (extreme), HI (High), ME (Medium) and LO (Low). Adaptive capacity is rated as VH (Very High), High (HI), Moderate (MO) and Low (LO).

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4 VULNERABILITY ANALYSIS

The method presented in Section 3 was applied to all identified assets. For each planning horizon, each category was then assigned an overall vulnerability rating, as presented in Table 4-1. The full results are presented in Appendix A..

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Table 4-1 Erosion Vulnerability Ratings, grouped by Management Unit & Planning Horizon

Asset Classification Group	2023	2033	2048	2073	2123						
Management Unit 1 - MU 1											
Public and Community	ublic and Community Extreme Extreme Extreme Extreme Extreme										
Environmental En											
Residential	High	Extreme	Extreme	Extreme	Extreme						
Developed Foreshore Reserve	Medium	Medium	Medium	Medium	Medium						
Commercial	Extreme	Extreme	Extreme	Extreme	Extreme						
Roads	Extreme	Extreme	Extreme	Extreme	Extreme						
Heritage	Extreme	Extreme	Extreme	Extreme	Extreme						
	M	anagement Unit 2 – N	/IU 2								
Public and Community	Extreme	Extreme	Extreme	Extreme	Extreme						
Environmental	Extreme	Extreme	Extreme	Extreme	Extreme						
Residential	Extreme	Extreme	Extreme	Extreme	Extreme						
Developed Foreshore Reserve	Medium	Medium	Medium	Medium	Medium						
Commercial			Not Applicable								
Roads	Extreme	Extreme	Extreme	Extreme	Extreme						
Heritage	Extreme	Extreme	Extreme	Extreme	Extreme						

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5 SUMMARY & NEXT STEPS

This report presents the vulnerability analysis for the Town of Cottesloe CHRMAP.

The following key observations can be made from the results:

- Although residential properties are not reached by present day erosion hazard lines (some properties are identified under erosion hazard lines by 2073) they are rated as having high (MU1) and extreme (MU2) levels of vulnerability in the present day because they have low adaptive capacity.
- Public and Community properties are vulnerable to erosion at present, including Cottesloe groyne. North Cottesloe SLSC building(s) is vulnerable to erosion by 2033 and the golf club is vulnerable to erosion by 2123.
- Developed foreshore reserve, beach, foredune and Roads are vulnerable to present day erosion hazards.
- The Indiana Tea Rooms building is presently vulnerable to erosion risk, noting the existing seawall functions as expected.

All categories are at high or extreme vulnerability to erosion from present day, except Developed Foreshore Reserve. Essentially most categories are considered unacceptably vulnerable and require adaptation planning to consider the best way to treat the risk. The next stage of the CHRMAP development will involves risk evaluation and treatment, including reporting on updates to the risk priorities in context of any physical and planning controls. It will identify and assess risk treatment pathways with a multi criteria analysis and consider risk treatment pathways and options for each management unit.

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6 REFERENCES

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APPENDIX A VULNERABILITY RESULTS







Table A-1 Summary of Vulnerability Analysis

Management Unit		Likelihood			Sensitivity			Impact			Adaptative		١	ulnerability			
	present	2033	2048	2073	2123		present	2033	2048	2073	2123	Capacity	present	2033	2048	2073	2123
	MU1-North of Cottesloe Groyne																
Public & Community	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Major	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme
Environmental						Major						Low					
Residential	Rare	Unlikely	Possible	Likely	Almost Certain	Catastrophic	Medium	High	Extreme	Extreme	Extreme	Low	High	Extreme	Extreme	Extreme	Extreme
Developed Foreshore Reserve	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Moderate	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Medium
Commercial	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Catastrophic	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme
Roads	Possible	Likely	Almost Certain	Almost Certain	Almost Certain	Catastrophic	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme
Heritage	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Major	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme
							MU	J2-South of	Cottesloe	Groyne							
Public & Community	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Major	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme
Environmental	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Major	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme
Residential	Unlikely	Possible	Likely	Almost Certain	Almost Certain	Catastrophic	High	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme
Developed Foreshore Reserve	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Moderate	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Medium
Commercial									Not	Applicabl	е						
Roads	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Catastrophic	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme
Heritage	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Major	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Extreme	Extreme	Extreme	Extreme	Extreme

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Figure A-1 Assets under Hazard Lines MU 1



Figure A-2 Assets under Hazard Lines MU 2

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Attachment 8.1.1(c)



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TOWN OF COTTESLOE



COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN (CHRMAP) STEERING COMMITTEE

ATTACHMENT

ITEM 8.1.1D:
R04 RISK EVALUATION AND RISK TREATMENT
OPTIONS



Town of Cottesloe CHRMAP

Chapter Report: Risk Evaluation and Risk Treatment Options

Town of Cottesloe

24 November 2023







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EXECUTIVE SUMMARY

It is internationally recognised that the mean sea level has been rising globally since the nineteenth century and is predicted to rise at an increasing rate in the future (IPCC 2021). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary coastal flooding), storm erosion and long-term shoreline recession. State governments across Australia have introduced statutory obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is potentially vulnerable to coastal hazards. Specific guidelines have been developed to assist in this process (WAPC, 2019).

SPP2.6 requires adequate risk management planning is undertaken where existing or proposed development is in an area at risk of being affected by coastal hazards over the 100-year planning timeframe. SPP2.6 and the CHRMAP Guidelines provide the risk assessment framework to be applied to identify risks that are intolerable to the community, and other stakeholders such as local governments, Indigenous and cultural interests, and private enterprise. Risk Management measures are then developed according to the adaptation hierarchy outlined in SPP2.6.

The aim of present study is to investigate the nature and severity of coastal hazards which are likely to affect Town of Cottesloe over future planning horizons. Refer Figure 1-1 for locality and study area extent.

The objective of this CHRMAP project is to increase knowledge and understanding of coastal hazard risks, and to identify risk management and adaptation measures for implementation. The outcomes will be used to inform local and state government policies, strategies and plans, including (but not limited to), planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans. The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with the objectives identified by these guidelines and SPP2.6. The project will identify the strategic direction for coastal adaptation scenarios from the present-day to 2123 (100-year management time frame) and identify an implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway for the region and serve as a key reference for management, planning and policy making for the short-term (0-15 years), medium-term (15-30 years), and long-term (100 years).

This report presents the Risk Evaluation and Treatment Chapter Report, which identifies risks and presents and assesses treatment options using multi-criteria analysis.

The vulnerability ratings assigned in the previous chapter report (Water Technology, 2023) were assessed against any available controls. No changes to the vulnerability results are required: existing vulnerability results become final results. The erosion vulnerability ratings were considered for each Management Unit (MU) as a whole, by averaging the vulnerability ratings of individual asset categories; see Table 2-1. All MUs at all planning horizons have unacceptable levels of vulnerability for erosion (medium or above) and therefore need to be considered for risk treatment options. Potential risk treatment options are described in Sections 3 to 5 with context to the adaptation hierarchy and site-specific conditions. All relevant options are then assessed using a multi-criteria analysis in Section 6, with full results presented in Appendix B.

The next report will present the cost benefit analysis and benefit distribution analysis of the positively scored adaptation options. Their adaptation pathways, including identifying triggers, will also be presented.

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1 INTRODUCTION

It is internationally recognised that the mean sea level has been rising globally since the nineteenth century and is predicted to rise at an increasing rate in the future (IPCC 2021). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary coastal flooding), storm erosion and long-term shoreline recession. State governments across Australia have introduced obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is potentially vulnerable to coastal hazards. Specific guidelines have been developed to assist in this process (WAPC, 2019).

SPP2.6 requires adequate risk management planning is undertaken where existing or proposed development is in an area at risk of being affected by coastal hazards over the 100-years planning timeframe. SPP2.6 and the CHRMAP Guidelines provide the risk assessment framework to be applied to identify risks that are intolerable to the community, and other stakeholders such as local governments, Indigenous and cultural interests, and private enterprise. Risk management measures are then developed according to the adaptation hierarchy outlined in SPP2.6.

The study area for this CHRMAP is the entire shoreline within the Town's jurisdiction (see Figure 1-1). The study has been undertaken across two Management Units (MUs) being Management Unit 1 (North of Cottesloe Groyne, including the groyne) and Management Unit 2 (South of Cottesloe Groyne). The study area is shown in Figure 1-2 and Figure 1-3 for North and South areas respectively. The study area consists of various shoreline types and many coastal assets, involving multiple stakeholders:

- Physical controls rubble mound rock groynes at Beach Street and Cottesloe Beach; seawalls at Cottesloe Beach
- Sandy pocket and "perched" beaches backed and underlain by rock shelves and adjacent narrow foreshore reserve
- Presence of various rock features including shore-attached reef and rock outcrops and cliffs
- Roads along the shoreline Curtin Avenue and Marine Parade
- Two Surf Life Saving Clubs
- Registered Aboriginal Heritage Site at Mudurup Rocks, south of the Cottesloe Surf Life Saving Club
- Significant built infrastructure buildings, car parks, shore-parallel dual use path, utilities, playgrounds
- Large number of foreshore amenities such as showers, fencing, information signage, access paths and stairways
- Highly valued recreational assets beach and ocean areas used heavily by locals and visitors for many different pursuits.

The objective of this CHRMAP project is to increase knowledge and understanding of coastal hazard risks, and to identify risk management and adaptation measures for implementation. The outcomes will be used to inform local and state government policies, strategies and plans, including (but not limited to); planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans.

The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with the objectives identified by these guidelines and SPP2.6. The project will identify the strategic direction for coastal adaptation scenarios from the present-day to 2123 (100 yrs. management time frame) and identify an

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implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway for the region and serve as a key reference for management, planning and policy making for the present day (2023), 2033, 2048, 2073 and 2123 planning timeframes.

Delivery of this project will occur over 8 stages (as summarised in Figure 1-4, each of which represents a key hold point. The staged approached is developed according to the Town of Cottesloe scope and is in line with the CHRMAP Guidelines (WAPC, 2019). This report presents the combined Risk Evaluation and Risk Treatment Options Reports. The red bubble displayed in Figure 1-4 indicates where this component sits with reference to the greater study.

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Figure 1-1 Study Area

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Figure 1-2 MU 1 North of Cottesloe Groyne, including Groyne to the North end of Town's jurisdiction



Figure 1-3 MU 2 South of Cottesloe Groyne to the South end of Town's jurisdiction

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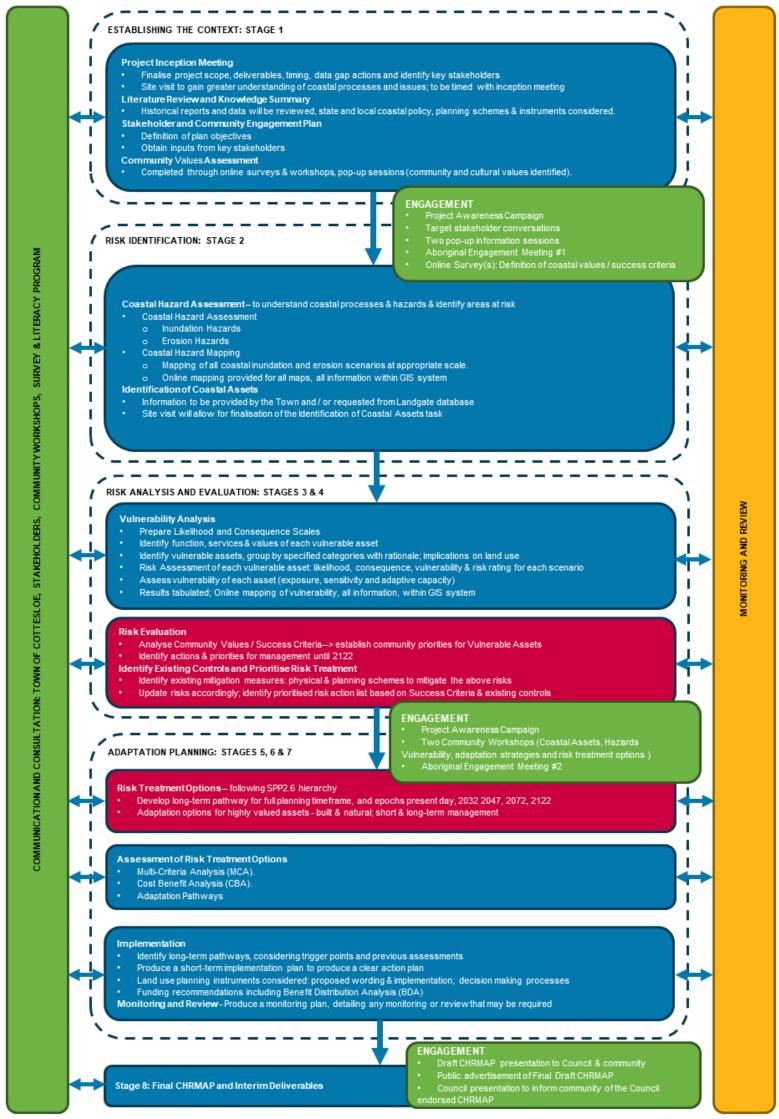


Figure 1-4 Methodology

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2 RISK EVALUATION

This section assesses any available controls against the vulnerability ratings assigned in the previous chapter report (Water Technology, 2023). The coastal hazard assessment (Cardno, 2023) has already assigned any relevant physical controls.

2.1 Existing Controls

2.1.1 Planning Controls

A summary of relevant planning controls for the study area is provided in Chapter 1 (Water Technology 2023). The study area is guided by the State Government planning framework and the Town's local planning framework which comprises of a planning scheme, strategies, policies and guidelines. While the existing local planning framework makes reference to coastal hazards, there are limited planning controls that can be used to adapt to the coastal hazards identified. As such, the existing planning controls do not change the assigned vulnerability ratings for the CHRMAP study area.

This CHRMAP will consider what planning controls may be appropriate as adaptation measures within the study area.

2.1.2 Physical Controls

The existing physical controls in the study area are reported in Water Technology (2023) and Cardno (2023) include coastal protection structures such as groynes/breakwaters and seawalls. Where appropriate, these have already been considered in the hazard and vulnerability assessment. As such, the vulnerability results remain the same as previously reported. No changes to the vulnerability results are required.

2.2 Priorities for Treatment

The erosion vulnerability ratings presented in the previous report have been considered for each Management Unit as a whole, by averaging the vulnerability ratings of individual asset categories; see Table 2-1. All management Units at all planning horizons have unacceptable levels of vulnerability for erosion (medium or above) for one or more asset categories, and therefore need to be considered for risk treatment options.

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Table 2-1 Erosion Vulnerability Ratings, grouped by Management Unit & Planning Horizon

Asset Classification Group	2023	2033	2048	2073	2123						
Management Unit 1 - MU 1											
Public and Community	Extreme	Extreme Extreme Extreme Extreme									
Environmental	Not Applicable										
Residential	High	Extreme	Extreme	Extreme	Extreme						
Developed Foreshore Reserve	Medium	Medium	Medium	Medium	Medium						
Commercial	Extreme	Extreme	Extreme	Extreme	Extreme						
Roads	Extreme	Extreme	Extreme	Extreme	Extreme						
Heritage	Extreme	Extreme	Extreme	Extreme	Extreme						
	M	anagement Unit 2 – N	/IU 2								
Public and Community	Extreme	Extreme	Extreme	Extreme	Extreme						
Environmental	Extreme	Extreme	Extreme	Extreme	Extreme						
Residential	Extreme	Extreme	Extreme	Extreme	Extreme						
Developed Foreshore Reserve	Medium	Medium	Medium	Medium	Medium						
Commercial			Not Applicable								
Roads	Extreme	Extreme	Extreme	Extreme	Extreme						
Heritage	Extreme	Extreme	Extreme	Extreme	Extreme						

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3 RISK TREATMENT APPROACH

3.1 Risk Management and Adaptation Hierarchy

SPP2.6 provides a hierarchy of adaptation pathways to guide decision making in coastal areas. This should be used by planning authorities and development proponents when considering adaptation options to minimise coastal hazard risks at the local level. The hierarchy, presented in Figure 3-1, indicates a clear preference against the adoption of 'protect' as a long-term adaptation pathway. This preference is re-emphasised in SPP2.6, the policy guidelines, the CHRMAP Guidelines and the WA Coastal Zone Strategy. This hierarchy is discussed further below.

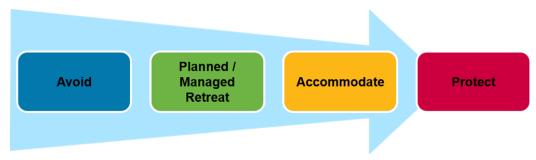


Figure 3-1 Coastal Hazard Risk Management and Adaptation Planning Hierarchy (adapted from WAPC, 2019)

3.2 Avoid

The "avoid" pathway aims not to install new public and private assets within areas affected by coastal hazards. The "avoid" pathway can be applied to manage coastal erosion and inundation hazards.

Sometimes this is unavoidable when assets are necessary in the coastal hazard zone. However, a screening question to assist in making such a decision would be: "Does this asset need to be close to the coast to perform its primary function?" Most assets will benefit from being located near the coast. However, few assets have a primary function genuinely related to the coast.

The lifetime (design life) of a new coastal asset is a key consideration in locating new assets near coastal hazard areas. For instance, the construction of picnic facilities or public toilets should be avoided if coastal hazards are likely to impact these assets within their projected lifetime.

Similarly, the construction of new private assets likely affected by coastal hazards over their projected lifetimes should not be allowed.

3.3 Planned or Managed Retreat

The "planned or managed retreat" pathway aims to relocate or remove assets located in hazard zones in an orderly manner, where hazard risks are likely to become intolerable over relevant planning timeframes. In recognition of the increased risk to assets in the coastal zone, the DPLH and the Western Australian Planning Commission provide guidance on implementing a planned or managed retreat policy through property acquisitions (WAPC, 2019). "Planned or managed retreat" can manage coastal erosion and inundation hazards.

Planned or managed Retreat is mostly applicable to developed areas, where there is less potential to adapt to coastal hazards through development planning controls, such as setbacks in Greenfield areas. The retreat

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strategy supports social, environmental and economic sustainability and ties into the SPP2.6 objectives and adaptation hierarchy. It allows for continuing public access to beaches, beach amenity, and the provision of a coastal foreshore reserve.

The CHRMAP Guidelines (WAPC, 2019) suggest various mechanisms for "managed retreat" in developed areas, using compulsory or voluntary acquisition provisions outlined in state legislation. Land swaps and/or leaseback of private property are also possible alternatives to acquisition. These alternatives can reduce overall implementation costs and remove people and assets "out of harm's way".

The main challenge of "managed retreat" is the significant political capital and investment necessary to fund acquisitions. A considerable funding contribution may need to be gathered from the State or Commonwealth to implement managed Retreat at large scale. In the meantime, pilot projects could be considered to demonstrate the benefits associated with this pathway.

Economically, relocation or managed retreat options may be triggered by the physical costs of repair exceeding the relocation costs. As per the success criteria and adaptation hierarchy, consideration should be given to the continued allowance for a recreational reserve. This may mean relocating buildings ahead of their risk rating to continue allowing this space.

At the time of writing, "managed retreat" has not been implemented to manage coastal hazards in WA. Therefore, landholders and the broader public should be aware of the risks in decisions related to valuing, purchasing or developing lands in coastal hazard zones.

3.4 Accommodate

The "accommodate" pathway controls the coastal hazards with design and management strategies. Accommodate can minimise coastal inundation and erosion hazards effectively but is primarily suited to adapting to inundation risk. For example, to minimise inundation risks, design and management strategies can include minimum finished floor levels (FFLs) or elevated electrical circuitry. Erosion hazards may be accommodated via deep foundations or relocatable buildings, which can be subject to a "planned retreat" pathway when at high risk. In this way, the 'Accommodate' pathway allows landholders to use assets until hazards become intolerable while mitigating existing coastal hazards and potential legal and financial liabilities.

It should be noted that the current State legislative framework means that permanently inundated private land does not become Crown land, unlike in other Australian states (Robb et al 2017, Robb et al 2018). Therefore, if the shoreline is allowed to recede beyond private property boundaries, public access and trespass issues may arise. This should be a key consideration when assessing the appropriateness of this pathway.

3.5 Protect

The "protect" pathway stabilises the shoreline using hard or soft coastal protection works such as seawalls, groynes, offshore breakwaters, geotextile sand-containers, sand renourishment and levee banks. Protection is a pathway that can be applied to manage coastal erosion and inundation hazards.

The adaptation hierarchy considers the construction of new protection measures as the least preferred pathway of all potential pathways listed in the hierarchy. This is because protection measures, particularly hard measures such as rock groynes and seawalls, interfere with local coastal processes and can have detrimental effects on local ecological systems. Protection measures can also inflate property values in hazard areas, creating expectations that protection measures can be maintained indefinitely. Adopting this pathway early will limit the capacity of future decision-makers to adopt another pathway as climate change progresses. This is particularly important beyond 2100 as sea level rise is very unlikely to abate in the 22nd century (IPCC, AR6).

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Over the short- to medium-term, public authorities may need to consider interim protection measures to delay shoreline recession. Interim measures such as coastal dunes revegetation and beach nourishment can effectively mitigate coastal hazards.

Where public and private assets are proposed inland of interim protection measures, the design life of the protection measure should be a determining factor in assessing the appropriateness of the proposed development.

3.6 No Regrets

"No regrets" pathway improves coastal hazard resilience and preparedness at a low cost and in a flexible manner. These can be undertaken simultaneously with investigations necessary to implement a thorough risk treatment pathway.

Coastal monitoring is a "no regret pathway" that improves the understanding of coastal hazards, risks and vulnerabilities and the effective life of existing coastal structures.

Similarly, modifying planning frameworks and providing clear direction for planning authorities when assessing applications for new development and affected landholders is a "no regret" pathway. However, the political capital necessary to make such planning changes can be high. Therefore, modifying planning frameworks should be done opportunistically and sensitively. Planning frameworks might introduce or modify the following instruments:

- Special Control Areas (SCA), to ensure planning discretion over new development
- Clear development assessment criteria, to ensure that new development gives due regard to coastal hazards
- Notifications on title, to inform current and future property owners at risk
- Time or event-limited planning permits to allow the continued use of land until hazards become intolerable
- Requirements for emergency evacuation plans (also relevant to Accommodate pathways)

3.7 Do Nothing

The do-nothing pathway assumes that no action will be taken, and that all levels of existing risks are accepted.

This pathway can be useful for comparisons with other pathways but is considered unacceptable because it will increase risk to people and properties. Developed foreshores require public safety management and basic public services.

3.8 Hierarchy Summary

Maintaining public access to the coast in developed areas is one of the main objectives of SPP2.6.

The current State legislative framework means that where the shoreline recedes beyond private property boundaries, public access and trespass issues are likely to arise. This situation implies that public authorities have two main adaptation pathways available to them for preserving public coastal access:

- Planned or Managed Retreat i.e., maintaining a foreshore reserve through the public acquisition of private property; or,
- Protect i.e., preventing the shoreline from receding beyond private property boundaries by stabilising the current shoreline position using various protection measures.

Where public authorities cannot commit to either of these pathways over the long term, they may modify local planning frameworks to manage new development so that they are appropriately designed and located. Public

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authorities in this situation may also consider the appropriateness of interim Protection measures to preserve public interests by delaying shoreline recession and minimising the effect of regular nuisance inundation events on existing development and infrastructure.

The coastal hazard assessment has provided an indicative timeframe for when adaptation will be required. However, it is recommended to use triggers for adaptation, including relocation or managed retreat purposes in line with WAPC (2019):

- Where the most landward part of the Horizontal Shoreline Datum (HSD) is within 40 metres or S1 of the most seaward point of a development / structure / foreshore reserve area.
- Where a public road is no longer available or able to provide legal access to the property.
- When water, sewage or electricity to the lot is no longer available as they have been removed / decommissioned by the relevant authority due to coastal hazards.

3.9 Success Criteria

The success criteria for the study identified in the Water Technology (2023) Report are presented in Table 3-1. These criteria demonstrate that the stakeholder and community values in the study area reflect the requirements of the state, regional and local planning controls. The success criteria highlight the need to maintain the natural environment, ensure that future developments do not accelerate erosion or inundation, manage land at risk, and manage recreational assets.

Table 3-1 Preliminary Success Criteria

- Preserve and protect the Town's beaches and natural assets such as vegetation and dunes.
- Ensure the natural environment is protected and sustained in its current condition or an improved condition.
 - o Maintaining the natural state of any underdeveloped areas is important.
 - o Preserve and consider the cultural significance of Mudurup Rocks.
- Preserve the function and opportunity for all types of water-based and land-based activities, particularly those that help to improve the health and well-being of people.
- Preserve and accommodate the existing surf lifesaving clubs as these facilities were seen as a hub
 of water and land-based activities that also helped to improve social connection and mental
 wellbeing.
- Continue to provide public amenities at the coast, such as parks, restrooms parking and access
 paths.
- Ensure that areas for community events and access to remain within the coastline. Provide and maintain spaces and infrastructure for community events, arts and entertainment.
- Minimise impacts on existing private property.
- Consider treatments for coastal areas that have current inundation and erosion issues. Preserve the current uses of the beach areas.
- Develop solutions to coastal processes that are sustainable (financially, socially and in their built form) and locally responsive.
- Revisit regularly with community and key stakeholders their values in relation to development adiacent the foreshore.

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3.10 Summary for Decision Makers

Table 3-2 presents a summary of the relevant information for adaptation. It is important to note that there is no law requiring public authorities to provide protection of private property from natural hazards, nor compensation when land is lost due to coastal hazards. The CHRMAP process aims to minimise coastal hazard risks and maximise beneficial use of the coast.

Table 3-2 Adaptation Consideration Summary

- Adaptation options should minimise coastal process interference and avoid creating legacy issues
 - The adaptation hierarchy is presented in Figure 3-1
- Coastal development must be sustainable in the long term, and must balance the community, economic, environmental and cultural needs
- Local Governments are responsible for managing risks to public assets and any assets they
 manage. They should also:
 - o Develop local policies and regulations consistent with state legislation and policy
 - Facilitate building resilience and adaptive capacity within the local community
 - Work in partnership with community to identity and manage risks / impacts
- Management strategies that preserve the natural coastline and move development away from the
 active coastal zone in an orderly manner are considered ideal. Of particular relevance to the
 CHRMAP process is the user-pays principle, whereby those who benefit most from protection
 must provide the greatest financial contribution
- · Adaptation options should maintain future flexibility, in order to build resilient coastal communities.
- A key adaptation option will be the use of planning instruments, including managed retreat.

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4 RISK TREATMENT OPTIONS

4.1 General Options

Table 4-1 below lists available adaptation options suitable for most coastal sites. These adaptation options relate to both short-term and long-term adaptation to coastal hazards, not just in relation to planning for climate change impacts. The column on the right-hand side discusses the application potential for the study area.

The option categories of Avoid, Planned or Managed Retreat, No Regrets and Do Nothing all apply generally to adapting to both erosion and inundation hazards. Accommodate applies primarily to inundation. Most Protection options apply primarily to erosion with PR6 (Levee / Weir / Storm Surge Barrier) applicable to inundation.

Any new assets should avoid the hazard zone. If they must be located within the hazard zone, they should be designed to withstand the inundation hazard. For example, new buildings to be constructed with permeable lower levels (e.g., a stilt or deep pile foundation arrangement designed for coastal exposure, including wave actions) and services above the flood level. This avoids the need to use fill to raise the FFL. Fill is expensive and alters overland flow, which could lead to increased hazards elsewhere, leading to legal challenges.

Whilst the risks and their corresponding adaptation options are assessed separately, triggers to adapt can occur at any time from either erosion or inundation.

4.2 Planning Control Options

This section outlines the key planning-based mechanisms which can be implemented by the Town in response to the coastal hazards identified in the CHRMAP. As the coastal inundation hazard has been identified as insignificant for this study area, the planning mechanisms have been prepared to respond to the impacts of coastal erosion only.

4.2.1 Special Control Area

The introduction of a Special Control Area (SCA) into the Town's local planning scheme is considered the most appropriate statutory planning mechanisms to holistically address coastal erosion. An amendment to the local planning scheme will be required to introduce the SCA over all zoned land located seaward of the 2123 coastal processes setback line.

An SCA is typically put in place to establish special provisions to target a single issue or related set of issues often overlapping zone and reserve boundaries. The provisions of an SCA would establish the purposes and objectives, specific development requirements and referral requirements to agencies relevant to the SCA.

The CHRMAP Guidelines (WAPC 2019) provides draft amendment text including the purpose, objectives and provisions to be contained within an SCA. The purpose of the SCA is to provide guidance as to the appropriate scope of land use and development to be permitted within a coastal hazard risk area. This would be achieved through the following overarching objectives:

- To ensure land in the coastal zone is continuously provided for coastal foreshore management, public access, recreation and conservation.
- b. To ensure public safety and reduce risk associated with coastal erosion and inundation.
- c. To avoid inappropriate land use and development of land at risk from coastal erosion and inundation.
- d. To ensure land use and development does not accelerate coastal erosion or inundation risks; or have a detrimental impact on the functions of public reserves.
- To ensure that development addresses the Town of Cottesloe CHRMAP prepared in accordance with SPP 2.6.

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The SCA would also include additional provisions to ensure development and use of land subject to erosion over the 100-year planning timeframe. The additional provisions to be included within the SCA will include requirements relating to:

- a. The need to obtain development approval for all development, including development that is considered exempt under the Deemed Provisions and the local planning scheme.
- b. Temporary or time limited approvals with the option to seek extensions where the risk from coastal processes is still considered acceptable.
- c. The referral of development applications to relevant agencies for comment and advice, including the Department of Transport, the Department of Planning, Lands and Heritage and any other relevant authority.
- d. Construction and servicing design requirements.

4.2.2 Coastal Local Planning Policy

A local planning policy (LPP) can be prepared by a local government in accordance with Schedule 2 of the Planning and Development (Local Planning Schemes) Regulations 2015. The purpose of a LPP is to guide the development and use of land in relation to a particular matter. LPPs allow a level of discretion and flexibility to be applied in the decision-making process given they are a due regard planning instrument.

The Town can prepare a Coastal LPP to ensure future development aligns with the overarching objectives of the SCA. The Coastal LPP will include provisions relating to strategic planning proposals, subdivision and development applications on land identified as being prone to coastal erosion.

4.2.3 Notifications on Title

Freehold land identified as being at risk of coastal erosion should have a notification registered on its certificate of title to ensure current and future landowners are aware of the potential for the land to be impacted by coastal processes. The notification shall state the following noting that shorter timeframe than 100 years may be appropriate where identified in the CHRMAP:

'This lot is located in an area likely to be subject to erosion over the next 100 years from the date this notification is registered.'

Notifications can be registered on the certificate of title as part of the decision-making process for subdivision and development applications under the following legislation:

- The WAPC requires a notification pursuant to Section 165 of the Planning and Development Act 2005 to be registered on the lots associated with a subdivision approval; and
- The Town requires a notification pursuant to Section 70A of the Transfer of Land Act 1893 to be registered on the lot associated with a development approval.

Landowners can also voluntarily seek to register a notification on the certificate of title pursuant to Section 70A of the Transfer of Land Act 1893.

4.2.4 Other Instruments

Additional instruments that can be considered for implementation include:

 Updates to the Local Planning Strategy to reference SPP2.6 and avoid the identification of at-risk land for further intensification of development through rezoning or subdivision.

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Preparation of a foreshore management plan to provide a strategy to deliver the recommendations of the CHRMAP for foreshore reserves throughout the Town.

- The use of restrictive covenants to restrict development in high-risk areas or limit the use certain protective barriers which may contradict the recommendations of the CHRMAP.
- Introduction of special area rates to equitably distribute costs associated with protection options across beneficiaries.
- The application of SPP2.6 in the structure planning process where the comprehensive redevelopment of land remains an option.
- Internal processes and systems to ensure coastal hazard information and data is readily available and accessible to landowners, prospective buyers and the real estate industry.

The intent of these instruments aligns with guidance provided in the WA Coastal Zone Strategy, noting that private parties are responsible for managing risks to their private assets and incomes, which might arise from coastal erosion and inundation hazards.

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Table 4-1 Risk Treatment Options from WAPC (2019)

Option Category	Option Name	Option Code	Description of how it will help
Avoid	Locating assets in areas that will not be vulnerable to coastal hazards	AV	Assets will not be vulnerable to risk arising from coastal hazards.
Planned / Managed Retreat	Leaving assets unprotected	PMR1	Accept loss following hazard event. Only implement repairs to maintain public safety. Allow for Retreat with natural recession of the shoreline over the long-term.
	Demolition / removal / relocation of asset from inside hazard area	PMR2	Relevant for assets of low value where it is impractical both technically and financially to design the asset to withstand the impact of the coastal hazards instead of relocating it.
	Prevention of further development / prohibit expansion of existing use rights	PMR3	This risk treatment option would enable existing development and use rights to continue without increasing them, until such time that risk arising from coastal hazards is intolerable. Specified in a local planning scheme.
	Voluntary acquisition	PMR4	This risk treatment option would require the acquisition of affected properties, on a voluntary basis.
Accommodate	Design assets to withstand impacts	AC1	Where avoiding or relocating an asset is not an option, design of assets to withstand the impact of inundation.
Protect	Beach nourishment or replenishment (*)	PR1	Placement of sand on the upper beach face and dunes to re-establish the sandy beach and provide a sediment supply.
	Groyne	PR2	Construction of groynes to stop or restrict the movement of sand around the end of the structure, to provide protection to assets behind the beach/foreshore reserve. They are primarily effective where there is longshore sand supply or when partnered with sand nourishment.
	Seawall	PR3	Construction of a seawall usually along an entire section of shoreline. Where a beach is to be retained, this risk treatment option should generally be accompanied with beach nourishment or replenishment.
	Artificial reef	PR4	Construction of a submerged artificial reef offshore, to dissipate wave energy impacting the shore by causing waves to break on their seaward side and reducing wave energy on the leeward side. Artificial reefs do not block waves and during storm events water depths over the reef may be sufficient to allow waves to pass over the reef without breaking, reducing their effectiveness in protecting the beach from erosion.
	Offshore breakwater	PR5	Construction of an emergent offshore barrier (often referred to as an offshore breakwater). Offshore breakwaters effectively block wave energy by absorbing wave impact on their seaward side. They create a lower wave energy section of beach immediately in its lee, which is characterised by a salient where sand accretes in the low energy environment.
No Regrets	Monitoring	NR1	Involves long term baseline monitoring and event-based monitoring following storm erosion events.
	Protection Structure Audit	NR2	Involves undertaking an audit of existing protection structures, to determine their current condition, effectiveness and future protection potential.
	Notification on Title	NR3	Indicates to current and future landowners that an asset is likely to be affected by coastal erosion and/or inundation over the planning timeframe. Helps current and future owners make informed decisions about level of risk they are/may be willing to accept, and that risk management is likely to be required at some stage within the planning timeframe.
	Emergency evacuation plans	NR4	Where existing assets may be affected by inundation and are not already identified in an existing emergency evacuation management plan. Such plans are important in managing the safety of community and stakeholders.
Do Nothing	Do Nothing	DN1	Assumes all levels of risk are accepted and assumes that there is no change in existing planning controls, and no actions are implemented (i.e., no controls are implemented to treat known coastal risks).

^(*) Based on Engagement sessions in July and August 2023, community members expressed interest in nearshore sand nourishment where the sand is placed offshore following dredging of offshore sand sources. Nearshore nourishment works with nature and is designed for the coastal processes to move the sand to shore and is considered as part of this option.

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5 RISK TREATMENT OPTIONS: EROSION

This section discusses adaptation options identified to respond to erosion hazards.

5.1 All Management Units – Present Day

As per the erosion adaptation options, it is recommended to implement adaptation options in the present day that will facilitate flexible adaptation in the future:

- Prevention of further development / limiting existing use rights
 - Introduce 'Special Control Area Coastal Hazard: Erosion'. Depending on the nature of development proposed, approval may be time limited or require structures to be removed by a specified date or when a specified trigger is reached.
 - Require notification on Title for all land located seaward of the 100-year hazard line for coastal erosion. This should be made a condition of any approval for development or subdivision/amalgamation of land. The LGAs should also negotiate with landholders whose land is not subject to an application for planning approval to place such a notification on the title with their consent.
 - Introduce a local planning policy outlining the LGAs' requirements for building construction, land fill, and other relevant matters within the Special Control Area, noting requirements will be slightly different for erosion and inundation.
- Any new assets should avoid the hazard zone.
- Coastal monitoring to regularly document changes to the shoreline and understand system; enables better prediction of management trigger timeframe

Commence investigations to determine options for appropriate longer-term relocation of affected properties / assets.

5.2 All Management Units – Future Timeframes

The modelling has provided an indicative timeframe as to when adaptation will be required. However, it is recommended to employ the use of triggers for adaptation, including for relocation or managed retreat purposes. These are as per those of WAPC (2019).

- **Trigger 1**: Where the most landward part of the Horizontal Shoreline Datum (HSD) is within 40 metres of the most seaward point of a development / structure / foreshore reserve area.
 - The recreational and dune area is considered the asset in this case, as per the values and vulnerability assessment.
- Trigger 2: Where a public road is no longer available or able to provide legal access to the property.
- Trigger 3: When water, sewage or electricity to the lot is no longer available as they have been removed or decommissioned by the relevant authority due to coastal hazards.

The management measures discussed above apply in the addition to those discussed below in Section 6.

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6 MULTI-CRITERIA ANALYSIS

Successful risk management and adaptation planning require identifying and diligently assessing suitable risk treatment options to select the best strategy. The selected risk treatment option should mitigate risk to an acceptable level whilst maximising the values important to the stakeholders.

6.1 Assessment Criteria

For this CHRMAP, the key assessment criteria are:

- Effectiveness
 - Ability for the option to mitigate the coastal hazard
- Environmental Impact
 - Impact on existing native vegetation / dunes / coastal processes
 - Includes consideration of:
 - Any construction / clearing impacts
 - Impact of maintenance on the environment
- Social Impact
 - This considers stakeholder and community impacts from previous CHRMAP chapters
 - Incorporates feedback provided by engagement workshop attendees in Winter 2023
 - Potential impacts on Aboriginal and European heritage sites and values are considered in this criterion.
- Aesthetic Impact
 - The visual appeal of the option
 - Consideration of option aesthetics tying into the wider Town / Management Unit vision
- Cost
 - Upfront capital costs
 - Ongoing maintenance costs
 - Economic affects such as loss of businesses, income, value
- Future Adaptability
 - Whether the option is easily adaptable in future, such as for updated sea level rise actuals or projections
 - If the option limits the feasibility of selecting other options in future

Water Technology's coastal management professionals initially assessed the risk treatment options against the criteria. All ratings are somewhat subjective; however, community and stakeholder engagement allowed for additional feedback from the community and further review of the scores attributed – discussed further below.

Information provided to date by stakeholders was included in the assessment of each value as required. Risk Treatment Options were assessed using the multi-criteria assessment (MCA) matrix shown in Table 6-1, which indicates the rating given to each criterion for a given option and provides the recommendation for pursuing the risk treatment option.

In most cases, it is necessary to implement more than one option, and the options selected through the MCA may vary between management units and with implementation timeframes. The results of the MCA for each Management Unit are summarised in the sections below.

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6.2 Assessment Framework

Table 6-1 Multi-Criteria Assessment Framework

Rating; Score	Effectiveness	Environmental Impact	Social Impact	Aesthetic Impact	Cost (Capital & Ongoing)	Future Adaptability	Final Recommendation
Positive; +2	Expected to be very effective	Significant positive impact; return to more natural coastline	Significant positive social impact; encourages community development	Positive aesthetics, improves existing coastline and place recognition	Low costs. Higher capital costs accepted if other criteria met. Very low economic loss.	Very adaptable, not likely to leave legacy issues	Further Investigation Recommended; Score > 0
Positive; +1	Expected to be effective	Positive impact; return to more natural coastline	Positive social impact; encourages community development	Positive aesthetics, retains the existing coastline and place recognition	Reasonable costs. Higher capital costs accepted if other criteria met. Low economic loss.	Adaptable, not likely to leave legacy issues	Further Investigation Recommended; Score > 0
Neutral; 0	May or may not be effective, possibly unable to predict	No (or unclear) environmental impact	No discernible social impact; indeterminate net impact	Neutral aesthetic	Moderate costs	May leave legacy issues	Suitability unclear; Score = 0
Negative; -1	Likely to be ineffective in the short or long term	Potential significant negative impacts, including losing beaches altogether	Negative social impact. May discourage new or existing people from the area	Coastline / foreshore appearance negatively altered	High initial or ongoing costs, especially if low likelihood of success. High economic loss.	Likely to create legacy issues	Not recommended; Score < 0
Negative; -2	Very likely to be ineffective in the short or long term	Significant negative impacts, including losing beaches altogether	Significant negative social impact. May discourage new or existing people from the area	Coastline / foreshore appearance degraded	Very high initial or ongoing costs, especially if low likelihood of success. Very high economic loss.	Will create legacy issues	Not recommended; Score < 0

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Table 6-2 Multi-Criteria Analysis summary by Management Unit. Green indicates recommended for further investigation. Refer 8Appendix B for full MCA results

Option	MU1 (North of Cottesloe Groyne, including Groyne)	MU2 (South of Cottesloe Groyne)
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	N/A	11
Leaving assets unprotected (PMR1)	2	2
Demolition / removal / relocation of asset from inside hazard area (PMR2)	6	6
Prevention of further development / prohibit expansion of existing use rights (PMR3)	7	7
Voluntary acquisition (PMR4)	5	5
Design assets to withstand impacts (AC1)	N/A	N/A
Beach nourishment or replenishment (PR1)	7	7
Groynes (PR2)	1	1
Seawalls (PR3)	-4	-4
Artificial reef (PR4)	-4	-4
Offshore breakwater (PR5)	-2	-2
Levy / Weir / Storm Surge Barrier (PR6)	N/A	N/A
Monitoring (NR1)	8	8
Protection Structure Audit (NR2)	6	6
Notification on title (NR3)	8	8
Emergency evacuation plans (NR4)	N/A	N/A
Do nothing (DN1)	-8	-8

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7 SUMMARY & NEXT STEPS

This report presents the risk evaluation and multi-criteria analysis for the Town of Cottesloe CHRMAP. The MCA results are presented in full in 8Appendix B; a summary is presented in Table 6-2.

Succeeding the MCA will be a cost-benefit analysis (CBA) and benefit distribution analysis (BDA) of options carried forward from the MCA. This is the subject of the next CHRMAP chapter report. The CBA will allocate an estimated cost to all significant values and detractions of a given option, both at Present and over the option's intended design life, independently from the MCA costs. A net present value (NPV) will be estimated for each risk treatment option. The CBA and MCA will inform a preferred strategy.

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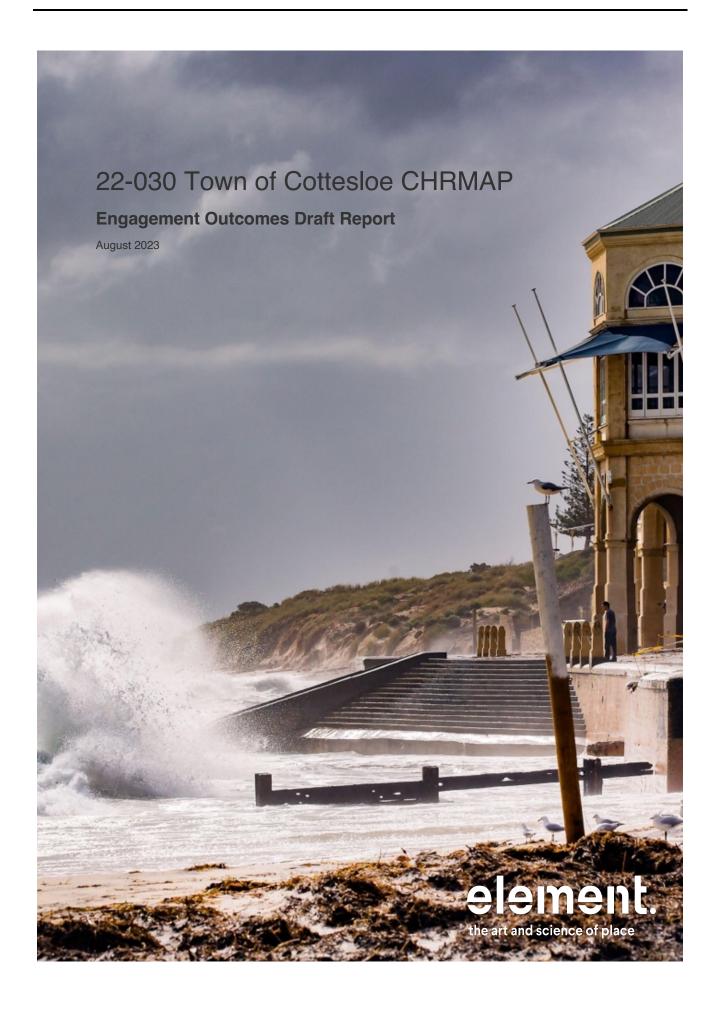
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APPENDIX A ENGAGEMENT OUTCOMES REPORT





Docum	nent ID: 21-601 D	Documents / 04 Rep	ports			
Issue Date		Status	Prepared by		Approved by	
			Name	Initials	Name	Initials
1	7.11.2022	Draft	Misha White	MW	Cath Blake-Powell	CBP
			Yasmine Mnahy	YM		
2	24.08.2023	Draft	Misha White	MW	Misha White	MW

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Executive Summary

In 2021, the Town of Cottesloe engaged the project team of Water Technology, Cardno-Stantec and **element** to provide specialist land use planning, community engagement and coastal engineering consultants to produce a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP). The CHRMAP will be prepared in accordance with the CHRMAP Guidelines and State Planning Policy 2.6, adopted by the Town of Cottesloe and used to guide future decision making for vulnerable assets in its coastal area.

An important part of this study is speaking with the community and key stakeholders to identify their values and aspirations for the foreshore. The engagement for this project has been primarily spread across two key stages in the project lifecycle: Stage 1: Establish the Context and Stage 5: Risk Treatment.

In Stage 1 of the project, we engaged with over 141 people across 3 activities and promoted the project through an awareness campaign. The purpose of engagement in Stage 1 was to understand coastal values, aspirations, visitation and usage of the coastline. Below is a summary of the key findings.

- The community valued the 'natural environment' most about their foreshore, with 'access to water-based activities' and 'opportunities for health and well-being' also highly valued.
- The Cottesloe foreshore is well utilised with a range of land and water-based activities occurring frequently in the area.
- Whilst a smaller proportion of respondents noted that they were undertaking activities in the area
 because 'I can't do this activity elsewhere, it is unique to this area', a vast many felt that their lives
 would be impacted adversely if they were unable to undertake these along the Cottesloe foreshore.
- The community were concerned about erosion and inundation along the coast, particularly in relation to sand erosion and the potential to expose rocks. This was also noted by the key stakeholders are being an important issue that influenced the use of Cottesloe beach.

In Stage 2 of the project, we engaged with 44 community members who participated in two 2 hour workshops to determine priority assets and the corresponding adaptation pathways and management options for these.

Cottesloe main beach and the coastal path were viewed as having a very high value amongst the community.

Overall, the most popular adaptation pathway for assets was to protect them, however a significant number of participants opted for and understood that over time managed retreat was preferable and necessary. Beach nourishment (while possible) was important to a range of community and stakeholders, to maintain the sandy beach. Groynes and off-shore reefs were also seen as being appropriate management options.

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1. Introduction

1.1 Project Overview

In 2021, the Town of Cottesloe (ToC) appointed the project team of Water Technology, Cardno and element to produce a Coastal Hazard Risk Management Adaptation Plan (CHRMAP) consistent with Western Australian Planning Commission (WAPC) 2019 guidelines. The Cottesloe CHRMAP will be used guide future decision making for vulnerable assets in its coastal area.

A Stakeholder and Community Engagement Strategy (SCEP) was prepared to guide the engagement process and ensure that the community and stakeholders were effectively and actively involved in the CHRMAP preparation process.

The SCEP outlines how the community and stakeholder participation, and engagement process aligns within the inform, consult and involve levels of IAP2 Public Participation Spectrum. The goals of each level of engagement are described in the table below.

Table 1: Levels of Engagement for the Project (based on IAP2 Public Participation Spectrum)

Goal	To provide balanced and objective information in a timely manner.	To obtain feedback on analysis, issues, alternatives and decisions.	To work with the public to make sure that concerns and aspirations are considered and understood.
Promise	"We will keep you informed."	"We will listen to and acknowledge your concerns."	"We will work with you to ensure your concerns and aspirations are directly reflected in the decisions made."

The engagement objectives and the engagement tools are summarised in the Sections that follow based on the information in the SCEP.

The CHRMAP process is being completed in 7 stages, where the community will review the draft prepared at the end of each stage. In this way, community and stakeholder involvement will guide the preparation process. See the diagram overleaf for a breakdown of the 7 stages.

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Figure 1 Diagram of the CHRMAP stages



This report is a summary of the community engagement undertaken during Stage 1 and Stage 5 of the CHRMAP process. This report reflects the engagement outcomes throughout the CHRMAP project at these stages.

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1.2 Project Scope

The subject area, is located on Whadjuk Noongar land within the Town of Cottesloe. The approximate 4 km of coastline contains some of Perth's most iconic and popular beaches and lies between North Street and just South of the Vlamingh Memorial. Bordered by the residential suburb of Cottesloe, the coastal foreshore area has interactions with many landmarks and recreational features including Cottesloe main beach recreation area, Cottesloe Surf Life Saving Club, North Cottesloe Surf Life Saving Club, The Cottesloe Sundial, Indiana Tearooms, South Cottesloe Beach exercise park, South Cottesloe playground, Cottesloe Nature discovery Space, the Vlamingh Memorial, several public beaches, and hospitality venues, as well as the Cottesloe and Beach Street Groynes.

The project site also includes the Cottesloe foreshore masterplan concept and redevelopment area. The study area was split into 2 Management Units, North and South of the main groyne, shown in the Figures below.





Figure 3: Study area (Management Unit) South of Cottesloe Groyne



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1.3 Project Objectives

The objectives of the CHRMAP are to:

- improve understanding of coastal features, processes and hazards in the study area;
- identify significant vulnerability trigger points and respective timeframes to mark the need for immediate or medium-term risk management measures;
- identify assets (natural and man-made) situated in the coastal area and the services and functions they provide;
- · gain an understanding of asset vulnerability;
- identify the value of the assets that are vulnerable to adverse impacts from coastal hazards;
- determine the consequence and likelihood of coastal hazards on the assets, and assign a level of risk;
- identify possible (effective) risk management measures (or 'actions') and how these can be incorporated into short and longer-term decision-making; and
- engage stakeholders and the community in the planning and decision-making process.

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2. Engagement Methodology

2.1 Purpose and Objectives of Engagement

The purpose of the engagement during Stage 1 and Stage 5 of the CHRMAP process was to raise project awareness, engage with Aboriginal cultural representatives and collect community coastal values including social, economic and environmental values, including which coastal foreshore assets the community hold important. It also included looking at the potential adaptation pathways for these assets and the coastline.

As such, the objectives of the engagement were to:

- Utilise reliable communication channels to ensure information is shared with interested stakeholders.
- Identify stakeholders and understand the nature of their interest and potential to contribute towards success of the project or otherwise.
- Establish early in the project opportunities to have authentic conversations with people, particularly
 those most affected by potential change from future coastal adaptation measures.
- Inform key community member and stakeholders to develop understanding and alignment with the goals of coastal hazard risk assessment within the Cottesloe community.
- Ensure adjacent neighbours (residents and businesses) to the project site are kept informed and are invited to undertake targeted engagement as required, giving sufficient notice to do so.
- · Inform, consult and involve the community in identifying suitable adaptation options
- Collect and collate the community and stakeholders' coastal values and aspirations for the long term.
- Understand the level of tolerance of specific risks within the community for specific assets, or groups
 of assets.
- Develop a shared vision between the Town, landowners and surrounding community for the future CHRMAP recommendations.

A number of communication channels and engagement tools have been used throughout Stage 1 and Stage 5 of the CHRMAP project process, these are identified below.

2.2 Engagement Tools

2.2.1 Targeted Stakeholder Conversations

Understanding project stakeholders is a critical consideration of any engagement and communications program. By understanding who these groups or individuals are, we may better understand and analyse their degree of influence and interest, and therefore the involvement they are likely to request and require.

To ensure that key stakeholders were able to provide input into the project element held interviews with strategic landowners or primary lessees and user groups along the foreshore, as identified by the Town of Cottesloe.

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2.2.2 Aboriginal Engagement Session(s)

Engagement with Aboriginal cultural representatives occurred alongside the broader community engagement activities at key stages of the CHRMAP process. This engagement provided input into the Cottesloe CHRMAP by providing Aboriginal cultural values and knowledge about the coastline and its natural assets specifically cultural values and ensuring that responses to potential hazards incorporates this viewpoint.

Aboriginal engagement consisted of 2 meetings with appropriate cultural representatives and was facilitated by a Cultural consultant aligned with both;

Stage 1 - Establishing the context

Stage 5 - Risk Treatment

2.2.3 Pop-up Information Sessions

Two pop-up information sessions were held to introduce the CHRMAP process and provide information about the project including;

- Why does a CHRMAP need to be prepared
- Outline of foreshore areas to be included in the study
- · Identification of coastal assets
- · Explanation of coastal hazards
- · Overview of management options

These were attended by the project team and Town staff who were available to explain the process and answer any questions

2.2.4 Coastal Values Survey

The Coastal Values survey ran was composed of 22 questions and considered the Cottesloe coastal area in the context of North and South Management Units of the Cottesloe Groyne (see Figure 2 and 3) and was hosted online via the Town's webpage. The Management Units were described as 'Zones' in the survey, to aid comprehension for the community.

An outline of the questions in the Coastal Values survey is shown in Table 1 below.

Table 1 Coastal Values Survey Questions Overview

No.	Question			
About you	About you – Respondent Demographic Information			
1	Roughly how close do you live to the Cottesloe CHRMAP project area?			
2	What suburb do you live in?			
Connection	Connections with the Coastline			
3	What is your connection to the Cottesloe Coastline (between North Street and Vlamingh Memorial)? Select all that apply.			
Thinking about your interactions and experiences at the Cottesloe Foreshore what are three words that come to mind?				
Values an	Values and Activities			

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5	Which locations, places or experiences are most important to you within the Cottesloe CHRMAP area. Write in up to 5.		
6	Please indicate what activities you or your family undertake along the Cottesloe coastline and where you undertake them (tick all that apply).		
Activities	in the North Zone		
7	How often do you participate in these activities in the North Zone?		
8	Why do you choose to undertake these activities in the North Zone as opposed to other nearby areas? (Choose all that apply).		
Activities	in the South Zone		
9	How often do you participate in these activities in the South Zone?		
10	Why do you choose to undertake these activities in the South Zone as opposed to other nearby areas? (You may select more than one option).		
Site Impa	cts		
11	If you were unable to do these activities along the Cottesloe coastline, how much would this impact your life?		
12	Why do you chose to undertake these activities along the Cottesloe coastline compared to other coastal areas in Perth?		
13	Below is a list of values that can apply to a variety of coastline and foreshore environments. Please tell us how important each value is to you in the context of the Cottesloe coastline.		
Impact of	Hazards		
14	How concerned are you about coastal erosion and/or inundation in the Cottesloe coastal area?		
15	From your experience within the project area, have you noticed any areas along the foreshore that may be affected by, or increasingly impacted by inundation and/or erosion hazards over the past 5 years? Please tell us more below, including the location/s of concern.		
Other den	nographics and comments		
16	We will be conducting further workshops early next year about mitigation strategies. If you would like to be invited to this or kept up to date with the project please let us know.		
17	Please provide your name and email address below. This information will be used for project communications for the Cottesloe CHRMAP only and will remain confidential.		
18	How young are you?		
19	What is your gender?		
20	Are you of Aboriginal and/or Torres Strait Islander descent?		
21	Please tell us how you heard about this survey.		
22	Do you have any further questions or comments about the project for the CHRMAP Team?		

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2.2.5 Community Scenario Workshops

Two community scenario workshops were held with the community to understand the potential adaptation pathways for the Cottesloe coastline. The workshops aimed to inform the community of the project and the projected impact from coastal processes, as well as gather feedback about asset prioritisation, and the preferred adaptation pathways along the foreshore coastline.

2.3 Communication Channels

Project information, updates and invitations to participate in engagement opportunities were distributed to the community in the following ways, particularly prior to Stage 1 and Stage 5.

Table 2 Communications Methods

Project website	Project webpages were hosted via the ToC webpage,
	https://www.cottesloe.wa.gov.au/services/environment-and-
	sustainability/coastal-hazard-risk-management-and-adaptation-plan-
	chrmap.aspx
	These contained all project information including; FAQ's, project background,
	engagement event information and project contact.
Project flyer	A project flyer was distributed to nearby residents and businesses.
	*This flyer also contained information regarding the ToC Heritage Strategy
Project emails/ e-	Emails were sent out via the ToC to community members as a call to action for
newsletters	engagement opportunities.
Posters and signage	Posters were erected at local businesses and signage at key locations along
	the coast directing people back to webpage.
Social media	Established social media channels for the ToC were used to provide
	information and direct people to the webpage

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3. Key Findings

3.1 Stakeholder Conversations

A total of 6 interviews were conducted out of a possible 10 stakeholders identified. The stakeholder groups represented a variety of views from key stakeholders in the area and their members/associates.

Of those that did not participate 1 refused and 3 did not respond to multiple requests to meet.

The six stakeholder groups interviewed were;

- Cottesloe Coastcare
- North Cottesloe Surf Life Saving Club
- Cottesloe Surf Life Saving Club
- Fiveight
- Sculptures by the Sea
- Cottesloe Longboard Club

Each stakeholder provided insight from the perspective of their relevant group regarding the Cottesloe CHRMAP process.

Values

The Cottesloe coastline was valued for a variety of reasons by the key stakeholders.

The importance of the environment in its natural state both in and around the water was a common theme. The ability to use the area to recreate via water-based and land-based activities was highly valued.

In addition to this the clubs with members particularly valued the social aspects of the beach and being part of a group that utilised the area to connect to one another. This was also seen as having flow on effects to mental wellbeing and a healthy lifestyle.

Given the iconic nature of Cottesloe and its existing heritage and cultural features, these were also seen as bringing value for the area.

Activities

In terms of the activities that were noted by stakeholders, these were varying from club specific activities to individual pursuits in and out of the water, with and without equipment. However, from all accounts the Cottesloe coastline is heavily utilised, by a variety of people for an extensive range of sports and activities. Not surprisingly this is more apparent during winter

Assets

The beach sand itself was seen as an important asset – as without it there would be limited beach-based activities and reduced access to the ocean. For the surf clubs and 'Sculptures by the Sea' without this asset their reason for being would disappear.

Cottesloe main beach and foreshore was seen as an important coastal area due to its heritage and social value. Within this were several notable landmarks including the Indiana Tearooms. The facilities on the

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coastal side of Marine Parade were also noted as being at risk and particularly the surf clubs that had facilities close to the beach.

Erosion and inundation

Erosion was seen as the main concern along the Cottesloe coast, particularly that the beach sand disappeared at times and exposed limestone rocks that interfered with recreational use. Another issue was maintaining access via beach paths. Stormwater run-off was also noted as being erosive.

Those areas closer to the groynes were seen as less likely to suffer the effects of erosion.

The erosion of sand around the North Cottesloe Surf Life Saving Club ramp was seen as an ongoing issue.

Inundation was seen as a part of winter storm events, but otherwise it was seen as a slow process that there would be time to prepare for. The most viable short-term mitigation strategy for built form assets was adapting them to allow storm inundation to wash through.

3.2 Aboriginal Engagement

An initial meeting with 4 cultural representatives was held 14 September at the Council offices.

The discussion focussed around the importance of the natural environment and specifically around Mudurup Rocks. It is noted that Mudurup Rocks is registered as Site ID 435 at the Department of Aboriginal Affairs, Heritage and Culture Division, Perth.

Some of the comments raised during this meeting were that:

- The Mudurup rocks were seen as a very important site to local Aboriginal people. It holds importance
 due to the fishing and swimming that happened there. A lot of whiting are in the area. It was also seen
 as a place where ceremonies were held.
- There are connections to Aboriginal people coming from Rottnest Island who visited the coast at Mudurup rocks for fishing. One of the members claimed to have a bloodline connection to Johnny Kudjal who is said to have used a cave within the Rocks and turned into a crow.
- There were some thoughts about the different ways that the name was spelt and pronounced.
- This area is also known as a place inhabited by the spirit of the crow man, with many crows being
 present in the area. This was verified by a direct descendant connection deemed as a custodian of
 the rock.
- The natural environment is important to Aboriginal culture, including that along the coastline, and a desire that it should be enjoyed in its natural state.
- It was felt that the rock area should not be interfered with, and that nothing should be placed on it.
- Although there was a desire to protect it they did not want it fenced but felt that it should be acknowledged.
- There were some comments regarding the active protection of the rocks or allowing them to succumb
 to nature due to sea level rise.

A secondary meeting with 3 cultural representatives was held on 26 July 2023 at the Council offices. This reaffirmed that Muderup Rocks was of most cultural significance along with native animals in the area and the natural environment, both on land and the ocean. Native plants and animals (including those that were marine-based) represented local food sources and shelter for Aboriginal people.

Potential adaptation strategies and management options were presented and explained the participants, who preferred the use of natural materials for any options implemented to protect the coastline. Any structures

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introduced should use natural materials or rocks, rather than anything man-made or concrete based. Revegetation of the coastline using plants and trees native to the area was preferred to mitigate erosion.

3.3 Pop-up Information Sessions

Two pop-up information sessions were held on Saturday 17 September at the Main Cottesloe Beach foreshore (near II Lido) from 9am – 12pm and 21 September from 4.30pm to 6.30pm at the Cottesloe Civic Centre, 109 Broome Street.

The 2 sessions were visited by 68 people who came to view the information and chat to the project team to gather more information about the project.

The information session included static information displays about the project and affected area and was attended by the following project team members:

- Cardno-Stantec coastal engineering specialists
- · element, planning and engagement specialists
- Town of Cottesloe officers

A handout was also provided with a QR code for the coastal survey.

3.4 Coastal Values Survey

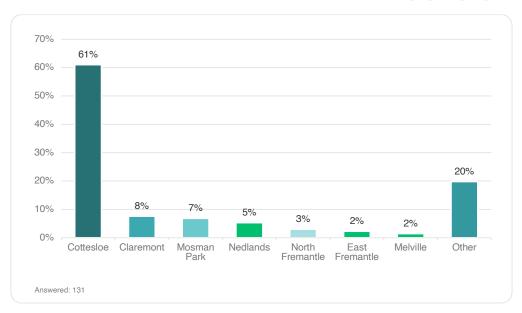
The main tool for collecting community feedback was through a Coastal Values survey which ran from to 1 September to 16 October 2022. A total of 131 respondents undertook the Coastal Values survey however not all questions were answered by everyone participating.

3.4.1 Who did we reach

As seen in figure 4, the majority (61%) of respondents were residents within Cottesloe. The remainder of respondents came from a range of other suburbs, with Claremont (8%), Mosman Park (7%) and Nedlands (5%) having the most involvement. A small number of respondents were from nearby suburbs including; Swanbourne, Peppermint Grove, Mount Claremont, South Fremantle, Fremantle, Subiaco, Clackline, Shenton Park, Lower King, Beckenham, Hamilton Hill, Churchlands, Attadale, Joondanna, Dalkeith, South of the River.

Figure 4: Q2 – What suburb do you live in?

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Over half (56.5%) lived within 1km of the site, while a further (26%) lived up to 5km away. The remainder lived more than 5km away.

The two most common age ranges were 45-54 and 65-74, making up 50% of total participants combined.

Most respondents were male (53.70%). However the number of female participants (41.67%) was not significantly less.

Graphs for the demographics can be found in Appendix A.

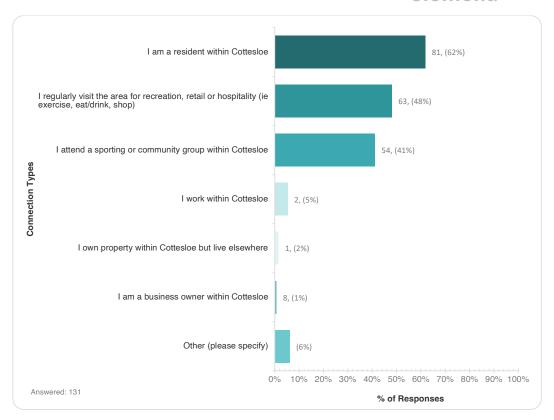
3.4.2 Connections with the Coast

The majority of respondents (62%) taking part in the CHRMAP survey reside within Cottesloe. Others regularly visit for recreation, retail or hospitality (48%) or attend a sporting/community group within Cottesloe (41%).

Out of the 8 responses that made up the 'other' category, 3 mentioned an activity that were applicable to other answers (e.g. swimming, surfing, walking the dog). 1 responder mentioned the spiritual and cultural values associated with the coastline and another mentioned the site's aesthetic value.

Figure 5: Q3 – What is your connection to the Cottesloe Coastline (between North Street and Vlamingh Memorial)? Select all that apply.

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3.4.3 Perceptions and Importance of the foreshore area

Respondents were asked about what three words they associated with the Cottesloe foreshore based on their experiences and interactions. A lot of the descriptions related to water and land-based activities that occurred as well as an appreciation of the natural assets associated with the coast.

A fifth of respondents (23%) mentioned 'Swimming' as what came to mind. 'Clean' was mentioned by 15%, with walks/walking mentioned by 12%, along with 'Beach' (11%), 'Natural' (10%) and 'Nature' (9%). The Surf Clubs were also mentioned specifically be 9%.

The image below shows a graphical representation of the word descriptions that were used

Figure 6: Q4 – Thinking about your interactions and experiences at the Cottesloe Foreshore what are three words that come to mind?

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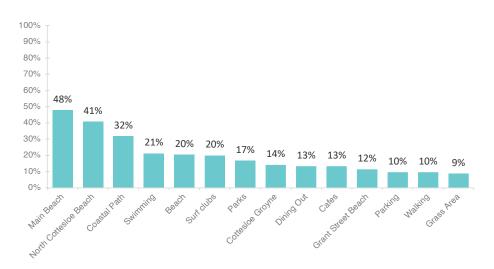


Respondents were asked about the most important aspects of the Cottesloe coast. As seen in figure 7 below, specific locations within the coastline that were frequently mentioned included the Main Beach (mentioned by 48%) and North Cottesloe Beach (41%). Also seen as important were the Coastal Paths along the coastline (32%), swimming (21%) which also covered the shark nets and the Beach/sand.

Other locations mentioned frequently included the Cottesloe Groyne, Dining out venues, cafes, Grant Street Beach and the grassed areas along Cottesloe.

Figure 7: Q5 – Which locations, places or experiences are most important to you within the Cottesloe CHRMAP area. Write in up to 5.





3.4.4 Activities

Respondents were asked to indicate what activities they did in each zone (Management Unit). People may have participated in the same activity across both zones. Therefore, the results below indicate how many people took part in activities for each zone – rather than a % of total participation in an activity.

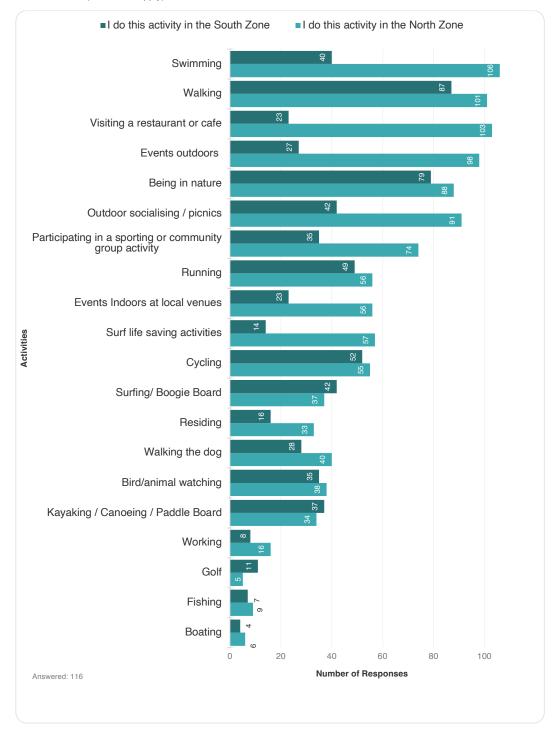
Based on the data collected and results shown in Figure 8 overleaf, the North Zone generally appears to be more active. Notable activities that respondents prefer to do in the North include swimming (n=106 people), visiting a restaurant or café (n=103), walking (n=101) outdoor events (n=98), socialising and picnics (n=91), and being in nature (n=88).

The top activities in the South Zone included Walking (n=87) being in nature (79) and cycling (n=52), walking (n=109 combined) and visiting a restaurant/café (n=106 combined).

Boating and fishing were the least popular activity for both zones.

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Figure 8: Q6 – Please indicate what activities you or your family undertake along the Cottesloe coastline and where you undertake them (tick all that apply).



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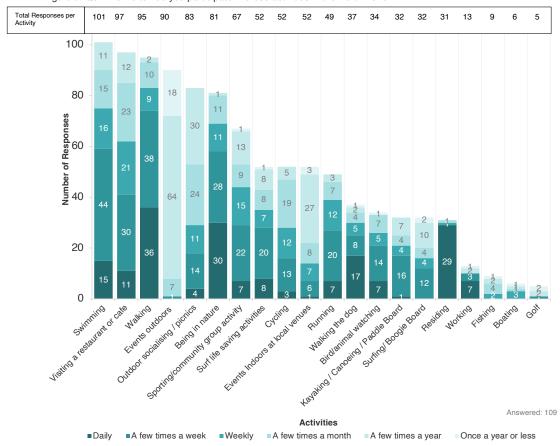
3.4.5 North & South Zone (Management Unit) Activities

For each Management Unit (zones), respondents that participated in an activity were asked how frequently they undertook that. This is shown in Figure 9 (North Zone) and Figure 10 (South Zone) below, based on the number of respondents who undertook that activity.

North Zone

- The activities that respondents undertook in the North Zone most frequently (at least once a week) were walking, swimming, being in nature and visiting a restaurant or café.
- Swimming was mostly done on a few-times-per-week basis (n=44). Although swimming is overall the
 most popular activity, walking is done most frequently on a daily basis
- Visiting a restaurant of café is mostly done on a few-times-per-week basis (n=30),
- Walking is mostly done on a few-times-per-week basis (38),
- Those activities that were undertaken the least frequently in the North Zone (a few time a year or less) were events (outdoor and indoor) and outdoor socialising/picnics.
- Although outdoor events are generally popular (n=90), they are the most infrequent activity. Outdoor
 events are mostly attended on a few-times-a-year basis (n=64).

Figure 9: Q8 - How often do you participate in these activities in the North Zone?

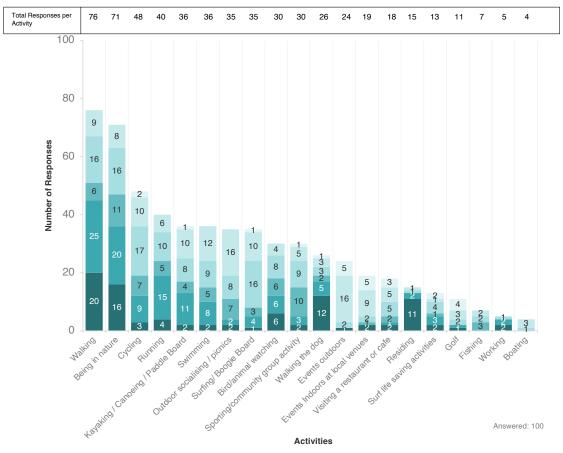


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South Zone





■ Daily ■ A few times a week ■ Weekly ■ A few times a month ■ A few times a year ■ Once a year or less

As seen in figure 10, the top forms of activity are ranked according to what respondents undertake most in the South Zone:

- However, the activities that respondents undertook in the South Zone most frequently (at least once a week) were walking, being in nature and running.
- Walking is mostly done on a few-times-per-week basis (n=25).
- Being in nature is mostly done on a few-times-per-week basis (n=20).
- Running is mostly done on a few-times-per-week basis (n=15).
- Although one of the most popular activities, cycling is mostly done on a few-times-per-month basis (n=17).
- Not only is walking the most popular activity, it is also done most frequently on a daily basis (n=20).
- Walking the dog was also one of the activities most frequently on a daily basis (n=12)

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3.4.6 Reasons for undertaking activities

People were asked to indicate why they chose to undertake an activity in an area rather than elsewhere based on the following choices;

- I can't do this activity anywhere else, it is unique to this area
- I've always done the activity here, it's what I know and like
- I live nearby so it is more convenient for me
- I like the quality of the public facilities
- · I feel a social connection with others who do this same activity
- Proximity to an attractive, natural setting

The results are shown in Figure 11 and 12 overleaf. Note that more than one reason could be provided for each activity in each zone.

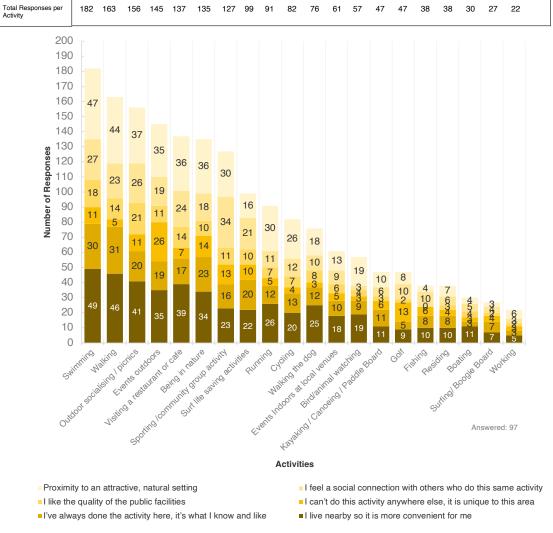
North Zone

When asked why the North Zone was so desirable for their preferred activity, respondents expressed:

- Overall, the North Zone was generally appealing because respondents live nearby and it being convenient. This was the was the biggest reason for those who walked their dog.
- The second statement that respondents resonated with most was 'Proximity to an attractive, natural setting'.
- The 'proximity to an attractive, natural setting' was especially important when people were
 undertaking swimming, walking, outdoor socialising/picnics, visiting a restaurant or being in nature.
- Being 'considered unique to the area' was the least chosen reason along with the 'quality of the public facilities'.
- Those who participated in group sporting activities were more likely to do because they 'felt a social connection with those who do the same activity'.

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Figure 11: Q8 – Why do you choose to undertake these activities in the North Zone as opposed to other nearby areas? (Choose all that apply)



South Zone

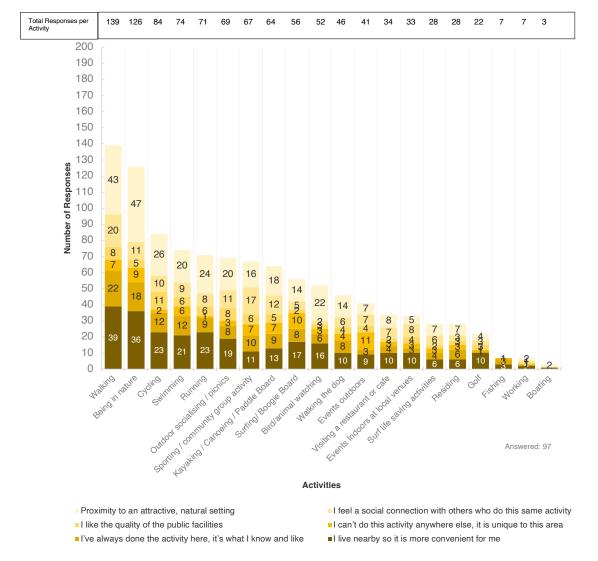
When asked to assign why they undertook activities in the South Zone, respondents expressed:

- The South Zone is generally appealing due to 'proximity to an attractive, natural setting', particularly for walking and being in nature.
- The second statement that respondents resonated with most was 'I live nearby so it is more
 convenient for me'. This was the was the biggest reason for those who undertook surfing/boogie
 boarding.
- Similar to the North Zone, being 'considered unique to the area' was the least chosen reason along with the 'quality of the public facilities'.

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 Those who participated in group sporting activities were more likely to do because they 'felt a social connection with those who do the same activity'.

Figure 12: Q10 – Why do you choose to undertake these activities in the South Zone as opposed to other nearby areas? (You may select more than one option).



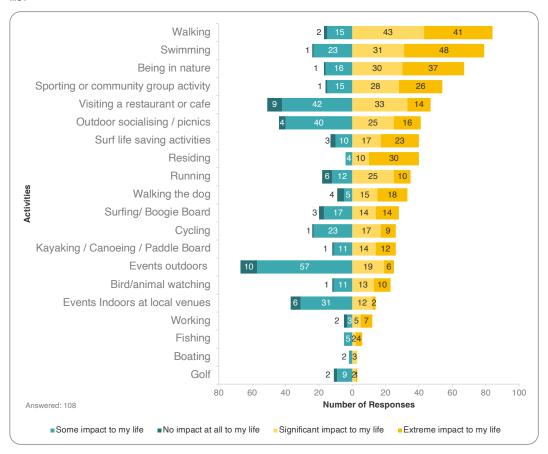
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3.4.7 Impact of Activities

Each of the respondents that indicated they participated in a particular activity, were subsequently asked 'If you were unable to do these activities along the Cottesloe foreshore, how much would this impact your life?'. Respondents then rated the impact on their lives from no impact, some impact, significant impact and extreme impact.

Figure 13: Q11 – If you were unable to do these activities along the Cottesloe coastline, how much would this impact your life?



When asked to evaluate how much of an impact the listed activities had on their lives, participants:

- Found walking to be the most valued activity (n=84 having an significant or extreme impact).
- Swimming (n= 79) and being in nature (n=67) were other activities that would have an impact on people's lives if they could no longer participate in them at Cottesloe.
- Not being able to attend outdoor events and visiting a restaurant/café were seen as having the least impact if they were unable to participate in them.

Respondents were also asked 'Why do you chose to undertake these activities along the Cottesloe coastline compared to other coastal areas in Perth?' A total of 88 respondents provided a response to this question.

element.

Of the 88 people who answered this question, the main reasons as to why the Cottesloe coastline was seen as unique was due to respondents either living in, or being proximate to, the area (66%). The specific beauty of the coastline (19%), and the underdeveloped/ natural state of the area (18%) were also popular reasons.

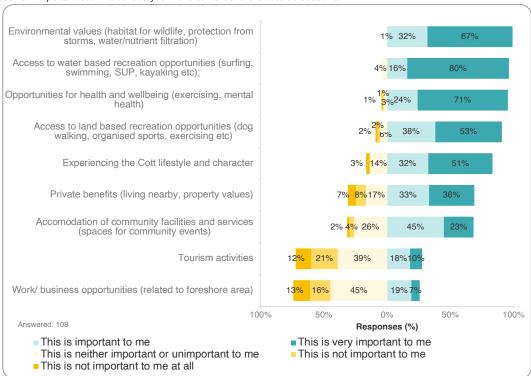
Further to this other mentions were; having specific connections to the area (ie through specific clubs or activies), feeling safe, the public amenities available and being able to connect to others.

3.4.8 Cottesloe Values

There are a range of values that can apply to the Cottesloe coastal area. Respondents were asked to rate the following values to determine which were most important to them;

- Access to water based recreation
- · Access to land based recreation
- Private benefits
- Environmental values
- · Opportunities for health and wellbeing
- · Accommodation of community facilities and services
- Work/business opportunities
- Tourism activities
- Experiencing the Cott lifestyle and character

Figure 14: Q13 – Below is a list of values that can apply to a variety of coastline and foreshore environments. Please tell us how important each value is to you in the context of the Cottesloe coastline.



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element

Environmental values and access to water-based recreation opportunities and were the most appreciated with 99% and 96% indicating that they were either very important or important. Neither of these categories were recorded as unimportant.

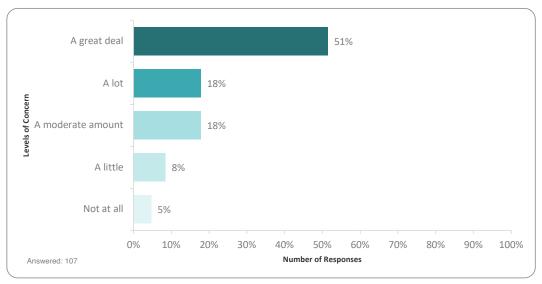
Opportunities for health and wellbeing came a close third (95% very important or important) with access to land based recreation opportunities also ranking highly (91%).

Tourism activities and work/business opportunities were least valued.

3.4.9 Impact of Hazards

Respondents were asked 'how concerned are you about coastal erosion and/or inundation in the Cottesloe coastal area?'. The majority (51%) answered 'a great deal'. 'A lot' and 'a moderate amount' were both equally the second most popular answer, with 5% responding 'not at all'.

Figure 15: Q14 How concerned are you about coastal erosion and/or inundating the Cottesloe coastal area?



Respondents were also asked 'From your experience, within the project area have you noticed any areas along the foreshore that may be affected by, or increasingly impacted by, inundation and/or erosion hazards over the past 5 years.' A total of 78 respondents provided a response to this question.

Of those who answered the question, sand erosion and the exposing of rocks along the beach was noted most with 24% mentioning it. Further to this the erosion of the dunes (17%) was an area of concern. Other locations where Coastal hazards were noticed were Cottesloe Main Beach (10%), the Northern Beaches (9%) and the Indiana Tearoom facilities/building (8%).

In addition to this 17% of respondents noted that they had not seen any notable change over time and there was a cyclical nature to the movement of sand in the area.

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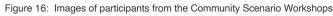
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3.5 Community Scenario Workshops

Two community scenario workshops were held on the 31st July and 3rd August 2023 at the Grove Library Community Centre and War Memorial Hall at the Cottesloe Civic Centre. The workshops were 2 hours long, with element, the Town of Cottesloe and Water Technology in attendance.

During the workshops, participants were placed in small groups and worked together to provide feedback.

A total of 44 attended. The 31st July session was attended by 19 community members, with 26 on the 3rd August session.





The objectives of the workshops were to:

- Share knowledge: CHRMAP, coastal hazards adaptation approaches
- Provide key information from previous stages.
- Gather feedback from the community.
- Identify and prioritise coastal assets and determine why these are important.
- Identify the consequence of erosion or inundation on key assets.
- $\bullet \quad \text{Identify potential adaptation and risk treatment options that could address the risks.}\\$

element.

The workshops consisted of three key tasks.

Coastal Assets Identification: Community members were asked to identify the coastal assets that were important to them and the reason why on post-it notes and placing them on a map provided during the workshop (shown in Figure 17).

Coastal Assets Prioritisation: Participants were then asked to indicate what were their top 4 assets were by marking with dot stickers. Environmental, social, and economic assets were encouraged to be thought about

Adaptation Strategy: Each group used the map (based on the below) as a basis for completing the task which showed the hazard lines for erosion until 2123 along the Cottesloe coastline. Due to the limited effect of inundation in this area, these hazard lines were not shown. The maps helped to illustrate which assets would be affected by coastal erosion and where over time.

Figure 17: Coastal Hazard Map for Erosion

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element.

The adaption strategies for coastal hazards were explained to participants (shown below). However, it was noted that for Cottesloe the only options were retreat or protect, as inundation was a limited risk for the area. Examples of coastal engineering management options that could be used to "protect" the area were also presented.

Groups were then asked to discuss and decide what their preferred adaptation strategy was along the Cottesloe coastline, as well as their adaptation management option ideas. Participants were able to provide responses for specific assets, part of the coastline or the entire area.

avoid
identify future 'no-build areas' and use planning tools to prevent new development in areas at risk now or in the future

retreat
withdraw, relocate or abandon assets that are at risk; ecosystems are allowed to retreat landward as sea levels rise

3.5.1 Coastal Asset Identification and Prioritisation

Cottesloe Main Beach was viewed as important for a number of reasons including beach-based activities, recreation and as a drawcard to the area. The coastal path that runs along the entire coastline was also seen as having a very high value amongst the community

The Study Zones (Management Units) discussed below are outlined earlier in Section 1.2 of the report.

Management Unit 1, the North Zone of the study area was noted as having the most assets of importance. The highest priority assets for the North Zone (and overall) from the combined workshop results were: Cottesloe Main Beach (n=27), Hospitality and retail venues (n=12) and the North Cottesloe Surf Life Saving Centre (n=10).

Management Unit 1 (North Zone) is the stretch of coast north from the main beach groyne, Management Unit 2 (South Zone) is the stretch to the south of the groyne and 'general' refers to assets found to be across the subject area. Full results can be found in the tables below.

The most important assets in the South Zone were South Cottesloe dog beach (n=7), Dutch Inn (n=7), Muderup Rocks (n=6). Muderup Rocks were also noted as an important asset by Aboriginal people.

A number of more 'general' assets that spanned the coastline were also mentioned, including the coastal path (n=23) and residences (n=7).

Full results can be found in the tables overleaf.

element.

Management Unit 1 (North Zone)

Asset	Why is it important	No. of sticky notes	No of dots (priority)
Cottesloe Main Beach	swimming, walking, picnicking, commercial draw, lifestyle, aesthetic, snorkelling, shark net, interaction	14	27
OBH, Restaurants, Coffee Shops	important local hub, social connection, walking distance, meet friends	9	12
North Cottesloe SLSC	recreation, health, wellbeing, community, voluntary organisation	5	10
North Cottesloe Beach	swimming, walking, dining	5	6
Dune systems	health and wellbeing, native vegetation, greenbelt for fauna movement, protection for our structures	6	5
Norfolk Pines	local heritage	4	4
Vera View Dog Beach	convenience for walking dog, community use, leisure	3	4
Car parking	convenience for patrons of beach	4	3
Beaches		2	3
Dog beach		2	2
Barchetta & Long View	morning coffee & breakfast, community contact, views	2	2
Cottesloe Main Beach grass area near/including teahouse	communal, recreational, peaceful, green public space, shade in summer	1	2
Views & visual amenity	nature, aesthetics, no sea walls	1	2
Peter's Pool	convenience, snorkelling	1	2
Surf clubs	community, safety, volunteering, recreation, exercise,	2	1
Indiana Teahouse	iconic	2	1
Grant Street Park	community gatherings	1	1
shark net	swimming	1	1
Cottesloe Tennis Club		1	1
Main Beach Groyne	functional value, protects beach for families	1	1
Council Office Grounds	must be preserved for future generations, beautiful area for private and public use	1	1
Marine Parade	coastal aspect, access to beach	5	
Formal playground	social, recreation, health	3	
Marine & Bird Life		1	
Sculptures by the Sea		1	
Il Lido building	local character	1	
Green spaces		1	

element.

Management Unit 2 (South Zone)

Asset	Why is it important	No. of sticky notes	No of dots (priority)
South Cottesloe Dog Beach	walks, exercise, pets mental health, community, dogs, all season use, beauty, exercise, companionship, swimming	5	7
Dutch Inn	playground, lawns, nature habitat	5	7
Aboriginal Heritage Mudurup Rocks	social, sense of place, culture, wren habitat, Whadjuk Noongar site, coastal environment for ecology studies	5	6
Coastal dunes	aesthetics, views, natural environment, habitat, coastal stability	2	4
Surfing	community, recreation, The Cove and Iso's	9	3
South Cottesloe (between groynes)	bird and marine life, no dogs, topography, swimming, snorkelling, peaceful, inclusive for sports, surf comps	3	3
Isolated reef		1	3
Native habitat	planting that harbours wildlife	3	1
Golf Club	views, dogs, companionship, open spaces, heart of Cott, public use, unique	2	1
Osprey nesting		1	1
Sydney Street	swimming	1	1
Seagrasses	unspoilt	2	
Diving sites		1	

General

Asset	Why is it important	No. of sticky notes	No of dots (priority)
Coastal path along entire length	recreation, nature, exercise, playgrounds, lifestyle, access to coast, running, atmosphere & commerce, physical & mental health	19	23
Residences	livelihoods, force people to move away	9	7
Reefs	social connection to nature	6	4
Beaches	walking, health, wellbeing, surf clubs	5	2
Cycle paths		2	1
Beach air	being close to nature	1	1
Coastal planting, flora & fauna	biosphere, diversity	4	1
Road	destruction of road could impact community access	1	1

element.

3.5.2 Adaptation Strategies and Management Options

The final workshop task involved developing adaptation strategies and preferred options for prioritised assets and/or specified areas as described by the community. The adaptation strategies were explained and examples of potential management options were presented, to assist with this task, although it was made clear participants could also suggest their own.

The first step was for participants at the table to identify the priority assets or specified areas, and then discuss which adaptation strategies (retreat or protect) they wanted to implement to mitigate risk. Following this, groups identified an adaptation management option they preferred be implemented. They could either choose one of the options presented or develop their own.

In terms of adaptation strategies, it was explained to participants that there were only two options, retreat or protect as the impact of inundation was less – so the other strategies were not applicable.

The North Zone contained the most assets and generated the most attention for participants. Maintaining a sandy beach at Cottesloe Main Beach and North Cottesloe was one of the main priorities to allow it's continued use and to be retained as a tourist attraction. Previous stakeholder interviews with the surf clubs particularly highlighted the need to retain a sandy beach as it was their main reason for being. The surf club buildings were also sought to be protected whilst they could or raised.

Therefore, most participants opted to protect the beach, with a range of management options such as groynes, and offshore reefs. Beach nourishment was also seen as an option for the coastline. However, there was an acknowledgement that this may only be possible for a period of time – and therefore retreat was also seen as a viable strategy. There was also a mention that the Golf Course could be transitioned to be used as the "new" Main Beach area over time.

In the South Zone of Cottesloe's coastline, retreat was the focus, noting that planning restrictions for development should be required.

Whilst the coastal path was seen as an asset that community wanted to protect, it could also be maintained over time by being rerouted.

Overall, protect was the most popular adaptation strategy for assets, however a significant number of participants opted for and understood that over time managed retreat was preferable and necessary. Beach nourishment (while possible), groynes and off-shore reefs were seen as being the most appropriate management options. The control of development was also mentioned.

Engagement with Aboriginal cultural representatives was also conducted regarding appropriate adaptation strategies and management options. Their thoughts were that natural materials were preferable for any options to protect the coastline, with bio-based options and revegetation using endemic species to help limit erosion. If structures were to be created, they preferred that this be done using rocks and natural materials, rather than anything concrete based.

The full list of adaptation strategies and management options are shown in the Tables overleaf.

element.

Management Unit 1 (North Zone)

Location (if specified)	Preferred adaptation	Management options
Cottesloe Main Beach	strategy Retreat	Continue to provide white beach and build a tourist attraction. Look at options to use Seaview Golf Course as a new Cottesloe beach and tourist attraction.
	Protect	Strategies that protect the beach or maximise beach sections - groyne, offshore reef.
	Protect	Groyne extension. Artificial reef options. Breakwater.
	Protect (given area's significance). Planned & managed retreat.	Review Development (Residential or Commercial) plans given shoreline forecast. Review Infrastructure spending. Consensus is to prioritise money and controls in other areas. Look at relocating development areas surrounding John Black car park to that area.
North Cottesloe Beach	Option 1: Protect if feasible. Fallback Option2: Retreat.	Not with offshore groynes, preferably with some offshore structure that doesn't affect visual amenity. Continue to provide public sandy beach.
	Planned and managed retreat.	Review development plans in at risk area (high rise). Maintain dune system management and spending. Household buy-back. All these points are considering the 100yr forecast. Invest in new technology re coastal protection.
	Protect	Reclaim land - foreshore area. Add sand pumping.
	Protect North Cott beach and surf club.	Renourishment and offshore breakwater, short term <30yr (proximity trigger). Concealed revetment to protect critical infrastructure, medium term >30-50yrs (proximity trigger). >50yrs
NCSLSC/Surf Clubs	Protect. Until beaches are impacted.	Then retreat - planned.
	Protection and Managed Retreat.	Offshore break walls to maintain a sandy beach. Retreat to park cnr Grant Street/Marine Parade. Pylons, raise NCSLSC onto jetty/platform.
	Need to exit	Retreat or protect
Restaurant/hotels	Protect	Until impacted.
Norfolk Pines	Protect	Replant new trees. Seawall to protect pines.

element.

Management Unit 2 (South Zone)

Location (if specified)	Preferred adaptation strategy	Management options
Dutch Inn Beach	Retreat	Use planning restrictions to prevent more significant assets in hazard areas. Fringing reed. Protect significant marine park bird life habitat.
	Retreat	Hold on development west of Marine Parade. No more development outside Port Beach.
South Cottesloe to Beach St Groyne	Retreat	Appears to have more natural protection. Protect marine park with no intervention.

General

Location (if specified)	Preferred Managemer	t options
	adaptation strategy	
Coastal walking path	Maintain the beach, the sand dunes, managing vegetation on dunes	Avoid physical structure e.g. groynes, offshore walls. Avoid defensive structures e.g. sea walls. Better to use beach maintenance - maintain dunes, nourish beach as required.
	Protect	Reroute
	Protect	Offshore breakwater.
	Protect	Offshore groynes/structures.
Desidence //constant	Managed retreat	The same and automate
Residence/housing	Explore. Protect with maintaining beach and beach access.	Then managed retreat.
Preserving coastline, dunes, reefs & beaches, Mudurup Aboriginal Site	More information to select best to retain.	Please note the table felt that expertise was required to look more strategically and productively at adoption (more detail). We would have liked to have seen modelling options and known what modelling has been done. Priority has been sandy beaches, dunes, coastal vegetation, marine park, bird habitat.
Sandy Beach	Nourishment and planned retreat	Nourishment
	Protect	Breakwater, groyne, ongoing nourishment.
Natural vegetation (including dunes)	Protect	Offshore groynes/structures.
Non-beach areas	Protect	Sandbags and rock placement.

element.

4. Success Criteria

As a result of the engagement findings, a set of criteria that can be used to guide the success of the CHRMAP report. The 'success' of the CHRMAP will be determined by the assets identified through the CHRMAP process continuing to provide their present function, services and values (or an accepted version of it as determined by community and stakeholders).

Therefore, the success criteria will be determined by the values collected in this part of the engagement process. The preliminary success criteria are outlined below and will be updated as the engagement progresses.

- Preserve and protect the Town's sandy beaches and natural assets such as vegetation and dunes.
- Consider treatments for coastal areas that have current inundation and erosion issues. Preserve the current uses of the beach areas.
- Ensure the natural environment is protected and sustained in its current condition or an improved condition.
 - Maintaining the natural state and underdeveloped nature of the area is important.
 - Preserve and consider the cultural significance of Mudurup Rocks.
- Preserve the function and opportunity for all types of water-based and land-based activities, particularly those that help to improve the health and well-being of people.
- Preserve or accommodate the existing surf lifesaving clubs and the beach areas surrounding these, as these facilities were seen as a hub of water and land -based activities that also helped to improve social connection and mental wellbeing.
- Maintain and support the current and future economic viability of Cottesloe retail and hospitality venues.
- Ensure that areas for community events and access to remain for the coastline. Provide and maintain spaces and infrastructure for community events, arts and entertainment.
- Continue to provide public amenities at the coast, such as parks, restrooms, parking and walking
 paths. There is scope to relocate these assets as long as the appropriate use can be maintained.
- Minimise impacts on existing private property, until this is no longer viable.
- Consider the viability of future land use and development in areas at risk of coastal erosion or inundation
- Develop solutions to coastal processes that are sustainable (financially, socially and built form) and locally responsive.
- Revisit regularly with community and key stakeholders their values in relation to development adjacent the foreshore.

element.

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5. Next Steps

This concludes the end to the Stage 5 and the engagement activities for the Cottesloe CHRMAP. The next steps are:

- Water Technology will incorporate the findings from the recent engagement into the draft CHRMAP.
- Once the draft CHRMAP is complete there will be a public comment period coordinated by the Town of Cottesloe. Community members that participated in the CHRMAP process, along with key stakeholders will be informed of this through the Town of Cottesloe's communication channels.

element.

6. Appendix A. Demographics

Figure 16: Q18 - How young are you?

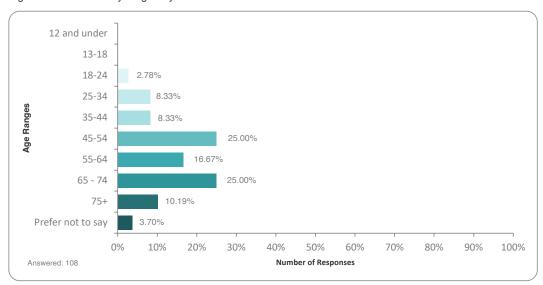
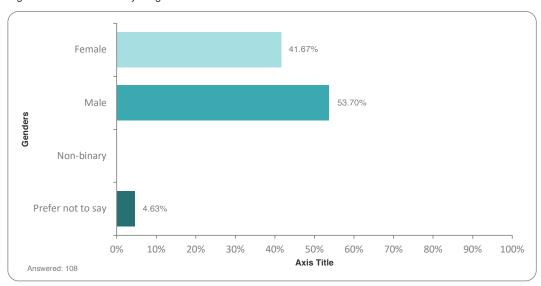
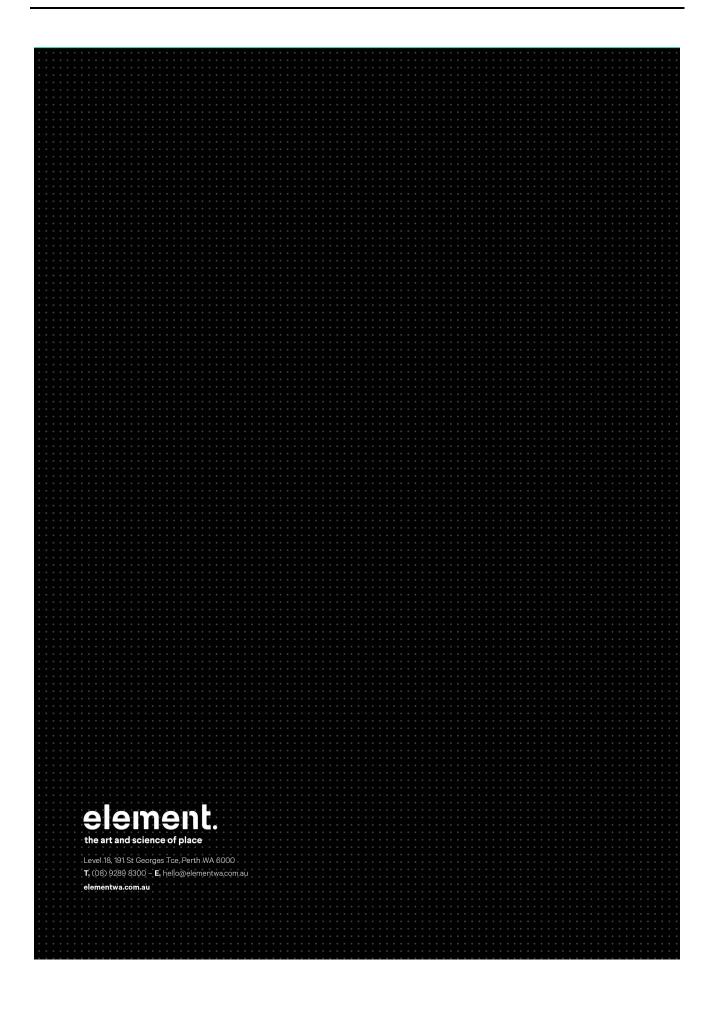


Figure 17: Q19 - What is your gender?









APPENDIX B MULTI-CRITERIA ANALYSIS







Table B-1 Multi-Criteria Analysis – MU 1 – North of Cottesloe Groyne, including Groyne

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)				NA				This option applies to undeveloped land. In this MU most beach and foredune area is identified as developed foreshore. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	1	1	-1	2	6	Suitable for low to medium value public assets such as car park and ablutions block. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	2	1	0	0	2	2	7	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	2	-2	2	5	For private property. Effective but costly option. Ensures foreshore reserve retained. May be unpopular with landholders, depending on implementation strategy.
Design assets to withstand impacts (AC1)				NA				For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed.
Beach nourishment or replenishment (PR1)	1	2	2	2	-2	2	7	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	1	0	1	0	-1	0	1	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Would require sand nourishment as part of works, which can help to sustain a sandy beach.
Seawalls (PR3)	2	-1	-2	-1	-1	-1	-4	Expensive option. Likely to lead to reduction or loss of usable sandy beach.
Artificial reef (PR4)	-1	0	1	0	-2	-2	-4	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	1	0	1	0	-2	-2	-2	Costly to build and maintain but can be designed to work effectively and provide usable sandy beach. Social concerns about ocean views likely.
Levy / Weir / Storm Surge Barrier (PR6)				NA				Some form of inundation protection on the banks. This would be costly but potentially effective. Impacts would need to be investigated thoroughly.
Monitoring (NR1)	2	2	1	0	1	2	8	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)	2	0	0	0	2	2	6	An audit should be undertaken of all existing coastal protection structures.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)				NA				For inundation hazard. Does not directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for single-road access to town.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

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Table B-2 Multi-Criteria Analysis – MU 2 – South of Cottesloe Groyne

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as Developed foreshore. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	1	1	-1	2	6	Suitable for low to medium value public assets such as car park and ablutions block. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	2	1	0	0	2	2	7	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	2	-2	2	5	For private property. Effective but costly option. Ensures foreshore reserve retained. May be unpopular with landholders, depending on implementation strategy.
Design assets to withstand impacts (AC1)				NA				For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed.
Beach nourishment or replenishment (PR1)	1	2	2	2	-2	2	7	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	1	0	1	0	-1	0	1	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Would require sand nourishment as part of works, which can help sustain a sandy beach.
Seawalls (PR3)	2	-1	-2	-1	-1	-1	-4	Expensive option. Likely to lead to reduction or loss of usable sandy beach.
Artificial reef (PR4)	-1	0	1	0	-2	-2	-4	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	1	0	1	0	-2	-2	-2	Costly to build and maintain but can be designed to work effectively and provide usable sandy beach. Social concerns about ocean views likely.
Levy / Weir / Storm Surge Barrier (PR6)				NA				Some form of inundation protection on the banks. This would be costly but potentially effective. Impacts would need to be investigated thoroughly.
Monitoring (NR1)	2	2	1	0	1	2	8	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)	2	0	0	0	2	2	6	An audit should be undertaken of all existing coastal protection structures.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)				NA				For inundation hazard. Does not directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for single-road access to town.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

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APPENDIX C PLANNING MEASURES AND IMPLEMENTATION





Town of Cottesloe CHRMAP Planning Measures and Implementation

November 2023

Docum	ent ID: 22-0)30		
Issue	Date	Status	Prepared by	Approved by
			Name	Name
1	17/08/23	Draft 1	Dylan Wray	Matt Raymond
2	13/11/23	Draft 2	Dylan Wray	Matt Raymond

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Planning Measures

Statutory Planning Mechanisms

The previous review of the existing planning controls concluded that a local planning scheme amendment to introduce a Special Control Area (SCA) is considered the most appropriate statutory planning mechanism to holistically address coastal hazards within the Town of Cottesloe (the Town). The following section provides a summary of recommendations for the Town to update its current planning framework to effectively manage the coastal hazard risks identified in the CHRMAP.

The recommended planning mechanisms only apply to land zoned under the Town's Local Planning Scheme No. 3 (LPS 3) identified as being subject to erosion over the 100-year planning timeframe. Inundation has not been considered in the planning response given the areas prone to coastal flooding are limited to the foreshore reserve which is not zoned under the Town's LPS 3. Should this change, future iterations of this CHRMAP will need to consider an appropriate planning response for both erosion and inundation.

The recommendations have been prepared in accordance with the CHRMAP Guidelines and the draft Planned or Managed Retreat Guidelines which provide guidance on planning risk treatment options across the risk management and adaptation hierarchy.

Avoid

The best form of risk management is to eliminate hazards, activities and exposures that can adversely affect an asset. Accordingly, the primary planning response shall be to avoid further intensification of development through rezoning or subdivision of properties at risk of erosion.

It is acknowledged that it may not be practically possible to completely avoid development on private land that has already been appropriately zoned under the Town's LPS 3. In these instances, alternative adaptation options will need to be considered.

Managed Retreat

The draft Planned or Managed Retreat Guidelines provide direction on how to effectively implement a policy of managed retreat for locations that have been identified as being vulnerable to coastal processes through the CHRMAP. The managed retreat process involves the introduction of mechanisms to reduce or prevent the ongoing use of private land at risk of erosion.

The first step involves changing the local planning framework to enable the mechanisms for managed retreat to be applied. The second step, once it has been determined that private use of the land should cease, contemplates the transfer of affected land from private to public ownership.

The CHRMAP Guidelines and draft Planned or Managed Retreat Guidelines provides a framework for triggering the voluntary or compulsory acquisition of private land affected by coastal erosion where the public foreshore can no longer provide a natural barrier or where physical protection measures are no longer provided. The options to acquire private land zoned under LPS include:

- Taking of land by agreement under the Land Administration Act 1997; or
- Compulsory taking with the assistance of the Minister for Lands for a 'public work' under the Land Administration Act 1997.

element.

The acquisition processes recommended in the CHRMAP Guidelines supports compensation paid to property owners. However, there is no obligation to adopt a policy that effectively forces the Town to compensate property owners. In addition, there is no legal responsibility for the Town to provide protection of a private property from natural hazards, nor compensate property owners where the land is lost to erosion. Accordingly, the Town will need to determine the most appropriate mechanism available for the taking of land and identify potential funding streams, actions, responsibilities and implementation for the acquisition of vulnerable properties.

Once at-risk properties have been acquired, all structures and assets shall be removed, and the land reserved for 'Parks and Recreation' under Metropolitan Region Scheme (MRS). This will enable expansion of the foreshore reserve, maintaining a natural barrier to coastal processes.

Accommodate

The accommodate risk treatment option aims to utilise design and management strategies to reduce the risk to an acceptable level, allowing for the continued use of land until it has been determined that private use of the land should cease. The accommodate risk treatment option will be enacted through provisions within LPS 3 under an SCA and the adoption of a CHRMAP Local Planning Policy which provides specific design requirements for development in vulnerable areas.

Protect

The protect risk treatment option refers to physical protection measures such as seawalls, groynes, offshore breakwaters, artificial headlands, beach nourishment and the likes. It is assumed that the existing structures along the Cottesloe foreshore will continue to provide ongoing protection of public and private assets.

It would be impractical for the planning framework to require landowners to undertake protection measures as part of the decision-making process. However, should landowners propose protection works on private land as a means of accommodating assets, the Town will need to ensure the protection structures proposed as part of any future development do not cause undue impact on nearby properties and the general locality.

Recommended Planning Controls

Local Planning Strategy

The Town is currently reviewing its Local Planning Strategy (the Strategy) which aims to guide the long-term land use planning direction for the Town. This CHRMAP will inform the Strategy and future revisions to guide sustainable land use planning and development along the Cottesloe coastline.

The Strategy shall reference the application of SPP 2.6 and consider the identified coastal hazards together with other relevant planning matters, including environmental, economic and social considerations, to holistically inform and shape future amendments to the Town's LPS 3. Areas at risk of erosion should not be identified in the Strategy for further intensification of development through rezoning or subdivision.

Structure Planning

Structure planning is considered the most effective mechanism where some degree of comprehensive redevelopment of land remains an option. The only area which is subject to erosion and contemplates the preparation of a structure plan is the Wearne Aged Care site at Lot 555 (No. 40) Marine Parade, Cottesloe. The Wearne Aged Care site is zoned 'Development' under LPS 3 which contemplates the preparation of a structure plan to guide future development and use of the site. However, it is acknowledged that a structure plan is unlikely to be prepared for the Wearne Aged Care site given Clause 4.1 of Local Planning Policy No. 2 overrides the requirement for a Structure Plan.

Should a structure plan be prepared for Wearne Aged Care site or any other sites within the coastal erosion zone, a provision must be included for SPP 2.6 requirements to be met through subsequent approval process, including subdivision and development applications.

element.

Local Planning Scheme Amendment

In accordance with the CHRMAP Guidelines, the Town shall initiate an amendment to LPS 3 to include the following:

- Insert Special Control Area 3 Land Subject to Coastal Erosion (SCA 3) under Part 6;
- Update Clause 10.2.2 (f) to include coastal erosion under Part 10; and
- Update the Scheme Maps to include SCA 3 which shall reflect zoned properties located shoreward of the 2123 erosion line.

The Town shall include the recommendations of this CHRMAP as part of next scheduled scheme review. The Town can defer implementation of certain recommendations given there is no immediate risk of erosion to properties zoned under LPS 3. At a minimum, the Town will need to update the local planning framework once it has been identified that zoned properties are seaward of the 50-year erosion hazard line. This will be identified through updated hazard modelling through future iterations of this CHRMAP.

Special Control Area

The introduction of an SCA over zoned land affected by erosion over the 100-year planning period will provide the most effective response to the identified coastal hazards. The SCA will stipulate provisions to respond to the hazards identified in this CHRMAP, including the trigger for normally exempt development to require development approval.

It is noted that some forms of development cannot be controlled by the SCA, such as works carried out by the State Government under the Public Works Act 1902 or development within the Parks and Recreation Reserve. The Town should liaise with the State regarding such development to ensure it is not incompatible with the outcomes of this CHRMAP.

Special Control Area 3 - Land Subject to Coastal Erosion

- 1. The objectives of this special control area are to
 - a) To provide guidance for land use and development within areas subject to erosion.
 - b) To identify land within Town of Cottesloe at risk of erosion by 2123.
 - c) To ensure land along the foreshore is continuously available for foreshore management, public access, recreation and conservation purposes.
 - d) To ensure public health and safety and reduce risk associated with erosion.
 - e) To avoid inappropriate land use and development of land at risk of erosion.
 - f) To ensure land use and development does not accelerate coastal processes or have a detrimental impact on the functions of public reserves.
 - g) To protect new development from the impacts of erosion.
 - To ensure coastal process considerations are taken into account in preparing strategic planning proposals and in assessing subdivision and development applications.
- 2. The following provisions are applicable to Special Control Area 3 (SCA 3):
 - Notwithstanding any other provision of the Scheme, all proposed development within SCA 3 requires the approval of the local government.
 - b) In considering any application for development approval, or its advice in relation to proposed structure plans or subdivision applications for subdivision for land within SCA 3, the local government is to have particular regard to:
 - i. The Town of Cottesloe Coastal Hazard and Risk Management Adaptation Plan
 - ii. State Planning Policy 2.6 State Coastal Planning Policy.
 - iii. The Coastal Local Planning Policy.

3

element.

c) An application for development approval for development proposed within SCA 3 may be referred to any statutory, public or planning authority for advice and recommendations before being considered by the local government.

- d) Where the local government decides to approve an application for development approval it may impose a condition to require the registration of a notification under section 70A of the Transfer of Land Act 1893 on the Certificate of Title of the subject land at the cost of the landowner advising that the lot is located in an area likely to be subject to coastal erosion over the next 100 years.
- e) Where subdivision applications are received within SCA 3, the local government may recommend that the Commission requires a notification under section 165 of the Act to be placed on the Certificate(s) of Title of the subject land, at the cost of the landowner advising that the lot(s) is located in an area likely to be subject to coastal erosion over the next 100 years.

Coastal Local Planning Policy

Following the introduction of SCA 3 into the LPS 3, the Town shall prepare and adopt a Coastal Local Planning Policy in accordance with Schedule 2 of the Planning and Development (Local Planning Schemes) Regulations 2015. It is recommended that the Coastal Local Planning Policy includes the following provisions which may be subject to further refinement by the Town following the completion of this CHRMAP.

1. Policy Application

This policy applies to all land within Special Control Area 3 (SCA 3), which is that land identified as being subject to coastal erosion. The policy applies to all strategic planning, subdivision and development proposals for land within SCA 3.

2. Policy Objectives

- 1. To identify land within the Town of Cottesloe at risk of erosion by 2123.
- 2. To ensure land along the foreshore is continuously available for foreshore management, public access, recreation and conservation purposes.
- 3. To ensure public health and safety and reduce risk associated with erosion.
- 4. To avoid inappropriate land use and development of land at risk of erosion.
- 5. To protect new development from the impacts of erosion.
- 6. To ensure coastal process considerations are taken into account in preparing strategic planning proposals and in assessing subdivision and development applications.

3. Definitions

<u>Average Recurrence Interval (ARI)</u> means how likely an event is to occur. For example, a 100-year ARI event is an event that occurs or is exceeded on average once every 100 years.

CHRMAP means the Town of Cottesloe Coastal Hazard Risk Management and Adaptation Plan.

<u>Coastal</u> means the area of water and land that may be influenced by coastal processes, including the tidal reaches of inland waters.

<u>Coastal hazard</u> means the consequence of coastal processes that affect the environment and safety of people.

<u>Coastal processes</u> mean any action of natural forces on the coastal environment.

Erosion Hazard Line means mapped erosion lines identified within the CHRMAP.

<u>Habitable Room</u> has the same meaning given in State Planning Policy 7.3 Residential Design Codes.

<u>Horizontal Shoreline Datum (HSD)</u> means the active limit of the shoreline under storm activity, as defined in State Planning Policy 2.6 – State Coastal Planning Policy.

Net Lettable Area has the same meaning given in the Planning and Development (Local Planning Schemes) Regulations 2015.

element.

<u>Permanent Development</u> means development that is not time or event limited as determined by the Town.

 $\underline{\mathsf{SCA}}$ 3 means Special Control Area 3 – Land Subject to Coastal Erosion as defined on the Scheme Maps.

<u>Scheme</u> means the Town of Cottesloe Local Planning Scheme No. 3 or any subsequent local planning scheme endorsed by the Minister for Planning.

SPP 2.6 means State Planning Policy 2.6 Coastal Planning Policy.

Strategic Planning Proposals means a Local Planning Strategy, Local Planning Scheme, amendment to a Local Planning Scheme, Local Structure Plan or Local Development Plan.

Trigger event means one or more of the following events:

- the HSD adjacent to a development is within 40m of the most seaward extent of a development; or
- 2. public road access to a property is no longer available or able to provide legal access to the property; or
- 3. water, sewerage or electricity to the property is no longer available.

4. Requirement for Development Approval

Notwithstanding any other provision in the Scheme, development approval is required prior to commencing or carrying out any works or use of land within SCA 3, unless specified as exempt development in this Policy.

Where development approval is required, applications will need to clearly demonstrate that the proposed development meets the objectives and requirements of this Policy and any other relevant requirements of the Town's planning framework.

5. Exempted Development

Notwithstanding the land being located within SCA 3, unless otherwise required by the Scheme, the provisions of this Policy do not apply to:

- Alterations and additions to a habitable room of an existing residential building or net lettable area of commercial, retail or community building which does not exceed 50m2 cumulatively from the date of adoption of this Policy; or
- 2. A change of use that does not intensify development or use of the land.

6. General Requirements

Coastal hazards must be considered in preparing strategic proposals and when making statutory planning decisions in order to avoid increasing the impacts of coastal processes on inappropriately located development.

Notwithstanding the requirements of this Policy, the Town may exercise discretion in its consideration of proposals where a site-specific coastal hazard assessment is prepared in accordance with SPP 2.6 to demonstrate the suitability of the proposal.

7. Strategic Planning Proposals

Strategic planning proposals for land on the seaward side of the 2123 Erosion Hazard Line should not provide for more intensive development or use of this land.

Strategic planning proposals for land on the seaward side of the 2123 Erosion Hazard Line must demonstrate how it is proposed to plan for and appropriately manage coastal hazards, including risk to public utility infrastructure servicing the land and roads which provide public access to the land.

Strategic planning proposals for land adjacent to the Swan River foreshore must include provision for a coastal foreshore reserve which is to be ceded free of cost to the Crown without payment of compensation. The coastal foreshore reserve width is to include a suitable allowance for coastal processes, in addition to sufficient land which is not vulnerable to coastal processes in order to provide for continued coastal foreshore management, public access, recreation, conservation and landscape amenity.

element.

8. Subdivision Applications

- 1. There is a general presumption against further subdivision of properties on the seaward side of the 2123 Erosion Hazard Line, except where the application is for:
 - a) a purpose which will not create the potential for additional private development within the erosion hazard area; or
 - b) boundary realignment, rationalisation of landholdings or lots created for a foreshore reserve which will not create the potential for additional private development within the erosion hazard area.

and the subdivision is otherwise consistent with the Scheme and the Commission's general subdivision policies.

A notification pursuant to Section 165A of the Planning and Development Act 2005 is to be
placed on the Certificate(s) of Title of the subject land, at the cost of the landowner, advising
that the lot(s) are located in an area likely to be subject to coastal erosion within the period to
2123.

9. Development Applications

- Development located seaward of the 2123 erosion hazard line will only be permitted provided:
 - a) the applicant demonstrates that the design life of the development is suitable for its location with regard to the erosion hazard lines contained within the CHRMAP and the development can be relocated or removed;
 - a condition is imposed limiting the term of the development approval and requiring the approved development to be removed and the land restored to its predevelopment condition to the satisfaction of the Town, upon a trigger event occurring; and
 - c) a condition is imposed requiring a notification to be placed on the certificate of title of the subject land pursuant to section 70A of the Transfer of Land Act 1893 to alert prospective purchasers of the limited term of the approval and the requirement to restore the land to its pre-development condition to the satisfaction of the Town, upon a trigger event occurring.
- 2. Wherever reasonably practicable to do so any new development is to be located on the least vulnerable portion of the land.
- 3. All development approvals will include a condition requiring a notification to be placed on the certificate of title of the subject land pursuant to section 70A of the Transfer of Land Act 1893 to alert prospective purchasers that the land is located within an area likely to be subject to coastal erosion within the period to 2123, except where the coastal hazard will be adequately addressed through the development works or is otherwise suitably addressed.

element.

Management Requirements

Model Conditions List

The Town shall include the following conditions and advice notes to the model conditions list which can then be applied to development applications within SCA 3, at the discretion of the Town.

Conditions:

- 1. The development approval shall cease to have effect and the development removed when:
 - a) The most landward part of the Horizontal Shoreline Datum is within the S1 distance of the most seaward part of the habitable buildings; or
 - A public road is no longer available or able to provide legal access to the property;
 or
 - Water, sewerage or electricity to the lot is no longer available due to coastal hazards.
- A notification, pursuant to Section 70A of the Transfer of Land Act 1893 is to be placed on the Certificate of Title of the proposed development lot advising of the existence of a coastal hazard. The notification is to state as follows:

'Vulnerable coastal area - This lot is located in an area likely to be subject to erosion over the next 100 years and is subject to conditions of development approval which requires removal of development to pre-development conditions if the time limit specified on the development approval is reached or any one of the following events occurs:

- a) the most landward part of the Horizontal Shoreline Datum being within (insert number) meters of the most shoreward part of the habitable building;
- a public road no longer being available or able to provide legal access to the property;
- c) when water, sewerage or electricity to the lot is no longer available as they have been removed/decommissioned by the relevant authority due to coastal hazards.'

Advice Notes:

- The applicant is advised that the Horizontal Shoreline Datum means the active limit of the shoreline under storm activity, as defined in State Planning Policy 2.6 – State Coastal Planning Policy.
- 2. The applicant is advised that the distance between the Horizontal Shoreline Datum and the most seaward part of the habitable building is the S1 value, as defined in the CHRMAP.
- The landowner accepts the potential risk of costal hazards as identified in the Town of Cottesloe CHRMAP. It is recommended that the landowner undertakes ongoing monitoring and review of the coastal hazards with any reporting provided to the satisfaction of the Local Government.

Foreshore Management Plans

Foreshore management plans can provide a strategy to deliver the recommendations of this CHRMAP for foreshore reserves throughout the Town. Foreshore management plans can be a key tool for communication and engagement with the community as they include detailed planning for community places and facilities.

The Town should prepare a Cottesloe foreshore management plan, in conjunction with relevant stakeholders, to provide guidance for the ongoing management of foreshore reserves, monitoring of assets and the triggers for the managed retreat of public assets and infrastructure at risk of coastal erosion.

element.

Publicly Available Information

It is recommended that the erosion hazard data is included on the Town's publicly available mapping system. This will ensure staff and the community have access to information on any affected land and can be made aware of the presence of the coastal hazards.

Information on relevant coastal hazards and the implications for property, now and into the future, should also be made available to potential buyers upon making a land purchase enquiry.

8

element.

Implementation

Implementation Triggers

The following planning and management controls presented in Chapter 5: Risk Treatment should be implemented by the Town as soon as practicable given the erosion impacts identified in the CHRMAP.

Planning Controls	Description	Implementation Triggers
Structure Plans	Require proponents to include coastal adaptation and management provisions into structure plans.	The submission of a structure plan containing lots being affected by coastal erosion, as identified in the CHRMAP.
Scheme Amendment	Introduce SCA 3 into the Town's local planning scheme.	Next scheduled scheme review, or as deemed appropriate by the Town.
Coastal Local Planning Policy	Adoption of a local planning policy to guide future development within SCA 3.	Following the introduction of SCA 3 into the Town's local planning scheme.
Model Conditions List	Update model conditions list to include conditions relating to notifications on title and managed retreat.	Following the introduction of SCA 3 into the Town's local planning scheme and adoption of the Coastal Local Planning Policy.
Foreshore Management Plan	Strategy to guide the ongoing management of the Cottesloe foreshore reserve.	Following completion of this CHRMAP, when deemed appropriate by the Town.
Publicly Available Data	Update the Town's IntraMaps to include the erosion hazard lines.	Following completion of this CHRMAP.



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TOWN OF COTTESLOE



COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN (CHRMAP) STEERING COMMITTEE

ATTACHMENT

ITEM 8.1.1E:
R05 COST BENEFIT ANALYSIS



Town of Cottesloe CHRMAP

Assessment of Risk Treatment Options (Cost Benefit Analysis)

Town of Cottesloe

27 February 2024







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ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present. We respectfully acknowledge the past and present Traditional Custodians of this land on which the project focusses, the Whadjuk Noongar people.

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EXECUTIVE SUMMARY

The Western Australian Government Western Australian Planning Commission's "State Planning Policy No. 2.6: State Coastal Planning Policy" (WAPC, 2013, herein referred to as "SPP2.6") addresses climate change, sea level rise, increased coastal inundation and coastal erosion. SPP2.6 recommends that management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development vulnerable to coastal hazards. Specific CHRMAP Guidelines have been developed to assist this process (WAPC, 2019).

The Town of Cottesloe has been identified as potentially exposed to significant erosion and minor inundation hazard. The adjacent foreshore reserves support a variety of recreational and commercial land uses, including substantial built infrastructure situated in close proximity to the shoreline. Such infrastructure includes the Cottesloe and North Cottesloe Life Saving Clubs (SLSC), Indiana Teahouse, restaurants and cafes, playgrounds, footpaths and several carparks, which may be subject to the impacts of coastal hazards at present or into the future. This coastal hazard risk is a key trigger for the requirement of this CHRMAP. Therefore, the present study aims to investigate and plan for coastal hazards likely to affect Town of Cottesloe.

The aim of present study is to investigate the nature and severity of coastal hazards which are likely to affect Town of Cottesloe over future planning horizons. Refer Figure 1-1 for locality and study area extent.

This CHRMAP increases knowledge and understanding of coastal hazard risks and identifies risk management and adaptation measures for implementation. The outcomes will be used to inform local government policies, strategies and plans, including (but not limited to), planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans. The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with their objectives and SPP2.6. In addition, the project will identify the strategic direction for coastal adaptation scenarios from the present to 2123 (100-year management time frame) and determine an implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway for the region and serve as a key reference for management, planning and policymaking for the short-term (0-25 years), medium-term (25-50 years), and long-term (100 years).

This report presents Stage 6: Assessment of Risk Treatment Options by using Cost Benefit Analysis (CBA), which identifies preferred risk treatment pathways and options. The CBA analysis is contingent on NPV discount rates and unit cost rates assumptions. Notwithstanding these assumptions, the process provides a tool to assist decision-makers in drawing comparisons between several coastal adaptation options. The large study area allows the consistent application of the CBA across a large section of the coast.

Sensitivity analyses on the NPV discount rate demonstrate the variability inherent in the methodology at some locations. A review of the CBA results shows that ranking options by NPV depend on which discount rate is used. If options stayed in the same ranking for all three discount rates, there would be a much stronger argument for selecting a single option with which to proceed. The unit cost assumptions would also need to be confirmed by carrying on further design and procurement studies. In particular, the procurement of sand suitable for nourishment works may be questionable in the study area and should be the subject of further studies.

Options have been recommended to proceed for further investigation and/or implementation for each MU for erosion. The recommendations have considered the CBA results holistically as well as being cognisant of the findings of previous stages of the CHRMAP.

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1 INTRODUCTION

It is internationally recognised that the mean sea level has been rising globally since the nineteenth century and is projected to rise at an increasing rate in the future (IPCC 2021). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary or permanent), storm erosion and long-term shoreline recession. State governments across Australia have introduced obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends that management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development potentially vulnerable to coastal hazards. Specific guidelines have been developed to assist this process (WAPC, 2019).

SPP2.6 requires adequate risk management planning where existing or proposed development is in an area at risk of being affected by coastal hazards over the 100-year planning timeframe. SPP2.6 and the CHRMAP Guidelines provide the risk assessment framework to be applied to identify risks intolerable to the community and other stakeholders such as local governments, indigenous and cultural interests, and private enterprises. Risk management measures are then developed according to the adaptation hierarchy outlined in SPP2.6.

The study area for this CHRMAP is the entire shoreline within the Town's jurisdiction (see Figure 1-1). The study has been undertaken across two Management Units (MUs) being Management Unit 1 (North of Cottesloe Groyne, including the groyne) and Management Unit 2 (South of Cottesloe Groyne). The study area is shown in Figure 1-2 and Figure 1-3 for North and South areas respectively. The study area consists of various shoreline types and many coastal assets, involving multiple stakeholders:

- Physical controls rubble mound rock groynes at Beach Street and Cottesloe Beach; seawalls at Cottesloe Beach
- Sandy pocket and "perched" beaches backed and underlain by rock shelves and adjacent narrow foreshore reserve
- Presence of various rock features including shore-attached reef and rock outcrops and cliffs
- Roads along the shoreline Curtin Avenue and Marine Parade
- Cottesloe Surf Life Saving Club and North Cottesloe Surf Life Saving Club
- Registered Aboriginal Heritage Site at Mudurup Rocks, south of the Cottesloe Surf Life Saving Club
- Significant built infrastructure buildings, car parks, shore-parallel dual use path, utilities, playgrounds
- Large number of foreshore amenities such as showers, fencing, information signage, access paths and stairways
- Highly valued recreational assets beach and ocean areas used heavily by locals and visitors for many different pursuits.
- Commercial and residential property owners/ operators

This CHRMAP project aims to increase knowledge and understanding of coastal hazard risks and identify risk management and adaptation measures for implementation. The outcomes will be used to inform local and state government policies, strategies and plans, including (but not limited to), planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans. The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with their objectives and SPP2.6. In addition, the project will determine the strategic direction for coastal adaptation scenarios from the present-day to 2122 (100-year management time frame) and identify an implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway

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for the region and serve as a key reference for management, planning and policymaking for the short-term (0-25 years), medium-term (25-50 years), and long-term (50-100 years).

Delivery of this project will occur over 8 stages (as summarised in Figure 1-4), each representing a key hold point. The staged approach is developed according to the Town of Cottesloe scope and is in line with the CHRMAP Guidelines (WAPC, 2019).

This report presents Stage 6: Assessment of Risk Treatment Options by using Cost Benefit Analysis (CBA), which identifies preferred risk treatment pathways and options. The red bubble in Figure 1-4, indicates where this component sits in the CHRMAP methodology.

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Figure 1-1 Study Area

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Figure 1-2 MU 1 North of Cottesloe Groyne, including Groyne

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Figure 1-3 MU 2 South of Cottesloe Groyne

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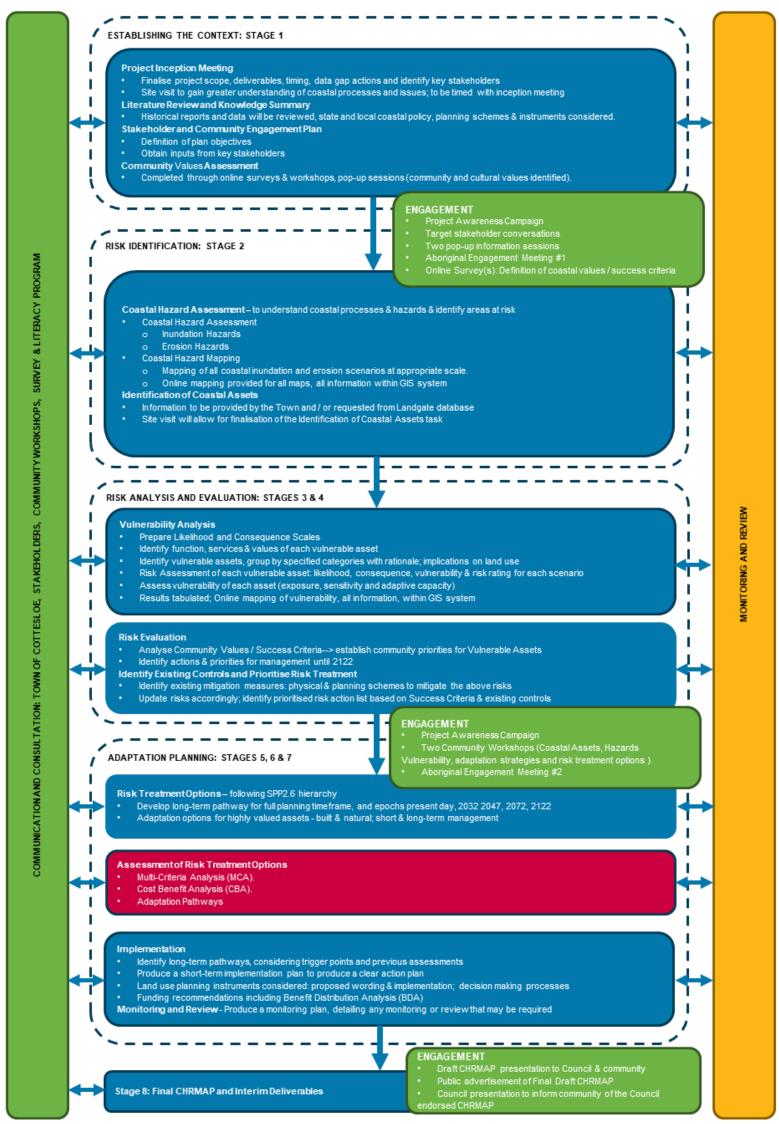


Figure 1-4 Methodology

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2 COST BENEFIT ANALYSIS APPROACH

The purpose of the Cost Benefit Analysis (CBA) is to further examine the selection of adaptation options through economic analysis. In the previous project stage 5, potential adaptation options were assessed against a range of criteria, including cost. Options that may require significant financial investment and scored positively in the MCA have been included in this CBA. A rigorous assessment of costs and benefits for each option will assist with preferential selection and potentially uncover any poor financial assumptions included in the MCA. This analysis will also ensure that a selected adaptation option is economically defendable. The CBA has addressed valuing the loss of assets, managed retreat and physical protection options. Losses or costs are assessed at each project timeframe. Indirect costs that another user might consider to be a loss are not considered. For example, costs associated with Special Control Area (SCA) title notifications, emergency planning or development restrictions are not considered.

The cost-benefit of each option is presented in net present value (NPV) terms. NPV is a standard economic analysis to compare options with time-variable costs and benefits. It allows for the adjustment of all future economic considerations to present day dollars for a more direct comparison. This relates to the time-value of money, as planned expenses in the future are, in a sense, cheaper than equivalent costs today, because the money required for a future expense could be spent elsewhere today to provide value over time (i.e., it can be invested now to generate a return). An expense that occurred today could not be invested elsewhere. In this case, all cashflows are costs, so options with a lower net present cost are considered better investments from a financial standpoint.

The real discount rate chosen for this project was 4% with sensitivity analyses at 7% and 2%. This decision was based on similar assessments (DPMC, 2016; Transport for NSW, 2022; Baird, 2020; APH, 2018; Abelson and Dalton, 2018), the long timeframe of analysis, and concerns that valuing future spending too low is at odds with resilient coastal planning principles.

The discount rate essentially converts all future costs back to today's dollar value for comparison (in the NPV). For example, a project with a cost of \$1 million per year for 10 years would discount to an NPV of roughly \$7.5 million, whereas a project that only has a single outlay of \$10 million in 10 years' time would have an NPV of roughly \$5.4 million, both discounted at 7%. A project that costs \$10 million today would have an NPV of \$10 million. This example shows the importance of when a cost is realised.

The CBA has been performed over the original project timeframe – notionally 2022 to 2122, to match the project planning timeframe and meet the requirements of the CHRMAP. It should be noted that the uncertainty around the CBA estimates and assumptions increase with time. Estimates beyond 2040 should be viewed as indicative trends only. Long-term adaptation pathways should always be monitored and updated over time.

2.1 Options Suitable for Cost Benefit Analysis

The CBA has only addressed options which include practical and economic actions across the planning timeframe. The economic base case used for comparison is calculated by valuing the loss of assets and values in an assumed scenario of inaction. This inaction is unrealistic in practical terms as severe erosion would require the Town to implement public safety measures. The scenario is therefore different to the Do-Nothing adaptation option and assumes literally no actions or management are undertaken by anyone over the planning timeframe, and that hazards and resultant asset loss/damage occurs exactly as the hazard analysis suggests. The adaptation options recommended for further analysis from the previous Multi-Criteria Analysis, and considered suitable for CBA, are summarised in Table 2-1 - managed retreat and physical protection options.

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Table 2-1 Risk Treatment Options from WAPC (2019) to be considered for CBA

Option Category	Option Name	Option Code
Planned / Managed Retreat	Voluntary acquisition	PMR4
Protect	Beach nourishment or replenishment	PR1
	Groynes	PR2
	Seawalls	PR3
	Artificial reef	PR4
	Offshore breakwater	PR5

2.2 Other Options

The remaining adaptation options from WAPC (2019), presented in Water Technology (2023) are not considered suitable for CBA and have been costed using traditional budgeting techniques for MUs where they received a positive MCA score. Future reporting for this project, at the Stage 7 Implementation Report will provide cost estimates and notes on any scoping details or assumptions for implementation of these options.

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3 METHODOLOGY

The steps taken to complete the CBA are:

- Re-analysis of GIS vulnerability datasets to extract asset category data by area. This was undertaken
 where previous information about the assets were not considered to provide enough detail for economic
 analysis.
- 2. Finalise quantities of assets at risk for all categories for erosion for each MU at each timeframe.
- 3. Determine an appropriate unit value for each category for loss to erosion and inundation.
- 4. Valuing the loss of existing assets and values this assumes the scenario of complete inaction over the project timeframe.
- 5. Scoping and designing the adaptation options.
- 6. Pricing the adaptation options.
- 7. Reducing all costs to NPV.
- 8. Conducting sensitivity analysis on NPV discount rate used in analysis.
- 9. Presenting summary of the inaction scenario and adaptation options in NPV.
- 10. Recommendation of options to be considered for implementation.

3.1 Valuing the Loss of Existing Assets and Values

To compare the cost of different adaptation pathways we first must estimate the total value of assets at risk if projected erosion and inundation were to occur. This will form the asset value component of the 'do nothing' strategy. The total damage costs for each category are estimated by using the area of each asset category, which might be expected to be affected for each hazard type at each timeframe. Note that these cost estimates are estimates only intended for general comparison.

The size of the study area has best suited the use of a detailed 'unit cost method' for estimating erosion loss and inundation damage costs to properties and assets. This method primarily assumes a locally determined cost for each unit area in each category. The total damage costs for each category are estimated by using the sum of areas of each category type which might be expected to be affected for each timeframe. Given the size of the study area, the accuracy of the erosion modelling used, we consider the method is suitable for estimating damage costs for the purposes of a cost benefit analysis.

3.1.1 Updated Assets and Values at Risk

Review of the asset information available resulted in a need to re-analyse the local planning scheme data in GIS as the existing information were not considered to provide enough detail for economic analysis. A summary of the input quantities for each category for each MU used are presented in Appendix A and land areas were quantified against the same categories:

- Roads
- Residential property
- Commercial property
- Developed Foreshore
- Public and Community
- Environmental
- Heritage

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3.1.2 Unit Costs

Reasonable economic assumptions have been used to determine unit costs for erosion loss. Unit cost values for erosion for different asset categories are listed in Table 3-1. For the two private categories (Commercial, Residential), approximation of current market value has been used. Although the exact timeframe and speed at which this value would be lost is unclear, at the time of writing market value is applicable and at some point in the future, it would be reduced to zero under an economic scenario of complete inaction over the project timeframe. For public categories with built infrastructure, construction cost information from Cardno (2018b), after Rawlinsons (2016) has been considered and factored. This is in line with current uncertainties in construction costs due to Covid19, and to ensure public infrastructure situated on land which is frequently not subject to land acquisition costs is adequately valued.

All public asset categories are not considered to appreciate in value in real terms. There is an argument that private asset categories, however, are a special case as these asset classes historically appreciate at a higher rate than inflation (RBA, 2015). For this analysis, we have assumed that residential real estate does not appreciate as it is uncertain how this trend will continue into the future. Construction costs, and all other costs, are assumed to increase at the expected inflation rate and therefore no adjustment is required in the analysis.

Table 3-1 Erosion Costs for Each Asset Category

Accet	Funcion Cook	Notes
Asset Category	Erosion Cost (\$AUD/m²)	Notes
Residential property	12,300	Based on review of median house prices in study area (On The House, 2023 and Real Estate, 2023). This method represents a market value. For pure economic analysis this may be considered on overestimate because the zoning value of the land is typically not included in pure economic analysis, but for CBA, financial and budgeting preparations for the Town it is considered appropriate.
Commercial property	1,300	A review of sales in the study area was undertaken but there were too few results to be relied upon. Rawlinsons (2016) was reviewed for an average rate of applicable developments to establish an estimate.
Roads	300	\$300/m² rate from DIRDC (2018) and Cardno (2018).
Developed Foreshore Reserve	350	This category has been valued highly because of the method used for private residential property and to represent the non-use values of this space evident through previous community and stakeholder consultation.
Public and Community	1,000	Allocated at 66% as Commercial to ensure government infrastructure accounted for adequately.
Environmental	250	Based on UWA (2019) study: Non-market valuation instruments for measuring community values affected by coastal hazards. Community has a willingness to pay for coastal area that includes amenities and flora and fauna species protection. A qualitative category, that has frequently been identified by the community as one of the most important during previous CHRMAP stages.
Heritage	36,900	As a qualitative category, but integral to the community fabric of the study area, this has been valued cognisant of the more easily valued developed/quantitative categories to ensure it is adequately represented in the CBA. It may not be practical for many assets in this category to be relocated. Assumed 3x Residential property category due to irreplaceable value and most likely unable to be relocated.

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3.1.3 Value of Existing Vulnerable Assets and Values

The base-case economic scenario of assuming complete inaction over the project timeframe was costed for each MU for each timeframe by multiplying the quantity of assets identified as vulnerable by the unit rate for that timeframe. The resultant amounts for each timeframe were then converted to one summary NPV.

3.2 Planned / Managed Retreat – Voluntary Acquisition (PMR4)

The costs for this option have been determined for each MU using the following steps:

- Calculate the acquisition cost for the two private categories at market values for the timeframe they are considered vulnerable to hazards.
- 2. Calculate the infrastructure removal and subsequent land improvement cost to return land to undeveloped foreshore reserve for all size categories with built infrastructure (Table 3-2). A factor of 25% has been allowed for preliminaries, project management, design, mobilisation and demobilisation. A contingency of 30% has been included for uncertainties in budget estimating. An annual maintenance cost of \$1/m² has been applied.
- 3. Include the value of losing the Public and Community category these facilities are considered lost to the study area as no cost to replace them elsewhere is included. Valuation is same as the base-case economic scenario. The two private categories have been priced to be acquired so are not counted again. Roads are not counted as they have been considered service assets without the need to access other land uses they are no longer needed so not considered an economic loss; and the developed foreshore category is not valued as a loss again because new usable foreshore is what is being created by this option.
- 4. The resultant amounts for each timeframe were then converted to one summary NPV.

Table 3-2 Valuation Considerations for Voluntary Acquisition Option

Category	Acquisition Cost	Infrastructure Removal and Land Improvement Cost
Residential Property	Same as base case valuation	20% of base-case
Commercial Property	Same as base case valuation	20% of base-case
Roads	Zero – government owned	20% of base-case
Developed Foreshore Reserve	Zero – government owned	5% of base-case
Public and Community	Zero – government owned	5% of base-case

3.3 Protection Options

3.3.1 Beach Nourishment – PR1

The costs for this option have been determined for each MU using the following steps:

- Calculate a sand nourishment volume, based on the length of coast requiring protection and a height and width estimate. Example values used are 1.5m high and 25m wide. A 10-year useful life has been assumed and costs have been annualised.
- 2. Estimate a sand volume that could be delivered each day considering location, access.
- 3. Estimate the number of mobile plant required to place the sand.
- Calculate the initial nourishment cost.
- 5. A factor of 25% has been allowed for preliminaries, project management, design, mobilisation and demobilisation. A contingency of 30% has been included for uncertainties in budget estimating. An annual

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volume increase in cost of 1% has been applied in response to climate changes (e.g. sea level rise and changes to sediment transport).

6. The resultant amounts for each timeframe were then converted to one summary NPV.

This concept cost estimate requires the use of several assumptions, as follows:

- Assume there is a suitable sand source in the sub-region that can supply adequate quality, particle size and volume of sand over the project timeframe.
- Assume a cost of \$40/m³ to supply and transport sand to work site.
- Assume an average day rate of \$1,500 per piece of mobile plant.

3.3.2 Rock Structure Options – PR2 to PR5

The costs for this option have been determined for each MU using the following steps:

- Scope and design the structural option using information from the existing CHRMAP reports and design drawings of existing structures in the study area.
- 2. Estimate an appropriate crest level, toe depth, structure length, structure slope.
- 3. Calculate quantity of materials required rock, sand, geofabric.
- 4. Use assumed costs to calculate initial costs of material purchase and installation.
- 5. A factor of 25% has been allowed for preliminaries, project management, design, mobilisation and demobilisation. A contingency of 30% has been included for uncertainties in budget estimating (40% for seawalls as they need to interface with any infrastructure crossing the shoreline).
- 6. An annual maintenance cost of 2% has been applied.
- 7. The resultant amounts for each timeframe were then converted to one summary NPV.

This concept cost estimate requires the use of several assumptions, as follows:

- Assume required armour sizes are available in sub-region and quarry production rates are suitable to supply adequate volume of required sizes.
- Assume initial costs of rock armour of between \$95 and \$190/tonne, core of \$75/tonne and Geofabric of \$30/m².
- Complex features have been approximated by modifying characteristics of cross-sections.
- Groynes are assumed to be two-sided revetments.
- High level assumptions regarding the structure shape and construction style.
- Replacement cost for the structure at **50yrs**, assumed to be 100% of capital cost.
- Beach and foreshore amenity is expected to be broadly similar to current levels, with the exception of seawalls which will likely result in the loss of a usable sandy beach. Due to uncertainties in monetising this loss it has been decided to consider this impact qualitatively in the analysis.

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4 RESULTS

CBA results for erosion are presented in Table 4-1 for MU1 and Table 4-2 for MU2.

Table 4-1 MU1 CBA Results for Erosion Adaptation

Net Present Value 2020	Do Nothing Economic Base-Case	PMR4: Voluntary Acquisition	PR1: Beach Nourishment	PR2: Groynes	PR3: Seawall	PR4: Artificial reef	PR5: Offshore breakwater
Option Notes	Economic base case for comparison purposes.	Acquisition assumed in same year as hazard line identifies land as vulnerable.	 Assumes 2023 implementation with treatment of 1700m of shoreline for whole MU. Assumes suitable sand source available (grain size, volume, cleanliness. proximity). 	Assumes 2023 implementation of 9 rock groynes, 100m long, approximately 200m apart to treat 1700m of shoreline. Capital sand nourishment is included. Ancillary foreshore costs are not included.	Assumes 2023 implementation of 1700m seawall to treat whole MU shoreline. Does not include sand nourishment - beachfront not maintained. Ancillary foreshore costs are not included.	Assumes 2023 implementation of 4 artificial reefs. Assumes crest at MSL, build in -5mAHD water depth; 200m long reef with 200m gaps in between. Capital sand nourishment is included. Ancillary foreshore costs are not included.	Assumes 2023 implementation of 4 offshore breakwaters. Assumes crest at +2mAHD (overtopping allowed, but emergent structure), build in -5mAHD water depth; 200m long with 200m gaps in between. Capital sand nourishment is included. Ancillary foreshore costs are not included.
7% NPV	\$569,193,266	\$565,233,853	\$12,393,510	\$38,823,239	\$12,963,402	\$82,809,112	\$105,539,219
4% NPV	\$660,017,688	\$663,738,671	\$19,137,914	\$47,852,105	\$15,978,215	\$106,248,857	\$135,412,892
2% NPV	\$867,039,412	\$929,036,098	\$33,115,993	\$65,322,057	\$21,811,577	\$150,916,058	\$192,340,705

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Table 4-2 MU2 CBA Results for Erosion Adaptation

Net Present Value 2020	Do Nothing Economic Base-Case	PMR4: Voluntary Acquisition	PR1: Beach Nourishment	PR2: Groynes	PR3: Seawall	PR4: Artificial reef	PR5: Offshore breakwater
Option Notes	Economic base case for comparison purposes.	Acquisition assumed in same year as hazard line identifies land as vulnerable.	Assumes 2047 implementation with treatment of 2100m of shoreline for whole MU. Assumes suitable sand source available (grain size, volume, cleanliness. proximity).	Assumes 2047 implementation of 7 rock groynes, 100m long, approximately 200m apart to treat 1300m of shoreline (868m of the 2134m shoreline already protected.) Capital sand nourishment included. Ancillary foreshore costs are not included.	Assumes 2047 implementation of 1300m seawall: 868m of the 2134m shoreline already protected. Does not include sand nourishment - beachfront not maintained. Ancillary foreshore costs are not included.	Assumes 2047 implementation of 4 artificial reefs. Assumes crest at MSL, build in - 5mAHD water depth; 200m long reefs with 200m gaps in between. Also allows for some sections already protected. Capital sand nourishment included. Ancillary foreshore costs are not included.	Assumes 2047 implementation of 4 offshore breakwaters. Assumes crest at +2mAHD (overtopping allowed, but emergent structure), build in -5mAHD water depth; 200m long with 200m gaps in between. Also allows for some sections already protected. Capital sand nourishment included. Ancillary foreshore costs are not included.
7% NPV	\$43,525,449	\$39,784,776	\$2,799,570	\$5,808,582	\$1,824,610	\$15,691,605	\$19,959,280
4% NPV	\$104,159,452	\$112,428,431	\$8,446,703	\$14,446,174	\$4,537,879	\$40,337,293	\$51,307,902
2% NPV	\$336,416,255	\$402,112,986	\$21,386,530	\$31,096,871	\$9,768,250	\$89,262,807	\$113,539,780

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5 DISCUSSION

5.1 Sensitivity Analysis of NPV Discount Rate

As the nature of CHRMAP principles requires robust and early planning for coastal hazards, the selection of a discount rate(s) to be used for NPV analysis is particularly important. The planning timeframe is very long compared to many CBA applications. The competing principles of early coastal planning making for more-resilient communities may not align well with the CBA principle of the future spending of money is cheaper. Given the long planning timeframe it could be argued that the 2% in the sensitivity analysis should be used, or given more weight than the higher numbers, particularly if private property inflation continues into the future at historic rates.

5.2 Planning Timeframe

It is important to note that this is a concept-level CBA, that has used high-level cost estimates, coupled with the timeframe of projected hazards, and the very long timeframe for such economic analyses, the results should be used cautiously.

5.3 Assumptions

This concept-level CBA has necessarily used several high-level assumptions and estimates. As no design information is available until later phases of implementation it is necessary to undertake option scoping and concept design on limited information. Assumptions about price, extent of forecast vulnerabilities and the very long timeframe mean the results are suitable for the relative comparison of options, but preliminary and detailed design phases require further consideration of actual costs. A summary of key assumptions is provided below:

- 1. Hazards occur as projected and trigger losses, or decision points on option implementation in accordance with the same projected timeframes.
- 2. NPV discount rates of 7%, 4% and 2% are suitable for the timeframe and level of detail of cost estimates.
- 3. Unit costs are representative of the study area.
- 4. The economic benefits provided by the beach (both use and non-use values) are not included as no meaningful inputs were available to use. This means the cost of the do-nothing base case may be a little higher than presented, but this has been offset by using higher rates for the loss of foreshore areas.
- 5. It is important to note that the process of purchasing developed private property for the purposes of planned / managed retreat (PMR4 Voluntary Acquisition) is not considered to result in an economic benefit it is simply transferring the cost from one party to another. For the purposes of this CBA, the methodology is considered appropriate to budget all options and compare their financial implications over
- 6. The PMR4 Option Voluntary Acquisition pathway assumes purchase of private property at a standard market rate. It is unclear how the real estate market will react to erosion from sea level rise as coastal erosion following storm events have a more immediate and significant impact. It is, however, expected that market values may reduce in areas that are actively eroding. This was considered beyond the scope of this project to attempt to model. However, if there is a significant reduction in the purchase price for this option it may represent a significant cost saving to a government body purchasing the property, that could make this option more competitive in more locations.
- 7. With the exception of PR3 Seawall, options are considered to provide similar levels of beach and foreshore amenity as the present day. Underlying this assumption includes several others around rehabilitation of rezoned land being practical and effective; resources required for coastal engineering will continue to be available as needed (construction rock and nourishment sand for example).

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- 8. Coastal management technologies will not substantially change in the future.
- 9. Assumed base costs for works (informed by historical information) are representative of future markets.

5.4 Recommended Options for Each MU

The CBA has been used as an additional tool to assist decision making when assessing adaptation options with which to proceed. The reality that only some of the WAPC adaptation options are suitable for CBA, and the uncertainty in effectiveness of those that are not suitable, means that the CBA results need to be used cautiously whilst considering the rest of the information identified during the CHRMAP project.

Review of the CBA results shows that the ranking of options for each MU by NPV depends on which discount rate is used. If options stayed in the same ranking for all three discount rates there would be a much stronger argument for selection of a single option with which to proceed.

From the WAPC hierarchy, "Avoid" is only practical for parts of MU1 and MU2. The "Accommodate" option principally applies to coastal inundation. The remaining results considered in the CBA process are essentially to consider the advantages and disadvantages of "Retreat" (PMR4) or "Protect" Options (PR1-5) for the erosion hazard.

Options recommended to proceed are presented in Table 5-1. Almost all options across all discount rates performed better than the economic base case. However, more detailed investigation is required can be undertaken to determine the scope and extent of such works.

For erosion, across both management units (MU1 and MU2) the PR3 Seawall outperforms all options across the NPV 4% and NPV 2% discount rates and has a positive benefit cost ratio. PR1 Beach Nourishment is the next best performing option under NPV4%.

Table 5-1 Recommended CBA Options for Erosion for each MU

Management Unit	Recommended Option	Notes
MU1	PR1 Beach Nourishment	 PR1 Beach Nourishment is recommended based on the results of the MCA and CBA combined. Best value for NPV 7% discount rate and has a positive benefit/cost ratio for all rates. PR1 Beach nourishment could also later be transitioned to both PR2 Groynes and PR3 Seawall if required. PR3 Seawall is not recommended as it would likely mean significant loss of the beach. Should the objectives of this MU change in the future PR3 Seawall may be suitable in the long-term as PR3 performs well across NPV 4% and 2% discount rates. It may suit smaller sub-sections of the MU, particularly if combined with PR1 Beach Nourishment.
MU2	PR1 Beach Nourishment	 PR1 Beach Nourishment is recommended based on the results of the MCA and CBA combined. PR1 Beach nourishment could also later be transitioned to both PR2 Groynes and PR3 Seawall if required. PR3 Seawall is not recommended as it would likely mean significant loss of the beach. Should the objectives of this MU change in the future PR3 Seawall may be suitable in the long-term as PR3 performs well across all NPV discount rates. It may suit smaller sub-sections of the MU. Particularly if combined with PR1 Beach Nourishment.

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6 SUMMARY

The CBA analysis is contingent on NPV discount rates and unit cost rates assumptions. Notwithstanding these assumptions, the process provides a tool to assist decision-makers in drawing comparisons between several coastal adaptation options. The large study area allows the consistent application of the CBA across a large section of the coast.

Sensitivity analyses on the NPV discount rate demonstrate the variability inherent in the methodology at some locations. A review of the CBA results shows that ranking options by NPV depend on which discount rate is used. If options stayed in the same ranking for all three discount rates, there would be a much stronger argument for selecting a single option with which to proceed. The unit cost assumptions would also need to be confirmed by carrying out further design and procurement studies. In particular, the procurement of sand suitable for nourishment works may be questionable in the study area and should be the subject of further studies.

One or more options have been recommended to proceed for further investigation and/or implementation for each MU for both erosion and inundation. The recommendations have considered the CBA results holistically as well as being cognisant of the findings of previous stages of the CHRMAP. Other non-CBA options will form part of the final recommended management approach and will be presented in the Stage 7 Implementation Report, which will also provide further detail for these investigations and implementation of options.

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APPENDIX A
SUMMARY OF VULNERABLE ASSET
CLASSIFICATIONS TO EROSION







Table A-1 Total Vulnerable Area (m²) of Asset Classification to Erosion in MU1 for Each Planning Timeframe.

Asset Classification Group	2023	2033	2048	2073	2123
Roads	0	0	610.80	12208.10	46463.11
Residential property	0	0	0	0	44,219.92
Commercial property	2,502.31	2,502.31	2,502.31	2,502.31	12,685.12
Public and Community	4648.56	5122.31	5916.77	7,022.47	10791.93
Developed Foreshore	20860.83	31988.03	51084.45	74191.15	82523.29
Environmental	0	0	0	0	0
Heritage	13583.12	17009.11	22707.86	31851.81	33,513.46

Table A-2 Total Vulnerable Area (m²) of Asset Classification to Erosion in MU2 for Each Planning Timeframe.

Asset Classification Group	2023	2033	2048	2073	2123
Roads	501.12	1374.32	6293.56	22063.97	52239.47
Residential property	0	0	0	5,356	39,217
Commercial property	0	0	0	0	0
Public and Community	758	758	857.45	3792.09	23089.40
Developed Foreshore	15410.03	25559.47	40423.06	58824.91	63,660
Environmental	5332.14	8176.55	11651.54	12628.80	13826.06
Heritage	471.65	1195.28	2289.63	6513.33	32569.18

Town of Cottesloe | 29 September 2023 Assessment of Risk Treatment Options (Cost Benefit Analysis)



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TOWN OF COTTESLOE



COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN (CHRMAP) STEERING COMMITTEE

ATTACHMENT

ITEM 8.1.1F: R06 STAGE 7 - IMPLEMENTATION



Town of Cottesloe CHRMAP

Chapter Report: Implementation

Town of Cottesloe

24 April 2024







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Town of Cottesloe | 24 April 2024 Chapter Report: Implementation

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ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present. We respectfully acknowledge the past and present Traditional Custodians of this land on which the project focusses, the Whadjuk Noongar people.



Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- Seven circles representing each of the States and Territories in Australia where we do our work
- Blue dots between each circle representing the waterways that connect us
- The animals that rely on healthy waterways for their home
- Black and white dots representing all the different communities that we visit in our work
- Hands that are for the people we help on our journey

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EXECUTIVE SUMMARY

It is internationally recognised that the mean sea level has been rising globally since the nineteenth century and is predicted to rise at an increasing rate in the future (IPCC 2021). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary coastal flooding), storm erosion and long-term shoreline recession. State governments across Australia have introduced statutory obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is potentially vulnerable to coastal hazards. Specific guidelines have been developed to assist in this process (WAPC, 2019).

SPP2.6 requires adequate risk management planning is undertaken where existing or proposed development is in an area at risk of being affected by coastal hazards over the 100-year planning timeframe. SPP2.6 and the CHRMAP Guidelines provide the risk assessment framework to be applied to identify risks that are intolerable to the community, and other stakeholders such as local governments, Indigenous and cultural interests, and private enterprise. Risk Management measures are then developed according to the risk management and adaptation hierarchy outlined in SPP2.6.

The Town of Cottesloe (Town) has been identified as potentially exposed to significant erosion and minor inundation hazard. The adjacent foreshore reserves support a variety of recreational and commercial land uses, including substantial built infrastructure situated in close proximity to the shoreline. Such infrastructure includes the Cottesloe and North Cottesloe Surf Life Saving Clubs (SLSC), Indiana Teahouse, restaurants and cafes, playgrounds, footpaths, and several carparks, which may be subject to the impacts of coastal hazards at present or into the future. This coastal hazard risk is a key trigger for the requirement of this CHRMAP. Therefore, the present study aims to investigate and plan for coastal hazards likely to affect the Town of Cottesloe.

The objective of this CHRMAP project is to increase knowledge and understanding of coastal hazard risks, and to identify risk management and adaptation measures for implementation. The outcomes will be used to inform local and state government policies, strategies and plans, including (but not limited to), planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans. The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with the objectives identified by these guidelines and SPP2.6. The project will identify the strategic direction for coastal adaptation scenarios from the present-day to 2123 (100-year management time frame) and identify an implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway for the region and serve as a key reference for management, planning and policy making for the short-term (0-25 years), medium-term (25-50 years), and long-term (100 years).

This report presents the Implementation Chapter Report, which details short-, medium- and long-term implementation plans, Land use planning measures, funding recommendations, and a Benefit Distribution Analysis (BDA). Based on the previous stage results, beach nourishment has been recommended to proceed for further investigation and/or implementation for both Management Units (MUs) for erosion for all timeframes. The recommendations have considered holistically as well as being cognisant of the findings of previous stages of the CHRMAP.

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1 INTRODUCTION

It is internationally recognised that the mean sea level has been rising globally since the nineteenth century and is predicted to rise at an increasing rate in the future (IPCC 2021). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary coastal flooding), storm erosion and long-term shoreline recession. State governments across Australia have introduced obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is potentially vulnerable to coastal hazards. Specific guidelines have been developed to assist in this process (WAPC, 2019).

SPP2.6 requires adequate risk management planning is undertaken where existing or proposed development is in an area at risk of being affected by coastal hazards over the 100-years planning timeframe. SPP2.6 and the CHRMAP Guidelines provide the risk assessment framework to be applied to identify risks that are intolerable to the community and other stakeholders such as local governments, Indigenous and cultural interests, and private enterprise. Risk management measures are then developed according to the risk management and adaptation hierarchy outlined in SPP2.6.

The study area for this CHRMAP is the entire shoreline within the Town's jurisdiction (see Figure 1-1). The study has been undertaken across two Management Units (MUs) being Management Unit 1 (North of Cottesloe Groyne, including the groyne) and Management Unit 2 (South of Cottesloe Groyne). The study area is shown in Figure 1-1, Figure 1-2, and Figure 1-3. The study area consists of various shoreline types and many coastal assets, involving multiple stakeholders:

- Physical controls rubble mound rock groynes at Beach Street and Cottesloe Beach; seawalls at Cottesloe Beach.
- Sandy pocket and "perched" beaches backed and underlain by rock shelves and adjacent narrow foreshore reserve.
- Presence of various rock features including shore-attached reef and rock outcrops and cliffs.
- Roads along the shoreline Curtin Avenue and Marine Parade.
- Two Surf Life Saving Clubs.
- Registered Aboriginal Heritage Site at Mudurup Rocks, south of the Cottesloe Surf Life Saving Club.
- Significant built infrastructure buildings, car parks, shore-parallel dual use path, utilities, playgrounds.
- Large number of foreshore amenities such as showers, fencing, information signage, access paths and stairways.
- Highly valued recreational assets beach and ocean areas used heavily by locals and visitors for many different pursuits.
- Commercial and residential property owners/ operators.

The objective of this CHRMAP stage is to increase knowledge and understanding of coastal hazard risks, and to identify risk management and adaptation measures for implementation. The outcomes will be used to inform local and state government policies, strategies and plans, including (but not limited to), planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans.

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The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with their objectives and SPP2.6 and follows the risk management and adaptation hierarchy of 'Avoid', 'Retreat', 'Accommodate' and 'Protect'. In addition, the project will determine the strategic direction for coastal adaptation scenarios from the present-day to 2123 (100-year management time frame) and identify an implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway for the region and serve as a key reference for management, planning and policymaking for the short-term (0-25 years), medium-term (25-50 years), and long-term (100 years).

Delivery of this project will occur over 8 stages (as summarised in Figure 1-4), each of which represents a key hold point. The staged approached is developed according to the Town of Cottesloe scope and is in line with the CHRMAP Guidelines (WAPC, 2019). This report presents the Implementation and Monitor and Review Stages. The red bubble displayed in Figure 1-4 indicates where this component sits with reference to the greater study.

The previous project stage was the Cost Benefit Analysis which detailed beach nourishment as the preferred coastal hazard mitigation option for both MU1 and MU2.

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Figure 1-1 Study Area

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Figure 1-2 MU 1 North of Cottesloe Groyne, including Groyne, to the North End of Town's Jurisdiction



Figure 1-3 MU 2 South of Cottesloe Groyne to the South End of Town's Jurisdiction

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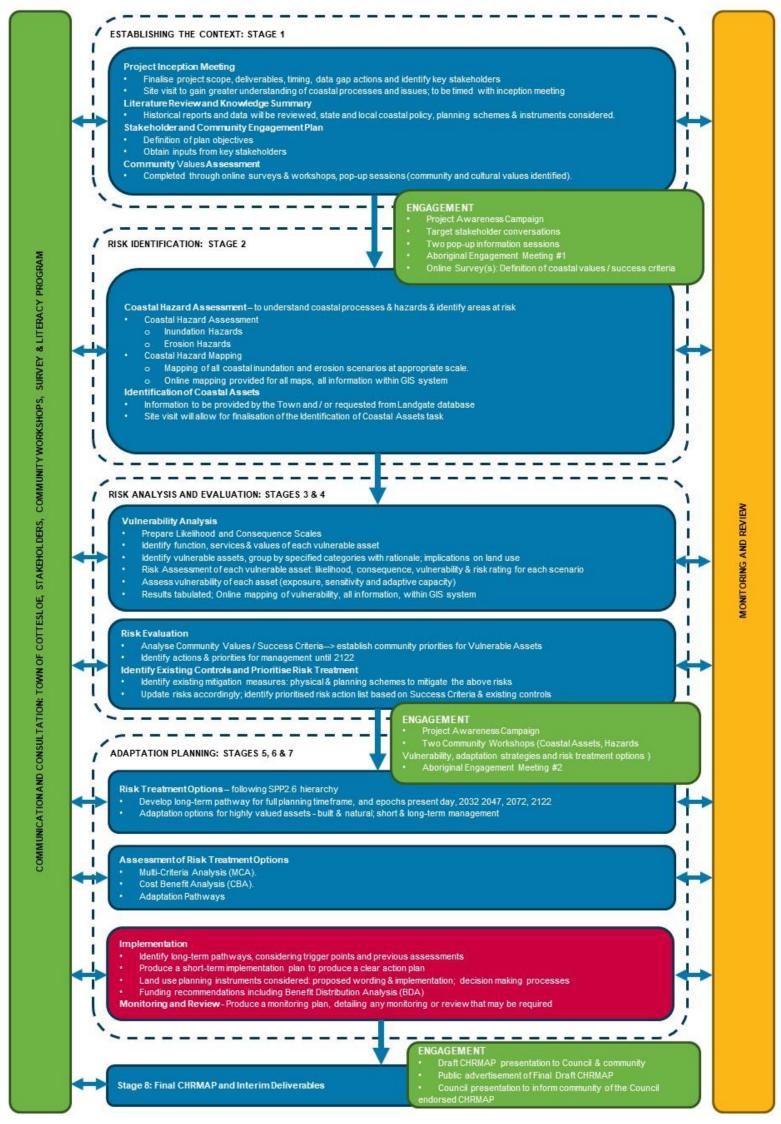


Figure 1-4 Methodology

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2 LAND USE PLANNING INSTRUMENTS

There is a direct relationship between coastal hazard exposure and development. The way that buildings and assets are designed and located determines their exposure, ultimately impacting risk to people and property.

Land use planning has an important role to play in increasing the resilience of coastal areas to sea level rise, storm surge inundation, and erosion, as they govern how coastal areas are developed and managed.

Therefore, development planning controls are an important tool to use in reducing risk exposure.

2.1 Existing Controls

2.1.1 Planning Controls

A summary of relevant planning controls for the study area is provided in *Establish the Context Chapter Report* (*Water Technology, 2023*). This study area is guided by the State Government planning framework and the Town's local planning framework which comprises of a planning scheme, strategies, policies and guidelines. While the existing local planning framework makes reference to coastal hazards, there are limited planning controls that can be used to adapt to the coastal hazards identified. As such, the existing planning controls do not change the assigned vulnerability ratings for the CHRMAP study area.

This CHRMAP will consider what planning controls may be appropriate as adaptation measures within the study area.

2.1.2 Physical Controls

The existing physical controls in the study area are reported in *Establish the Context Chapter Report (Water Technology, 2023)* and *Risk Identification Chapter Report (Cardno, 2023)* and include coastal protection structures such as groynes/breakwaters and seawalls. Where appropriate, these have already been considered in the hazard and vulnerability assessment. As such, the vulnerability results remain the same as previously reported. No changes to the vulnerability results are required.

2.2 Planning Control Options

This section outlines the key planning-based mechanisms which can be implemented by the Town in response to the coastal hazards identified in the CHRMAP. As the coastal inundation hazard has been identified as insignificant for this study area, the planning mechanisms have been prepared to respond to the impacts of coastal erosion only.

2.2.1 Special Control Areas

The introduction of a Special Control Area (SCA) into the Town's local planning scheme is considered the most appropriate statutory planning mechanism to holistically address coastal erosion. An amendment to the local planning scheme will be required to introduce the SCA over all zoned land located seaward of the 2123 coastal processes setback line.

An SCA is typically put in place to establish special provisions to target a single issue or related set of issues often overlapping zone and reserve boundaries. The provisions of an SCA would establish the purposes and objectives, specific development requirements and referral requirements to agencies relevant to the SCA.

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The CHRMAP Guidelines (WAPC 2019) provides draft amendment text including the purpose, objectives and provisions to be contained within an SCA. The purpose of the SCA is to provide guidance as to the appropriate scope of land use and development to be permitted within a coastal hazard risk area. This would be achieved through the following overarching objectives:

- To ensure land in the coastal zone is continuously provided for coastal foreshore management, public access, recreation, and conservation.
- To ensure public safety and reduce risk associated with coastal erosion and inundation.
- To avoid inappropriate land use and development of land at risk from coastal erosion and inundation.
- To ensure land use and development does not accelerate coastal erosion or inundation risks; or have a
 detrimental impact on the functions of public reserves.
- To ensure that development addresses the Town of Cottesloe CHRMAP prepared in accordance with SPP 2.6.

The SCA would also include additional provisions to ensure development and use of land subject to erosion over the 100-year planning timeframe. The additional provisions to be included within the SCA will include requirements relating to:

- The need to obtain development approval for all development, including development that is considered exempt under the Deemed Provisions and the local planning scheme.
- Temporary or time limited approvals with the option to seek extensions where the risk from coastal processes is still considered acceptable.
- The referral of development applications to relevant agencies for comment and advice, including the Department of Transport, the Department of Planning, Lands and Heritage and any other relevant authority.
- Construction and servicing design requirements.
- The Town will be responsible for assessing development against the objectives and provisions of the SCA which will only apply to land zoned under the Local Planning Scheme. Development within the Parks and Recreation reserve will continue to be determined by the WAPC, taking into consideration the objectives and provisions under the Metropolitan Region Scheme (MRS).

2.2.2 Coastal Local Planning Policy

A local planning policy (LPP) can be prepared by a local government in accordance with Schedule 2 of the Planning and Development (Local Planning Schemes) Regulations 2015. The purpose of a LPP is to guide the development and use of land in relation to a particular matter. LPPs allow a level of discretion and flexibility to be applied in the decision-making process given they are a due regard planning instrument.

The Town can prepare a Coastal LPP to ensure future development aligns with the overarching objectives of the SCA. The Coastal LPP will include provisions relating to strategic planning proposals, subdivision and development applications on land identified as being prone to coastal erosion.

2.2.3 Notification on Title

Freehold land identified as being at risk of coastal erosion should have a notification registered on its certificate of title to ensure current and future landowners are aware of the potential for the land to be impacted by coastal processes. The notification shall state the following noting that shorter timeframe than 100 years may be appropriate where identified in the CHRMAP:

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'This lot is located in an area likely to be subject to erosion over the next 100 years from the date this notification is registered.' (WAPC, 2013)

Notifications can be registered on the certificate of title as part of the decision-making process for subdivision and development applications under the following legislation:

- The WAPC requires a notification pursuant to Section 165 of the Planning and Development Act 2005 to be registered on the lots associated with a subdivision approval; and
- The Town requires a notification pursuant to Section 70A of the Transfer of Land Act 1893 to be registered
 on the lot associated with a development approval.

Landowners can also voluntarily seek to register a notification on the certificate of title pursuant to Section 70A of the Transfer of Land Act 1893.

2.2.4 Other Instruments

Additional instruments that can be considered for implementation include:

- Updates to the Local Planning Strategy to reference SPP2.6 and avoid the identification of at-risk land for further intensification of development through rezoning or subdivision.
- Preparation of a foreshore management plan to provide a strategy to deliver the recommendations of the CHRMAP for foreshore reserves throughout the Town.
- The use of restrictive covenants to restrict development in high-risk areas or limit the use of certain protective barriers which may contradict the recommendations of the CHRMAP.
- Introduction of special area rates to equitably distribute costs associated with protection options across beneficiaries.
- The application of SPP2.6 in the structure planning process where the comprehensive redevelopment of land remains an option.
- Internal processes and systems to ensure coastal hazard information and data is readily available and accessible to landowners, prospective buyers and the real estate industry.

The intent of these instruments aligns with guidance provided in the WA Coastal Zone Strategy, noting that private parties are responsible for managing risks to their private assets and incomes, which might arise from coastal erosion and inundation hazards.

More details of Land Use Planning Instruments are available in Appendix A.

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3 FUNDING OPTIONS

Stage 6, Assessment of Risk Treatment Options Chapter Report (Water Technology, 2024), provides details of the Cost Benefit Analysis (CBA), and presents a summary of financial and economic implications to inform the Town of the potential cost of coastal hazards over the planning timeframe and the cost to implement the recommended treatment options.

This section identifies all known revenue-raising mechanisms available for obtaining funds to assist implementation. Funding mechanisms considered include:

- Operating budget, general rates and coastal management fund,
- Special area rates / differential rating,
- Levies.
- Lease land management,
- State grants,
- Federal grants, and
- Beneficiary Pays.

3.1 Operating Budget, General Rates and Coastal Management Fund

The individual land managers within the study area should consider establishing a coastal management fund that includes specific allowance for managing and adapting to the risk posed by coastal erosion and inundation. The purpose of this fund includes:

- To allocate a percentage of the organisation's operating budget for coastal management. The percentage and amounts will vary for each organisation but between 0.5% and 3.0% is proposed.
- To save funds routinely so that when triggers are met the established management actions can be implemented efficiently.
- Acknowledge coastal management costs are forecast to increase in line with sea level rise and the realisation of coastal hazard projections.

3.2 Specified Area Rate

Where adaptation options are designed to protect specific sections of coastal land and assets, such as private property, it is recommended that the LGA progress the establishment of a specified area rate in line with the outcomes of benefit distribution analysis, please refer next Chapter, Chapter 4- Benefit Distribution Analysis. The rate can be applied to those beneficiaries within the 100-year hazard zone, and the amount raised should consider the estimated 100-year cost for each option.

3.3 Levies

It is recommended the LGA investigate the feasibility of establishing a particular levy for coastal management that would be a transparent source of the coastal management fund discussed above.

3.4 Lease Land Management

Coastal land vested with coastal managers in the study area and leased to third parties represents a unique scenario whereby implementation of some options may require specific lease clauses, but there is also potential to raise funds for coastal management. During considerations of lease renewal, coastal managers should consider the land use, vulnerability of the land, projected timeframe of unacceptable vulnerability, length

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of lease, recommended implementation options and need for any specific clause around triggers or required management actions by the lessee. Increases in lease amounts may be able to raise funds to help offset the cost of management.

3.5 State Grants – CoastWA

CoastWA aims to implement a strategic response to the growing impacts of coastal hazards to ensure sustainable land use and development on the coast for the long-term CoastWA has committed \$33.5 million of funding over five years from 2021-2026. For further information visit:

https://www.wa.gov.au/government/document-collections/coastwa-grants

It comprises the following grant programs:

- Coastal Adaptation and Protection grants,
- Hotspot Coastal Adaptation and Protection Major Project Fund,
- Coastwest grants,
- Coastal Management Plan Assistance Program.

There are also two other grant programs relevant to coastal hazard risk management in WA:

- Royalties for Regions,
- Local Government Financial Assistance Grants.

The Department of Transport administers the Coastal Adaptation and Protection (CAP) grants and the Hotspot Coastal Adaptation and Protection (H-CAP) Major Project Fund. CAP grants provide financial assistance for local projects that identify and manage coastal hazards. The program aims to build partnerships with local coastal managers, such as local governments, and help them understand and adapt to coastal hazards. CAP Grants fund up to 50% of project costs. H-CAP supports projects which design and implement adaptation options at coastal erosion hotpots identified by the DoT in recent years. Invitations to apply for H-CAP are sent directly to eligible coastal managers - those with a completed CHRMAP and an identified erosion hotspot.

Coastwest grants support eligible coastal land managers and community organisations to undertake projects that manage and enhance WA's coastal environments through rehabilitation, restoration and preventative actions. Coastwest grants are administered by the Department of Planning, Lands and Heritage.

Coastal Management Plan Assistance Program (CMPAP) grants support eligible coastal land managers to develop adaptation and management plans and strategies for coastal areas that are, or are predicted to become, under pressure from a variety of challenges. CMPAP grants are administered by the Department of Planning, Lands and Heritage.

Other WA grant programs which may provide funding for coastal projects include Royalties for Regions and Local Government Financial Assistance Grants.

Royalties for Regions is facilitated by Department of Primary Industries and Regional Development and promotes and facilitates economic, business and social development in regional Western Australia for the benefit of all Western Australians. For further information visit:

Royalties for Regions (www.wa.gov.au)

Local Government Financial Assistance Grants are administered by the Department of Local Government, Sport and Cultural Industries. They are grants funded by the Commonwealth Government and are distributed among 137 local governments in WA each year. The grants allow councils to spend the funds according to local priorities. For further information visit:

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https://www.dlgsc.wa.gov.au/local-government/local-governments/financial-assistance-grants

It should be noted that State funding mechanisms often require matching cash or in-kind contributions from the land manager, and as such, funding will still need to be sourced through one or more of the other available measures. State funding grants may also restrict access to funding where public monies would partially or predominantly benefit private landowners or users.

Because coastal hazards and coastal land management will continue to evolve and are unlikely to be resolved by 2026 (beyond the term of the CoastWA Grants), long-term sustainable funding is likely to be required from the State.

3.6 Federal Grants

Federal grants are variable and often unpredictable, but it is important for coastal managers to stay aware of any funding and grant programs available. Early planning and preparation will mean more-competitive applications can be prepared quickly when grants are announced.

It should be noted that Federal funding mechanisms may require matching cash contributions from the land manager, and as such, funding may still need to be sourced through one or more of the other available measures. Federal funding grants may also restrict access to funding where public monies would partially or predominantly benefit private landowners or users.

3.6.1 Disaster Ready Fund

The Australian Government has established the Disaster Ready Fund which will deliver up to \$200 million in funding per financial year for disaster risk reduction and resilience initiatives. Coastal hazards (erosion, inundation, and sea level rise) are an eligible hazard type. The total Australian Government funding is up to \$1 billion over five years from 2023 to 2028, with funding to be matched by the applicants. DRF Round Two opening date was Monday, 22 January 2024. For more information visit:

Disaster Ready Fund - Round Two | National Emergency Management Agency (nema.gov.au)

3.6.2 Coastal and Estuarine Risk Mitigation Program

The mitigation program, which is funded by the Emergency Response Fund, supports priority projects that reduce the impact of disasters on coastal communities and economies. Areas of focus for the program include:

- Adaptation and resilience actions, including investment in grey infrastructure and green-blue infrastructure (which includes nature-based solutions);
- Planning, including local and regional risk assessments and mapping, business case development, preparation of community focused regional coastal management programs; and
- Investment in monitoring infrastructure and activities to understand the coastal and estuarine zone over time.

For more information visit:

https://nema.gov.au/programs/emergency-response-fund/coastal-estuarine-risk-mitigation-program#Overview

3.7 Beneficiary (user) Pays

Beneficiary or 'User' Pays principles essentially dictate that the beneficiaries of adaptation options should pay for them. Mechanisms for fund raising may include:

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 Specified Area Rates – as described above and considering the findings of benefit distribution analysis (see chapter 4).

- Mechanisms for visitors to the town, as user of the coastline, to contribute. This could be in the form of a levy applied to their accommodation, or paid parking at key tourist sites.
- Developer contributions where specific developments benefit from their coastal location.

The next chapter provides recommendations on options for methods and proportions by which the Town could fund coastal works from direct beneficiaries.

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4 BENEFIT DISTRIBUTION ANALYSIS

4.1 Analysis Approach

A Benefit Distribution Analysis (BDA) was undertaken to assess the potential benefits and beneficiaries of implementing coastal protection. An assessment of the resultant relative distribution of benefits between stakeholders has been determined. The BDA provides an insight into how costs could be apportioned through the beneficiary pays principle in accordance with SPP2.6. This will provide an avenue to ensure that funding arrangements reflect the benefits derived from such actions, minimise subsidies, and avoid additional burden on local ratepayers.

A geographic analysis is undertaken to assess private versus public land area protected for the different management units at different years. This approach has the following features:

- Considers the land parcels projected to be impacted by erosion in 2123 holistically.
- Does not consider the sequencing of the projected erosion of individual assets such as the presence of Town land/assets between the ocean and private property. The proximity of private property to erosion has historically driven urgent decision making in many WA coastal locations.
- Is not reliant on competing economic valuation methods which are often lacking for social, and environmental assets.
- Does not include other considerations of economic valuation notional market property values, improved values, other infrastructure value, use and non-use values, avoided travel related costs (e.g., traffic detours because of road closures), avoided clean-up costs from storm damage, avoided amenity impacts on foreshore reserve. This results in a much more transparent method. This is especially important when much of the economic values are estimates based on many layers of assumptions, thus potentially leading to inaccurate or meaningless results; and disputes between beneficiaries.
- Assumes that for any land parcel the 2123 erosion hazard line is touching then the whole land parcel is assumed impacted and included in the calculations. Storm erosion typically undermines the structural footing of an asset rendering it unsafe and unsuitable for further habitation or use. For this reason, the full value of an asset is assumed to be lost when the erosion hazard line reaches the footprint of an asset or property because for functional purposes it will be.

Given the size of the study area and the accuracy of the erosion modelling used, we consider this method is suitable for the purposes of BDA.

4.2 BDA Method

The following steps summarise the BDA methodology undertaken for the Geographic Analysis:

- Use erosion hazard assessment mapping outputs from Cardno (2023) (Horizontal Setback Datum, and nominal erosion projections for 2023, 2048, 2073 and 2123) to identify impacted land parcels within each erosion hazard area between the Horizontal Setback Datum and each nominal erosion hazard line.
- 2. Create a database of the affected areas for each of the seven categories used for CBA.
- 3. Group the seven categories into the following overarching categories:
 - a. Private land (Residential property and Commercial property)
 - b. Public land (Developed Foreshore Reserve, Roads, Public and Community, Environmental, Heritage)
- 4. Define the proportionate beneficiaries as the relative areas of private and public land protected as a percentage comparison for each erosion hazard timeframe, for each Management Unit.

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4.3 BDA Results

The areas of land for each category protected by implementation of a coastal erosion protection option are presented in Table 4-1.

Table 4-1 Affected Categories Areas (m2) Showing Affected Area for 2123 Erosion Hazard Zone for Each MU

Category	MU 1	MU 2
Commercial property	12,685	0
Residential property	44,220	39,217
Developed Foreshore Reserve	82,523	63,660
Roads	46,463	52,239
Public and Community	10,792	23,089
Environmental	0	13,826
Heritage	33,513	32,569

The BDA area and percentage results are presented in Table 4-2.

Table 4-2 BDA Results for 2123 Erosion Hazard Zone

Management Unit	Private Area (m²)	Public Area (m²)	Private %	Public %
MU 1	56,905	173,292	25 %	75 %
MU 2	39,217	185,384	17 %	83 %

4.4 BDA Discussion

The method relies on interpretation of the land use maps received from the Town, which may no longer be current and require updating before any more detailed investigations can be undertaken.

4.4.1 Limitations

The geographic BDA method provides a snapshot of the relative areas of private and public land projected to be impacted by erosion between the 2023 HSD and 2123 erosion hazard lines. As the HSD moves because of erosion and accretion, the areas will change over time. Similarly, if the erosion hazard line is recalculated, the areas will change. Changes in individual management units may vary, but because of the large amount of public land present as foreshore reserve, with projected future erosion, and migration of the HSD inland, the area of public land on the landward side of the HSD is considered likely to decrease over time. This would result in a decrease of the public percentage and corresponding increase in the private percentage. Land at the back of the management units may become "newly vulnerable" to erosion, but generally that land is a mixture of private and public compared to the existing foreshore.

4.4.2 Utilisation of BDA Findings

Based on the findings presented above it is reasonable for the Town to consider future scenarios where the private landholders benefiting from a protection option pay in the order of 25% and 17% of the cost for MU 1 and MU 2 respectively. This analysis has detailed several assumptions and limitations which should be considered in further detail, and issues of intergenerational and geographical equity also need to be considered in subsequent analysis. If beneficiaries are to financially contribute, the mechanism must be fair and reasonable across current and future landholders and consideration of intangible community benefits needs further discussion. Protection of a section of coast may allow for additional community benefits that could not

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be adequately quantified in this analysis, such as opportunities for improved social/tourism amenities for the broader Cottesloe community to enjoy (represented by the Town) and potentially many other Western Australians and visitors (represented by state government departments). Additional beneficiary pays considerations, not included in the above BDA analysis, should be considered such as for visitors to the town, as users of the coastline, to contribute in the form of a levy applied to their accommodation, or paid parking at key tourist sites. This could, in part, be realised by implementation of the CHRMAP recommendations, extension of the developed foreshore areas and the provision of increased amenity. Further investigations and decision-making around the concept of "beneficiary pays" needs to acknowledge these requirements.

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5 MONITORING AND REVIEW

Monitoring is essential to managing coastal hazards, tracking when coastal hazards reach trigger points, understanding the coastline evolution, capturing changes to vulnerabilities, and measuring the success of coastal management actions.

Coastal monitoring will inform the short-term implementation phase and increase the knowledge base for subsequent CHRMAP revisions and targeted investigations. Monitoring and review tasks include:

- Review of existing coastal monitoring programs,
- Review of coastal hazard projects outlined in erosion hazard assessment,
- Recommend coastal monitoring activities to identify trigger points, to record dilapidation, to record when trigger points occur and to include indicative costs of monitoring works,
- Recommend Trigger points, and
- Recommend CHRMAP review.

5.1 Review of Existing Coastal Monitoring

The following coastal monitoring activities are currently undertaken in the study area and should be continued:

- Six monthly beach profile surveys at forty locations along the entire extent of the Town's shoreline, extending from the top of primary dune or fixed infrastructure to the approximate depth of closure offshore.
- 2. Remote shoreline imagery collected every hour (during daylight hours) from, three vantage points.
- 3. Sporadic storm monitoring of Cottesloe main beach, including:
 - a. Additional beach profile surveys collected before and after storm events
 - Beach sediment samples collected for analysis of particle size distribution before and after storm events
 - c. Installation of an additional remote imagery camera for one of the winter storm monitoring periods
- 4. Shoreline vegetation movement analysis from aerial photos undertaken by DoT
- 5. Regional water level monitoring undertaken by DoT
- 6. Wave monitoring at Cottesloe and Rottnest Waverider Buoys undertaken by DoT
- 7. Bathymetric surveys commissioned DoT

5.2 Recommended Coastal Monitoring Activities

The monitoring activities described below are designed to identify the impacts of the recommended options and to record the evolution of the coastal trigger points.

Should any option be modified, or other coastal projects be undertaken (such as maritime, or recreation/tourism projects) where coastal hazard risk management is not the primary focus, they should be subject to the same CHRMAP principles and require their own monitoring program appropriate to their location, size and objectives.

Regular monitoring of the coastal management structures is recommended (Protection Structure Audit – NR2) – e.g., seawalls and groynes. These should be undertaken with consistent methodology to allow comparison between inspections. These can be commenced immediately, and the initial assessment would identify an appropriate review schedule for each structure, or if there is an issue with an asset. Such assessment would then be incorporated into the Town's existing asset management reporting systems.

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5.3 Trigger Points

The CHRMAP consider four types of trigger points, as follows:

- Proximity trigger: Where the most landward part of the Horizontal Shoreline Datum (HSD) is within the Storm Erosion Allowance of the most seaward point of a public asset of interest or private property lot boundary. Due to the high value of the foreshore reserve, the foreshore reserve may be considered to be "the most seaward point". If individual assets have a specific distance-based trigger relating to the HSD then the beach and dune survey activities described above should be used to collect topographic data that can be used to map the updated HSD position.
- Access trigger: Where a public road is considered no longer available or able to provide legal access to the property.
- Utilities trigger: When water, sewage, communications or electricity to the lot is no longer available as
 they have been removed/decommissioned by the relevant authority due to coastal hazards.
- **Damage trigger**: Any property within the hazard zone and within a dedicated Special Control Area, that is damaged by a coastal hazard shall require LGA approval before being repaired. The review process should involve re-fit of minor or moderately damaged assets to accommodate coastal hazards in the future, or removal and redevelopment outside the hazard zone for damaged assets.

This list follows a sequential / prioritisation order. That is, a "proximity trigger" is recommended over a "damage trigger".

5.4 CHRMAP Review

This CHRMAP should be updated every 5 to 10 years to maintain currency and should be a "living document". An earlier review should be considered when the following event occurs:

- Substantial storm events generating severe coastal hazards approaching or exceeding the CHRMAP projections.
- Significant changes to land-use planning such as complex amendments to, or full review of, the Local Planning Scheme.
- New information becomes available which substantially affects the summary of local community values and assets (natural or built). This may typically occur when consulting the community regarding other documents such as the Local Planning Scheme or Foreshore Management Plan, or the occurrence of a significant storm event.
- Hazard modelling for the study area should be updated given any of the following:
 - recent data collection,
 - planning changes,
 - updates in climate change science, specifically local sea level rise projections,
 - coastal engineering methodology,
 - changes to the CHRMAP success criteria by coastal land managers, or
 - triggers are reached.

Ongoing coastal management operations within the study area should consider the status of both short and long-term adaptation strategy progress, including assessment of the performance and review of any identified strategies.

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Monitoring of CHRMAP outcomes, actions and future updates should always include consultation with stakeholders and the community to make sure any changes are communicated, and that the stakeholders' positions are reflected in the coastal management outcomes.

5.5 Surf Life Saving Clubs

Throughout the engagement activities undertaken during this CHRMAP project the important nature and role of the Cottesloe and North Cottesloe Surf Life Saving Clubs to the local and broader community has been clearly and repeatedly raised by community members.

SPP2.6 (WAPC, 2013) recognises that Surf Life Saving Clubs and their facilities may need to occur within an area identified to be potentially impacted by physical coastal processes within the 100 year planning timeframe. SPP2.6 requires they be considered within a CHRMAP framework, identified in a strategic plan and co-located with other public recreation and coastal node facilities. Any proposed development will be assessed on a case-by-case basis against the SPP2.6 Policy Measures and in consultation with other relevant agencies and community.

5.5.1 North Cottesloe Surf Life Saving Club

The North Cottesloe Surf Life Saving Club is co-located with other public buildings some of which are leased for private commercial business such as cafes/restaurant. These buildings are projected to become directly vulnerable to coastal erosion around 2033. As such it is recommended that these facilities are investigated in more detail as a priority site for the Town. Should protection via beach nourishment be implemented by the Town for MU1 then these buildings will also be protected. Alternatively further investigations could consider an alternative location for these facilities or targeted protection measures.

5.5.2 Cottesloe Surf Life Saving Club

The Cottesloe Surf Life Saving Club is projected to become directly vulnerable to coastal erosion around 2073, but only if no active management occurs to the section of coast immediately north of the Cottesloe groyne. As such it is recommended that these facilities are investigated in more detail after key decision making occurs for MU1. If protection is implemented, then the Club facilities will also be protected. It is recommended that the section of coast immediately north of the Cottesloe groyne are investigated in more detail as a priority site for the Town, following confirmation of the condition and remaining design life of the relevant coastal protection structures.

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6 IMPLEMENTATION

The coastal adaptation pathway includes short-term, medium-term and long-term actions. Short-term actions are anticipated to be implemented within the next 25 years; medium-term actions implementation would occur between 25-50 years; while long-term actions would be implemented beyond 50 years towards 100 years' time.

Detailed implementation plans for MU1 and MU2 are presented in Table 6-1 and Table 6-2.

6.1 Short-Term Implementation

Short-term coastal management actions (i.e., "options"), for each Management Unit were designed to be compatible with medium and long-term adaptation actions and include the following information:

- Recommended risk treatment option(s),
- Responsibility,
- Trigger,
- Cost,
- Potential funding source(s), and
- Timeframe.

6.1.1 Key Assumptions

The timeframes envisaged in the coastal adaptation pathways are not absolute. These timeframes are related to the current state of local land planning, coastal processes knowledge and climate projections, as outlined in the CHRMAP. Therefore, the timeframes are typically not aligned on "worst-case" scenarios but instead consider risk-adjusted and/or consensus-based adjustments and quantifications. Other options may be envisaged, particularly if land planning practices, coastal processes knowledge or climate projections are changed. Therefore, the implementation pathway will evolve overtime.

The options have been selected based on information gathered through all the previous CHRMAP project stages. Although the Multi-Criteria Analysis and Cost Benefit Analysis have been key gateway decision points for selecting many options. The preparation of the MCA and CBA required interpretation and approximations, particularly regarding the criteria and cost quantifications, and have limitations. Also, the proposed options have been developed only at a conceptual level to draw comparisons between several options.

The CHRMAP proposed options should be the subject of further investigations, surveys, policy review, environmental impact investigation, development approval and authorities' endorsement, local stakeholder and community engagement, preliminary design, detailed design, costing and any other applicable preparation work required prior to be implemented. The options should be optimised and modified following such additional investigations.

An example of this could be changes to Management Unit boundaries, to address priority areas and optimise option effectiveness and to reduce costs. It may also be practical to develop a staged implementation approach to some of these management actions to test their effectiveness and to refine design of subsequent stages (e.g. staged installation of works). It is recommended that further work is undertaken to identify priority sections of MU's and consider the use of composite treatment options in these MU's. This may see some sections of the current MU's being managed in different ways rather than one option for each MU. Appropriate supporting analysis is needed to propose preferred treatment options on smaller sections of coastline than the MU's presented in this CHRMAP as the cost benefit analysis has considered these boundary extents and quantities.

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It is anticipated the current MU's could be further split based on the projected hazard extents and predominant foreshore use.

6.1.2 Further Investigations

Information gaps identified in the CHRMAP should be addressed early. Some of these gaps can be closed by the collection of data, as discussed previously in Section 5.1 and 5.2. Other information gaps can be closed during the preliminary and/or detailed design phase when specific or detailed analysis of available data, information, modelling, and projections are carried out.

The following investigations are recommended:

- 1. Preparation of an Asset Management Plan to identify existing infrastructure and recreational facilities in the coastal erosion hazard zone and provide direction to:
 - a. Progressively relocate non-critical assets (PMR2) away from the coastal hazard zone once they reach the end of asset life or replace assets with suitably durable and/or sacrificial infrastructure. This may include vulnerable recreational car parks; recreational amenities such as public ablutions; barbeque/picnic/shade areas; playground and other recreational equipment; and access structures such as ramps, stairs and paths and fences, etc.
 - b. Plan for the relocation of critical service infrastructure outside of the coastal hazard zone once they reach the end of asset life, or at a minimum, modify the service infrastructure asset so that it does not run parallel to the coastline where possible and can be progressively removed when exposed to intolerable risk levels.
- Investigate opportunities for leaseback of land and land swaps in the context of planned and managed retreat. Seek legal advice regarding the basis of agreements with landholders and whether opt-ins can be time constrained.
- 3. Investigate opportunities for demarcating Special Control Areas, and for introducing development restrictions.
- 4. Sand source feasibility study Both MU's have recommended sand nourishment as the preferred option. The availability of suitable sand for beach nourishment works is unfortunately not well understood in the study area. It is recommended that a sand source feasibility study is undertaken to determine the capacity and cost of local sand supplies. This study should consider both land-based and marine sand sources as well as evaluate potential environmental impacts and approvals required. Cost estimates used in this CHRMAP have assumed that a reliable source of sand in reasonable proximity to the study area may be available. If this assumption is incorrect, costs may increase and affect the CHRMAP recommendations.
- 5. More detailed investigation of coastal hazards and the feasibility of treatment options at priority locations such as the North Cottesloe Surf Life Saving Club and the section of coast immediately north of the Cottesloe groyne. Targeted CBA and BDA analysis should be undertaken for prioritised sections of coast following the collection of suitable data and information.
- Foreshore Management Plans (FMPs) Updated foreshore management plans for the study area may increase the protective capacity of the natural dune system. Foreshore management plans should address:
 - The requirements of SPP2.6 and its supporting documentation.
 - b. The findings of this CHRMAP noting protection via sand nourishment has been recommended. Focus should be given to protection of the coastal foreshore reserves, and the existing land use and development east of Marine Parade.
 - Potential environmental issues such as biodiversity and environmental impacts and detail a weed management strategy for the coastline.

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- d. Incorporate findings of Asset Management Plans as appropriate.
- e. Include review of existing beach access points, ensuring appropriately fenced and signed paths, and signage for dune repair.
- f. Develop an education strategy for coastal and environmental management. The strategy should work to inform the community about the CHRMAP and FMP and their findings and use suitable engagement methods such as infographics and FAQ's. The education strategy should also include appropriate on-ground signage and information for beach access.
- g. Monitor impacts of general beach access on nesting habitats and migratory bird species in dune areas.

6.2 Medium and Long-Term Implementation

Medium (25-50 years) and long-term (50-100 years) implementation provides a strategic consideration of how the Town will adapt to long-term climate change impacts. Therefore, medium- and long-term implementation are not described in detail in the CHRMAP. Longer-term responses include:

- Continuing to action the revised planning instruments implemented in the short-term.
- Providing temporary/interim hazard protection may also become more costly and a change in adaptation pathway could be required. For example, as sea level rise progresses, it is possible that options using sand or rock resources to protect assets near the coast may become economically unsustainable.
- Implementing planned managed retreat if protection is found not to be feasible.

Long-term adaptation strategies/pathways have been recommended for each MU for erosion that will allow for the continuous function of local communities whilst accommodating the increasing burden of coastal hazards. The long-term strategy informs future planning instruments, supports monitoring, recommends planning reviews and underpins collaboration between coastal land managers, stakeholders and the community.

The two primary coastal management actions for mitigating erosion hazards at Town of Cottesloe are:

- Planned / Managed retreat (PMR4 Voluntary Acquisition): Use the planning instruments and long-term plan to systematically move assets with low adaptive capacity out of the hazard zone.
- Protect (PR1 Beach Renourishment): Undertake works as necessary to prevent erosion to assets. This is anticipated as relatively small scale works to maintain approximately the same level of beach and foreshore amenity currently experienced. If significant storm damage occurs or pre-emptive works are preferred larger scale works with additional foreshore vegetation rehabilitation could occur. If more frequent management works are undertaken the sandy beach could be rebuilt as required with small beach width amounts and volumes.

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6.3 Detailed Implementation Plan

Detailed Implementation Plans for MU 1 and MU 2 are presented in Table 6-1 and Table 6-2 respectively with recommendations listed in priority order.

Table 6-1 MU 1 (North of Cottesloe Groyne, including Groyne to the North end of Town's Jurisdiction) Recommendations in Priority Order

Recommendation	Notes	Responsibility	Trigger	Cost	Funding	2024-2025	2025- 2049	2049- 2074	2074-2124
INVESTIGATION 1 Update Foreshore Management Plans (FMPs)	 Prepare an updated Foreshore Management Plan (FMP) An updated FMP could help increase the protective capacity of the natural foreshore dune system. Updates should address the requirements of SPP2.6 and incorporate the findings of this CHRMAP Increased protective capacity by better management of beach and dune ensures better erosion resilience. 	■ LGA	■ Completed CHRMAP	 \$30,000 Assumes only undertaken for this MU in isolation, but synergies should be investigated. 	OperationalGrants	х	х	х	х
INVESTIGATION 2 Detailed investigation of coastal hazards and feasibility of treatment options at priority locations such as North Cottesloe Surf Life Saving Club, coast immediately north of Cottesloe groyne	Site specific details of coastal hazards could help increase the protective capacity of the assets.	■ LGA	■ Completed CHRMAP	• \$30,000 ·	OperationalGrants	х	х	х	х
INVESTIGATION 3 Sand Source Feasibility Study	 Determine the capacity and cost of local sand supplies, including both land-based and marine sources. Likely requires repetition over Mediumterm. 	■ LGA	■ Completed CHRMAP	\$75,000 Assumes one sand source study for both MUs, hence half of the price mentioned here.	OperationalGrants	х	х		
Monitoring (NR1)	 Bathymetric survey to monitor nearshore zone approximately every 5 years. Six monthly beach profile surveys along the entire extent of the Town's shoreline, extending from the top of primary dune or fixed infrastructure to the approximate depth of closure offshore. 	LGACan seek support and assistance from DoT	()	■ \$10,000 annually	OperationalGrants	х	х	х	х
Notification on title (NR3)	Item cost for investigations and implementation plans.	LGACan seek support and assistance from DPLH, WALGA	 	\$50,000(Plus 1% annual maintenance of \$500)	OperationalGrants	х	х		
Protection Structure Audit (NR2)	 Item cost to inspect coastal asset condition, influence on sediment transport and remaining design life on all coastal management structures. Includes rubble mound rock groynes at Beach Street and Cottesloe Beach, seawalls at Cottesloe Beach. 	■ LGA	■ Completed CHRMAP	\$30,000(Plus 2% annual maintenance of \$3,000)	OperationalGrants	х	х	х	х

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Recommendation	Notes	Responsibility	Trigger	Cost	Funding	2024-2025	2025- 2049	2049- 2074	2074-2124
Demolition / removal / relocation of asset from inside hazard area (PMR2)	 Preparation of Asset Management Plan to 2048 for public-built assets. Maintenance assumes ongoing allowance for foreshore reserve. Removal / Relocation of assets as required. 		 Audit of assets within 2048 erosion hazard zone and identification of assets where damage would be unacceptable 	 \$1,600,000 (Plus 1% annual maintenance of \$16,000) 	OperationalGrants	х	х		
Prevention of further development / prohibit expansion of existing use rights (PMR3)	 Item cost for investigations and management plans. Investigate opportunities for leaseback of land and land swaps in the context of planned and managed retreat. Seek legal advice regarding the basis of agreements with landholders and whether opt-ins can be time constrained. 		■ Completed CHRMAP	\$30,000(Plus 1% annual maintenance of \$300)	OperationalGrants	х	х		
Leaving assets unprotected (PMR1)	 To 2048 for low-value public assets. Assumes a clean-up rate following damage/loss. No private land acquisition included. Maintenance assumes ongoing allowance for foreshore reserve. 	■ LGA	Storm damage Audit of assets within 2048 erosion hazard zone and identification of assets where damage would be unacceptable	\$65,000(Plus 3% annual maintenance of \$1,950)	Operational	х	х	х	
Recommended Medium Term option to address Erosion is Protection with Beach Nourishment (PR1)	 Assumes suitable sand source available (grain size, volume, cleanliness, proximity). 2073 implementation is allowed for, so there are no priority actions in short-term. 		MonitoringUpdated CHRMAP	 Approximate capital cost of \$19.14M at NPV 4% Annual maintenance estimate of approximately \$0.2M 	OperationalGrantsDirect beneficiaries			х	X

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Table 6-2 MU 2 (South of Cottesloe Groyne to the South end of Town's Jurisdiction) Recommendations in Priority Order

Recommendation	Notes	Responsibility	Trigger	Cost	Funding	2024-2025	2025- 2049	2049- 2074	2074-2124
INVESTIGATION 1 Update Foreshore Management Plans (FMPs)	 Prepare an updated Foreshore Management Plan (FMP). An updated FMP could help increase the protective capacity of the natural foreshore dune system. Updates should address the requirements of SPP2.6 and incorporate the findings of this CHRMAP. 	■ LGA	■ Completed CHRMAP	 \$30,000 Assumes only undertaken for this MU in isolation, but synergies should be investigated. 	OperationalGrants	х	х	x	х
INVESTIGATION 2 Sand Source Feasibility Study	 Determine the capacity and cost of local sand supplies, including both land-based and marine sources Likely requires repetition over Medium-term. 	■ LGA	■ Completed CHRMAP	 \$75,000 Assumes one sand source study for both MUs, hence half of the price mentioned here. 	OperationalGrants	X	х		
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	Item cost for investigations and management plans.	■ LGA	■ Completed CHRMAP	\$50,000	Operational	х	х		
Monitoring (NR1)	 Bathymetric survey to monitor foreshore dune banks, approximately every 5 years. Six monthly beach profile surveys along the entire extent of the Town's shoreline, extending from the top of primary dune or fixed infrastructure to the approximate depth of closure offshore. 	LGACan seek support and assistance from DoT	Completed CHRMAPSevere storm event(s)	■ \$10,000 annually	OperationalGrants	х	X	X	х
Notification on title (NR3)	Item cost for investigations and implementation plans.	 LGA Can seek support and assistance from DPLH, WALGA 	■ Completed CHRMAP	\$50,000(Plus 1% annual maintenance of \$500)	OperationalGrants	х	х		
Protection Structure Audit (NR2)	 Item cost to inspect coastal asset condition, influence on sediment transport and remaining design life on all coastal management structures. Includes rubble mound rock groynes at Beach Street and Cottesloe Beach, seawalls at Cottesloe Beach. 	■ LGA,	■ Completed CHRMAP	■ Included in MU1	OperationalGrants	х	X	x	х
Demolition / removal / relocation of asset from inside hazard area (PMR2)	 Preparation of Asset Management Plan to 2048 for public-built assets. Maintenance assumes ongoing allowance for foreshore reserve. Removal / Relocation of assets as required. 	■ LGA	 Audit of assets within 2048 erosion hazard zone and identification of assets where damage would be unacceptable 	\$1,600,000(Plus 1% annual maintenance of \$16,000)	OperationalGrants	х	х		

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Recommendation	Notes	Responsibility	Trigger	Cost	Funding	2024-2025	2025- 2049	2049- 2074	2074-2124
Prevention of further development / prohibit expansion of existing use rights (PMR3)	 Item cost for investigations and management plans. Investigate opportunities for leaseback of land and land swaps in the context of planned and managed retreat. Seek legal advice regarding the basis of agreements with landholders and whether opt-ins can be time constrained. 		■ Completed CHRMAP	\$30,000(Plus 1% annual maintenance of \$300)	OperationalGrants	х	х		
Leaving assets unprotected (PMR1)	 To 2048 for low-value public assets. Assumes a clean-up rate following damage/loss. No private land acquisition included. Maintenance assumes ongoing allowance for foreshore reserve. 		Storm damage Audit of assets within 2048 erosion hazard zone and identification of assets where damage would be unacceptable	maintenance of \$1,950)	Operational	х	х	х	
Recommended Short Term option to address Erosion is Protection with Beach Nourishment (PR1)	 Assumes suitable sand source available (grain size, volume, cleanliness, proximity) 2047 implementation is allowed for, so there are no priority actions in short-term 		MonitoringUpdated CHRMAP	 Approximate capital cost of \$8.45M at NPV 4% Annual maintenance estimate of approximately \$0.2M 	OperationalGrantsDirect beneficiaries		х	х	х

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7 SUMMARY AND NEXT STEPS

In this report, one or more options have been recommended to proceed for further investigation and/or implementation for each MU for erosion. The recommendations have considered the CBA results holistically as well as being cognisant of the findings of previous stages of the CHRMAP.

The next stage for the project is to complete the CHRMAP summary report which will incorporate the findings of all the previous chapter reports including this one.

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APPENDIX A PLANNING MEASURES AND IMPLEMENTATION





Town of Cottesloe CHRMAP

Planning Measures and Implementation

March 2024

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			Name	Name			
1	17/08/23	Draft 1	Dylan Wray	Matt Raymond			
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Planning Measures

Statutory Planning Mechanisms

The previous review of the existing planning controls concluded that a local planning scheme amendment to introduce a Special Control Area (SCA) is considered the most appropriate statutory planning mechanism to holistically address coastal hazards within the Town of Cottesloe (the Town). The following section provides a summary of recommendations for the Town to update its current planning framework to effectively manage the coastal hazard risks identified in the CHRMAP.

The recommended planning mechanisms only apply to land zoned or reserved under the Town's Local Planning Scheme No. 3 (LPS 3) which has been identified as being subject to erosion over the 100-year planning timeframe. Inundation has not been considered in the planning response given the areas prone to coastal flooding are limited to the foreshore reserve which is not zoned or reserved under the Town's LPS 3. Should this change, future iterations of this CHRMAP will need to consider an appropriate planning response for both erosion and inundation.

Development within the foreshore reserve which is reserved for Parks and Recreation under the Metropolitan Region Scheme (MRS) will continue to be determined by the WAPC, taking into consideration the objectives and provisions under the MRS.

The roles and responsibilities for the subdivision and development of land within the project area is outlined in the table below.

Application Type	Subdivision Application	Development Application – MRS Reserved Land	Development Application – LPS 3 Zoned or Reserved Land
Definition	Subdivision of all land within the Town. Development proposed on land that is zoned or reserved under the MRS.		Development proposed on land that is zoned or reserved under the Town's Local Planning Scheme.
Assessing Body	Local Government and WAPC	Local Government and WAPC	Local Government
Approval Body	WAPC	WAPC	Local Government, Development Assessment Panel or WAPC.

The recommendations have been prepared in accordance with the CHRMAP Guidelines and the draft Planned or Managed Retreat Guidelines which provide guidance on planning risk treatment options across the risk management and adaptation hierarchy.

Avoid

The best form of risk management is to eliminate hazards, activities and exposures that can adversely affect an asset. Accordingly, the primary planning response shall be to avoid further intensification of development through rezoning or subdivision of properties at risk of erosion.

It is acknowledged that it may not be practically possible to completely avoid development on private land that has already been appropriately zoned under the Town's LPS 3. In these instances, alternative adaptation options will need to be considered.

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Managed Retreat

The draft Planned or Managed Retreat Guidelines provide direction on how to effectively implement a policy of managed retreat for locations that have been identified as being vulnerable to coastal processes through the CHRMAP. The managed retreat process involves the introduction of mechanisms to reduce or prevent the ongoing use of private land at risk of erosion.

The first step involves changing the local planning framework to enable the mechanisms for managed retreat to be applied. The second step, once it has been determined that private use of the land should cease, contemplates the transfer of affected land from private to public ownership.

The CHRMAP Guidelines and draft Planned or Managed Retreat Guidelines provides a framework for triggering the voluntary or compulsory acquisition of private land affected by coastal erosion where the public foreshore can no longer provide a natural barrier or where physical protection measures are no longer provided. The options to acquire private land zoned under LPS include:

- Taking of land by agreement under the Land Administration Act 1997; or
- Compulsory taking with the assistance of the Minister for Lands for a 'public work' under the Land Administration Act 1997.

The acquisition processes recommended in the CHRMAP Guidelines supports compensation paid to property owners. However, there is no obligation to adopt a policy that effectively forces the Town to compensate property owners. In addition, there is no legal responsibility for the Town to provide protection of a private property from natural hazards, nor compensate property owners where the land is lost to erosion. Accordingly, the Town will need to determine the most appropriate mechanism available for the taking of land and identify potential funding streams, actions, responsibilities and implementation for the acquisition of vulnerable properties.

Once at-risk properties have been acquired, all structures and assets shall be removed, and the land reserved for 'Parks and Recreation' under Metropolitan Region Scheme (MRS). This will enable expansion of the foreshore reserve, maintaining a natural barrier to coastal processes.

Accommodate

The accommodate risk treatment option aims to utilise design and management strategies to reduce the risk to an acceptable level, allowing for the continued use of land until it has been determined that private use of the land should cease. The accommodate risk treatment option will be enacted through provisions within LPS 3 under an SCA and the adoption of a CHRMAP Local Planning Policy which provides specific design requirements for development in vulnerable areas.

Protect

The protect risk treatment option refers to physical protection measures such as seawalls, groynes, offshore breakwaters, artificial headlands, beach nourishment and the likes. It is assumed that the existing structures along the Cottesloe foreshore will continue to provide ongoing protection of public and private assets.

It would be impractical for the planning framework to require landowners to undertake protection measures as part of the decision-making process. However, should landowners propose protection works on private land as a means of accommodating assets, the Town will need to ensure the protection structures proposed as part of any future development do not cause undue impact on nearby properties and the general locality.

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Recommended Planning Controls

Local Planning Strategy

The Town is currently reviewing its Local Planning Strategy (the Strategy) which aims to guide the long-term land use planning direction for the Town. This CHRMAP will inform the Strategy and future revisions to guide sustainable land use planning and development along the Cottesloe coastline.

The Strategy shall reference the application of SPP 2.6 and consider the identified coastal hazards together with other relevant planning matters, including environmental, economic and social considerations, to holistically inform and shape future amendments to the Town's LPS 3. Areas at risk of erosion should not be identified in the Strategy for further intensification of development through rezoning or subdivision.

Structure Planning

Structure planning is considered the most effective mechanism where some degree of comprehensive redevelopment of land remains an option. The only area which is subject to erosion and contemplates the preparation of a structure plan is the Wearne Aged Care site at Lot 555 (No. 40) Marine Parade, Cottesloe. The Wearne Aged Care site is zoned 'Development' under LPS 3 which contemplates the preparation of a structure plan to guide future development and use of the site. However, it is acknowledged that a structure plan is unlikely to be prepared for the Wearne Aged Care site given Clause 4.1 of Local Planning Policy No. 2 overrides the requirement for a Structure Plan.

Should a structure plan be prepared for Wearne Aged Care site or any other sites within the coastal erosion zone, a provision must be included for SPP 2.6 requirements to be met through subsequent approval process, including subdivision and development applications.

Local Planning Scheme Amendment

In accordance with the CHRMAP Guidelines, the Town shall initiate an amendment to LPS 3 to include the following:

- Insert Special Control Area 3 Land Subject to Coastal Erosion (SCA 3) under Part 6;
- Update Clause 10.2.2 (f) to include coastal erosion under Part 10; and
- Update the Scheme Maps to include SCA 3 which shall reflect zoned properties located shoreward of the 2123 erosion line.

The Town shall include the recommendations of this CHRMAP as part of next scheduled scheme review. The Town can defer implementation of certain recommendations given there is no immediate risk of erosion to properties zoned under LPS 3. At a minimum, the Town will need to update the local planning framework once it has been identified that zoned properties are seaward of the 50-year erosion hazard line. This will be identified through updated hazard modelling through future iterations of this CHRMAP.

Special Control Area

The introduction of an SCA over zoned land affected by erosion over the 100-year planning period will provide the most effective response to the identified coastal hazards. The SCA will stipulate provisions to respond to the hazards identified in this CHRMAP, including the trigger for normally exempt development to require development approval.

It is noted that some forms of development cannot be controlled by the SCA, such as works carried out by the State Government under the Public Works Act 1902 or development within the Parks and Recreation Reserve. The Town should liaise with the State regarding such development to ensure it is compatible with the outcomes of this CHRMAP.

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Special Control Area 3 - Land Subject to Coastal Erosion

- 1. The objectives of this special control area are to
 - a) To provide guidance for land use and development within areas subject to erosion.
 - b) To identify land within Town of Cottesloe at risk of erosion by 2123.
 - c) To ensure land along the foreshore is continuously available for foreshore management, public access, recreation and conservation purposes.
 - d) To ensure public health and safety and reduce risk associated with erosion.
 - e) To avoid inappropriate land use and development of land at risk of erosion.
 - f) To ensure land use and development does not accelerate coastal processes or have a detrimental impact on the functions of public reserves.
 - g) To protect new development from the impacts of erosion.
 - h) To ensure coastal process considerations are taken into account in preparing strategic planning proposals and in assessing subdivision and development applications.
- 2. The following provisions are applicable to Special Control Area 3 (SCA 3):
 - Notwithstanding any other provision of the Scheme, all proposed development within SCA 3 requires the approval of the local government.
 - b) In considering any application for development approval, or its advice in relation to proposed structure plans or subdivision applications for subdivision for land within SCA 3, the local government is to have particular regard to:
 - i. The Town of Cottesloe Coastal Hazard and Risk Management Adaptation Plan.
 - ii. State Planning Policy 2.6 State Coastal Planning Policy.
 - iii. The Coastal Local Planning Policy.
 - c) An application for development approval for development proposed within SCA 3 may be referred to any statutory, public or planning authority for advice and recommendations before being considered by the local government.
 - d) Where the local government decides to approve an application for development approval it may impose a condition to require the registration of a notification under section 70A of the Transfer of Land Act 1893 on the Certificate of Title of the subject land at the cost of the landowner advising that the lot is located in an area likely to be subject to coastal erosion over the next 100 years.
 - e) Where subdivision applications are received within SCA 3, the local government may recommend that the Commission requires a notification under section 165 of the Act to be placed on the Certificate(s) of Title of the subject land, at the cost of the landowner advising that the lot(s) is located in an area likely to be subject to coastal erosion over the next 100 years.

Coastal Local Planning Policy

Following the introduction of SCA 3 into the LPS 3, the Town shall prepare and adopt a Coastal Local Planning Policy in accordance with Schedule 2 of the Planning and Development (Local Planning Schemes) Regulations 2015. It is recommended that the Coastal Local Planning Policy includes the following provisions which may be subject to further refinement by the Town following the completion of this CHRMAP.

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1. Policy Application

This policy applies to all land within Special Control Area 3 (SCA 3), which is that land identified as being subject to coastal erosion. The policy applies to all strategic planning, subdivision and development proposals for land within SCA 3.

2. Policy Objectives

- 1. To identify land within the Town of Cottesloe at risk of erosion by 2123.
- 2. To ensure land along the foreshore is continuously available for foreshore management, public access, recreation and conservation purposes.
- 3. To ensure public health and safety and reduce risk associated with erosion.
- 4. To avoid inappropriate land use and development of land at risk of erosion.
- 5. To protect new development from the impacts of erosion.
- To ensure coastal process considerations are taken into account in preparing strategic planning proposals and in assessing subdivision and development applications.

3. Definitions

<u>Average Recurrence Interval (ARI)</u> means how likely an event is to occur. For example, a 100-year ARI event is an event that occurs or is exceeded on average once every 100 years.

CHRMAP means the Town of Cottesloe Coastal Hazard Risk Management and Adaptation Plan.

<u>Coastal</u> means the area of water and land that may be influenced by coastal processes, including the tidal reaches of inland waters.

<u>Coastal hazard</u> means the consequence of coastal processes that affect the environment and safety of people.

Coastal processes mean any action of natural forces on the coastal environment.

Erosion Hazard Line means mapped erosion lines identified within the CHRMAP.

Habitable Room has the same meaning given in State Planning Policy 7.3 Residential Design Codes.

<u>Horizontal Shoreline Datum (HSD)</u> means the active limit of the shoreline under storm activity, as defined in State Planning Policy 2.6 – State Coastal Planning Policy.

Net Lettable Area has the same meaning given in the Planning and Development (Local Planning Schemes) Regulations 2015.

<u>Permanent Development</u> means development that is not time or event limited as determined by the Town.

SCA 3 means Special Control Area 3 – Land Subject to Coastal Erosion as defined on the Scheme Maps.

<u>Scheme</u> means the Town of Cottesloe Local Planning Scheme No. 3 or any subsequent local planning scheme endorsed by the Minister for Planning.

SPP 2.6 means State Planning Policy 2.6 Coastal Planning Policy.

<u>Strategic Planning Proposals</u> means a Local Planning Strategy, Local Planning Scheme, amendment to a Local Planning Scheme, Local Structure Plan or Local Development Plan.

Trigger event means one or more of the following events:

the HSD adjacent to a development is within 40m of the most seaward extent of a development;
 or

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public road access to a property is no longer available or able to provide legal access to the property; or

3. water, sewerage or electricity to the property is no longer available.

4. Requirement for Development Approval

Notwithstanding any other provision in the Scheme, development approval is required prior to commencing or carrying out any works or use of land within SCA 3, unless specified as exempt development in this Policy.

Where development approval is required, applications will need to clearly demonstrate that the proposed development meets the objectives and requirements of this Policy and any other relevant requirements of the Town's planning framework.

5. Exempted Development

Notwithstanding the land being located within SCA 3, unless otherwise required by the Scheme, the provisions of this Policy do not apply to:

- Alterations and additions to a habitable room of an existing residential building or net lettable area
 of commercial, retail or community building which does not exceed 50m2 cumulatively from the
 date of adoption of this Policy; or
- 2. A change of use that does not intensify development or use of the land.

6. General Requirements

Coastal hazards must be considered in preparing strategic proposals and when making statutory planning decisions in order to avoid increasing the impacts of coastal processes on inappropriately located development.

Notwithstanding the requirements of this Policy, the Town may exercise discretion in its consideration of proposals where a site-specific coastal hazard assessment is prepared in accordance with SPP 2.6 to demonstrate the suitability of the proposal.

7. Strategic Planning Proposals

Strategic planning proposals for land on the seaward side of the 2123 Erosion Hazard Line should not provide for more intensive development or use of this land.

Strategic planning proposals for land on the seaward side of the 2123 Erosion Hazard Line must demonstrate how it is proposed to plan for and appropriately manage coastal hazards, including risk to public utility infrastructure servicing the land and roads which provide public access to the land.

Strategic planning proposals for land adjacent to the Swan River foreshore must include provision for a coastal foreshore reserve which is to be ceded free of cost to the Crown without payment of compensation. The coastal foreshore reserve width is to include a suitable allowance for coastal processes, in addition to sufficient land which is not vulnerable to coastal processes in order to provide for continued coastal foreshore management, public access, recreation, conservation and landscape amenity.

8. Subdivision Applications

- 1. There is a general presumption against further subdivision of properties on the seaward side of the 2123 Erosion Hazard Line, except where the application is for:
 - a) a purpose which will not create the potential for additional private development within the erosion hazard area; or

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 b) boundary realignment, rationalisation of landholdings or lots created for a foreshore reserve which will not create the potential for additional private development within the erosion hazard area.

and the subdivision is otherwise consistent with the Scheme and the Commission's general subdivision policies.

2. A notification pursuant to Section 165A of the Planning and Development Act 2005 is to be placed on the Certificate(s) of Title of the subject land, at the cost of the landowner, advising that the lot(s) are located in an area likely to be subject to coastal erosion within the period to 2123.

9. Development Applications

- 1. Development located seaward of the 2123 erosion hazard line will only be permitted provided:
 - a) the applicant demonstrates that the design life of the development is suitable for its location with regard to the erosion hazard lines contained within the CHRMAP and the development can be relocated or removed;
 - a condition is imposed limiting the term of the development approval and requiring the approved development to be removed and the land restored to its predevelopment condition to the satisfaction of the Town, upon a trigger event occurring; and
 - c) a condition is imposed requiring a notification to be placed on the certificate of title of the subject land pursuant to section 70A of the Transfer of Land Act 1893 to alert prospective purchasers of the limited term of the approval and the requirement to restore the land to its pre-development condition to the satisfaction of the Town, upon a trigger event occurring.
- 2. Wherever reasonably practicable to do so any new development is to be located on the least vulnerable portion of the land.
- 3. All development approvals will include a condition requiring a notification to be placed on the certificate of title of the subject land pursuant to section 70A of the Transfer of Land Act 1893 to alert prospective purchasers that the land is located within an area likely to be subject to coastal erosion within the period to 2123, except where the coastal hazard will be adequately addressed through the development works or is otherwise suitably addressed.

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Management Requirements

Model Conditions List

The Town shall include the following conditions and advice notes to the model conditions list which can then be applied to development applications within SCA 3, at the discretion of the Town.

Conditions:

- 1. The development approval shall cease to have effect and the development removed when:
 - a) The most landward part of the Horizontal Shoreline Datum is within the S1 distance of the most seaward part of the habitable buildings; or
 - b) A public road is no longer available or able to provide legal access to the property; or
 - c) Water, sewerage or electricity to the lot is no longer available due to coastal hazards.
- 2. A notification, pursuant to Section 70A of the Transfer of Land Act 1893 is to be placed on the Certificate of Title of the proposed development lot advising of the existence of a coastal hazard. The notification is to state as follows:

'Vulnerable coastal area - This lot is located in an area likely to be subject to erosion over the next 100 years and is subject to conditions of development approval which requires removal of development to pre-development conditions if the time limit specified on the development approval is reached or any one of the following events occurs:

- a) the most landward part of the Horizontal Shoreline Datum being within (insert number) meters of the most shoreward part of the habitable building;
- b) a public road no longer being available or able to provide legal access to the property;
- c) when water, sewerage or electricity to the lot is no longer available as they have been removed/decommissioned by the relevant authority due to coastal hazards.'

Advice Notes:

- The applicant is advised that the Horizontal Shoreline Datum means the active limit of the shoreline under storm activity, as defined in State Planning Policy 2.6 – State Coastal Planning Policy.
- 2. The applicant is advised that the distance between the Horizontal Shoreline Datum and the most seaward part of the habitable building is the S1 value, as defined in the CHRMAP.
- The landowner accepts the potential risk of costal hazards as identified in the Town of Cottesloe CHRMAP. It is recommended that the landowner undertakes ongoing monitoring and review of the coastal hazards with any reporting provided to the satisfaction of the Local Government.

Foreshore Management Plans

Foreshore management plans can provide a strategy to deliver the recommendations of this CHRMAP for foreshore reserves throughout the Town. Foreshore management plans can be a key tool for communication and engagement with the community as they include detailed planning for community places and facilities.

The Town should prepare a Cottesloe foreshore management plan, in conjunction with relevant stakeholders, to provide guidance for the ongoing management of foreshore reserves, monitoring of assets and the triggers for the managed retreat of public assets and infrastructure at risk of coastal erosion.

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Publicly Available Information

It is recommended that the erosion hazard data is included on the Town's publicly available mapping system. This will ensure staff and the community have access to information on any affected land and can be made aware of the presence of the coastal hazards.

Information on relevant coastal hazards and the implications for property, now and into the future, should also be made available to potential buyers upon making a land purchase enquiry.

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Implementation

Implementation Triggers

The following planning and management controls presented in Chapter 5: Risk Treatment should be implemented by the Town as soon as practicable given the erosion impacts identified in the CHRMAP.

Planning Controls	Description	Implementation Triggers
Structure Plans	Require proponents to include coastal adaptation and management provisions into structure plans.	The submission of a structure plan containing lots being affected by coastal erosion, as identified in the CHRMAP.
Scheme Amendment	Introduce SCA 3 into the Town's local planning scheme.	Next scheduled scheme review, or as deemed appropriate by the Town.
Coastal Local Planning Policy	Adoption of a local planning policy to guide future development within SCA 3.	Following the introduction of SCA 3 into the Town's local planning scheme.
Model Conditions List	Update model conditions list to include conditions relating to notifications on title and managed retreat.	Following the introduction of SCA 3 into the Town's local planning scheme and adoption of the Coastal Local Planning Policy.
Foreshore Management Plan	Strategy to guide the ongoing management of the Cottesloe foreshore reserve.	Following completion of this CHRMAP, when deemed appropriate by the Town.
Publicly Available Data	Update the Town's IntraMaps to include the erosion hazard lines.	Following completion of this CHRMAP.



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TOWN OF COTTESLOE



COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN (CHRMAP) STEERING COMMITTEE

ATTACHMENT

ITEM 8.1.1G: R07 SUMMARY





Town of Cottesloe CHRMAP

Summary Report

Town of Cottesloe

26 July 2024







Document Status

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ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.



Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- Seven circles representing each of the States and Territories in Australia where we do our work
- Blue dots between each circle representing the waterways that connect us
- The animals that rely on healthy waterways for their home
- Black and white dots representing all the different communities that we visit in our work
- Hands that are for the people we help on our journey

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EXECUTIVE SUMMARY

The Western Australian Planning Commission's "State Planning Policy No. 2.6: State Coastal Planning Policy" (WAPC, 2013, herein referred to as "SPP2.6") addresses climate change, sea level rise, increased coastal inundation and coastal erosion. SPP2.6 recommends that management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development vulnerable to coastal hazards. Specific CHRMAP Guidelines have been developed to assist this process (WAPC, 2019). Cottesloe has been identified as potentially exposed to erosion hazard. Therefore, this CHRMAP study aimed to investigate and plan for coastal hazards likely to affect Cottesloe.

This CHRMAP increases knowledge and understanding of coastal hazard risks and identifies risk management and adaptation measures for implementation. The outcomes will be used to inform local government policies, strategies and plans, including (but not limited to), planning strategies, community strategic plans, drainage strategies, asset management plans, and foreshore management plans. The project adhered to the WAPC (2019) guidelines with scope and deliverables consistent with their objectives and SPP2.6. In addition, the project has identified the strategic direction for coastal adaptation scenarios for the next 100 years (management time frame) and determined an implementation plan describing risk management measures to be undertaken to achieve this direction. Overall, this CHRMAP has developed flexible adaptation pathways for the region and will serve as a key reference for management, planning and policymaking for the short-term (0-25 years), medium-term (25-50 years), and long-term (100 years).

The study area shoreline was divided into two management units:

- MU1 North of Cottesloe Groyne (including Cottesloe Groyne) to the North end of the Town's Jurisdiction
- MU2 South of Cottesloe Groyne to the South end of the Town's Jurisdiction

A Coastal Hazard Assessment identified the coastal hazards in the study area that need to be considered in the CHRMAP. Hazard maps were produced defining the erosion and inundation extents for present day, 2033, 2048, 2073 and 2123. It is acknowledged that the hazard identification component of the present study was undertaken to provide a broad understanding of exposure that can support government planning at a regional level. The hazard identification may be superseded by future site-specific studies. Results derived from this study should not be over-interpreted at a micro-scale due to the assumptions applied and the limitations in resolution.

Following the Hazard Assessment, a Coastal Assets and Community Values Identification investigation was undertaken to identify the assets within the coastal hazard zone. All the assets in the coastal hazard zone were identified and classified into seven categories: Public and Community, Environmental, Residential, Developed Foreshore Reserve, Commercial, Roads, and Heritage. The quantity of each asset category by Management Unit, category and planning horizon are presented for each erosion hazard. Inundation has been shown to not impact on any assets in the study area.

Community and stakeholder involvement is a critical component of the CHRMAP process, as it defines what and how much value is placed on assets within the study area. Engagement outcomes have informed the adaptation planning process. A Community Values assessment was used to identify key values and concerns for the study area and generate success criteria for the project:

- Preserve and protect the Town's beaches and natural assets such as vegetation and dunes,
- Ensure the natural environment is protected and sustained in its current condition or an improved condition.
- Preserve the function and opportunity for all types of water-based activities,
- Preserve and accommodate the existing surf lifesaving clubs,
- Continue to provide public amenities at the coast, such as parks, restrooms parking and access paths,

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- Ensure that areas for community events and access to remain within the coastline,
- Minimise impacts on existing private property,
- Consider treatments for coastal areas that have current inundation and erosion issues,
- Develop solutions to coastal processes that are sustainable (financially, socially and built form),
- Revisit regularly with community and key stakeholders their values in relation to foreshore development.

A Vulnerability Analysis was undertaken to develop likelihood, consequence, level of risk, adaptive capacity and vulnerability ratings for the asset categories. All identified at-risk assets within the management units are presented for each of the planning horizons, for each hazard. Extreme vulnerability to erosion has been identified from the present day onwards in both MU1 and MU2.

Recommended adaptation options to manage the coastal erosion vulnerability are presented to give direction for future investigations and funding opportunities. The recommendations are preliminary as they are based on currently available information. The proposed options should be the subject of further investigations, surveys, policy review, impact investigations (environmental, visual and social), development approval and authorities' endorsement, local stakeholder and community engagement, preliminary design, detailed design, costing and any other applicable preparation work required prior to be implemented. The options should be optimised and modified following such additional investigations.

To address erosion along the Cottesloe coastline, a combination of Planned / Managed Retreat and Protection with Beach Renourishment has been shown to be the preferred approach as a result of this analysis.

A number of additional general investigations are recommended:

- Preparation of Asset Management Plans.
- Investigate opportunities for leaseback of land, land swaps and demarcating Special Control Areas in the context of planned and managed retreat.
- Sand source feasibility study.
- More detailed investigation of coastal hazards and options feasibility at priority locations such as the North Cottesloe Surf Life Saving Club and the section of coast immediately north of Cottesloe Groyne.
- Foreshore Management Plans (FMPs).

The CHRMAP is a strategic planning document that considers long timeframes. While the CHRMAP provides a rationale for coastal hazard management a substantial amount of preparatory work, detailed in the CHRMAP recommendations, is required before "on-the-ground implementation" can proceed.

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Appendix E Assessment of Risk Treatment Options Chapter Report

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CHRMAP implementation strategy.

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1 INTRODUCTION

1.1 Background

It is internationally recognised that the mean sea level has been rising globally since the nineteenth century and is predicted to rise at an increasing rate in the future (IPCC 2021). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary coastal flooding), storm erosion and long-term shoreline recession. State governments across Australia have introduced obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is potentially vulnerable to coastal hazards. Specific guidelines have been developed to assist in this process (WAPC, 2019).

SPP2.6 requires adequate risk management planning is undertaken where existing or proposed development is in an area at risk of being affected by coastal hazards over the 100-years planning timeframe. SPP2.6 and the CHRMAP Guidelines provide the risk assessment framework to be applied to identify risks that are intolerable to the community and other stakeholders such as local governments, Indigenous and cultural interests, and private enterprise. Risk management measures are then developed according to the risk management and adaptation hierarchy outlined in SPP2.6.

The study area for this CHRMAP is the entire shoreline within the Town's jurisdiction (see Figure 1-1). The study has been undertaken across two Management Units (MUs) being Management Unit 1 (North of Cottesloe Groyne, including the groyne) and Management Unit 2 (South of Cottesloe Groyne). The study area is shown in Figure 1-1, Figure 1-2, and Figure 1-3. The study area consists of various shoreline types and many coastal assets, involving multiple stakeholders:

- Physical controls rubble mound rock groynes at Beach Street and Cottesloe Beach; seawalls at Cottesloe Beach.
- Sandy pocket and "perched" beaches backed and underlain by rock shelves and adjacent narrow foreshore reserve.
- Presence of various rock features including shore-attached reef and rock outcrops and cliffs.
- Roads along the shoreline Curtin Avenue and Marine Parade.
- Two Surf Life Saving Clubs.
- Registered Aboriginal Heritage Site at Mudurup Rocks, south of the Cottesloe Surf Life Saving Club.
- Significant built infrastructure buildings, car parks, shore-parallel dual use path, utilities, playgrounds.
- Large number of foreshore amenities such as showers, fencing, information signage, access paths and stairways.
- Highly valued recreational assets beach and ocean areas used heavily by locals and visitors for many different pursuits.
- Commercial and residential property owners/ operators.

The objective of this CHRMAP stage is to increase knowledge and understanding of coastal hazard risks, and to identify risk management and adaptation measures for implementation. The outcomes will be used to inform local and state government policies, strategies and plans, including (but not limited to), planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans.

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The project has adhered to the WAPC (2019) guidelines with scope and deliverables consistent with their objectives and SPP2.6 and follows the risk management and adaptation hierarchy of 'Avoid', 'Retreat', 'Accommodate' and 'Protect'. In addition, the project determines the strategic direction for coastal adaptation scenarios from the present-day to 2123 (100-year management time frame) and identifies an implementation plan to achieve this direction. Overall, this CHRMAP has developed a flexible adaptation pathway for the region and serves as a key reference for management, planning and policymaking for the short-term (0-25 years), medium-term (25-50 years), and long-term (100 years).

Delivery of this project has occurred over 8 stages (as summarised in Figure 1-4), each of which represents a key hold point. The staged approached is developed according to the Town of Cottesloe scope and is in line with the CHRMAP Guidelines (WAPC, 2019). This report presents the CHRMAP project summary and makes recommendations to address erosion and inundation vulnerabilities. The red bubble displayed in Figure 1-4 indicates where this component sits with reference to the greater study.

1.2 Structure of this report

This report is a summary document outlining the CHRMAP project and presenting content from the previous project stages and technical chapter reports. It has been written to provide an overview that is more accessible to a wider audience. This report addresses coastal hazard vulnerabilities for the Town and should be considered in combination with the more detailed technical reports which are provided as appendices. References are provided throughout this document and refer to the documents listed in the reference section of the relevant technical reports.

To facilitate the coastal hazard assessment and development of adaptation options, the study area was delineated into several management units which are determined according to a set of factors:

- Jurisdiction boundaries
- Presence of coastal assets and relevant stakeholders
- Shoreline orientation
- Natural and manmade shoreline features, such as extended shoreline hardening (e.g. seawalls), and
- Points established by geological features and/or localised sediment transport regimes
- Coastal processes and potential hazard types.

The study area shoreline was divided into two management units:

- MU1 North of Cottesloe Groyne (including Cottesloe Groyne) to the North end of the Town's Jurisdiction
- MU2 South of Cottesloe Groyne to the South end of the Town's Jurisdiction

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Figure 1-1 Study Area

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Figure 1-2 MU 1 North of Cottesloe Groyne, including Groyne, to the North End of Town's Jurisdiction



Figure 1-3 MU 2 South of Cottesloe Groyne to the South End of Town's Jurisdiction

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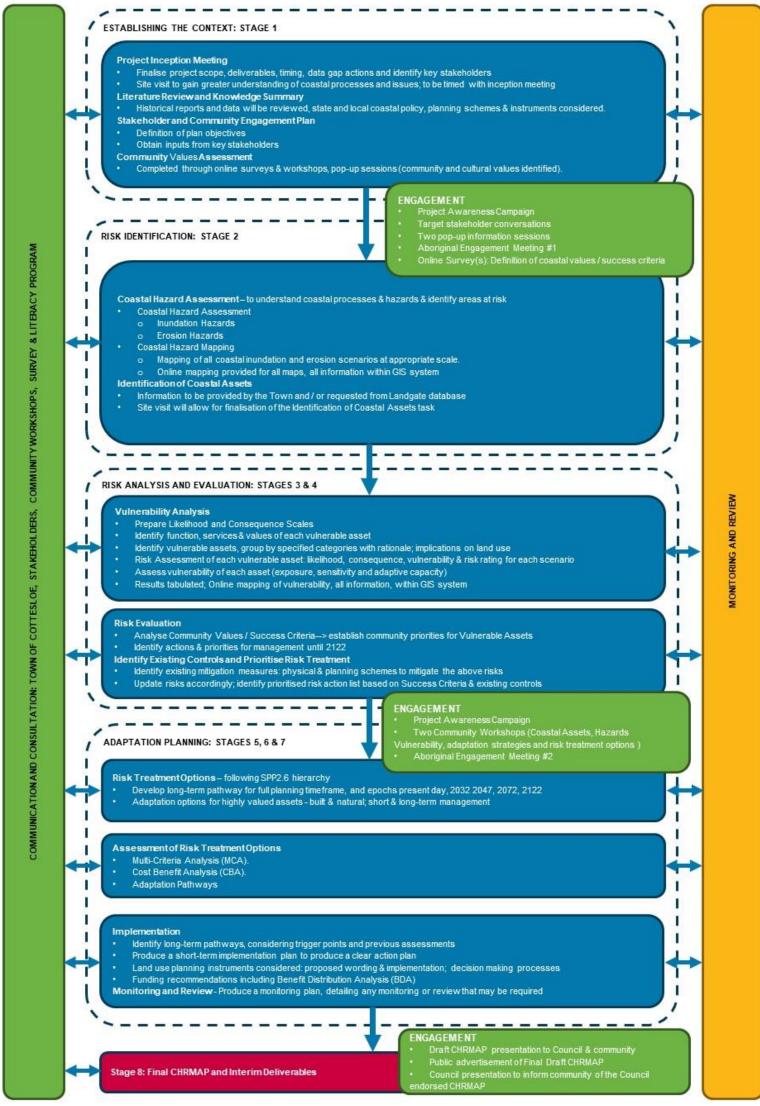


Figure 1-4 Methodology

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2 ESTABLISH THE CONTEXT

An Establish the Context Chapter Report was prepared (Appendix A). This report outlines in detail the key management and adaptation issues that need to be considered in the CHRMAP, summarised below.

2.1 Purpose

The purpose of this project was to prepare a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for the Town of Cottesloe.

The CHRMAP sets the framework for the assessment, by identifying coastal hazards, analysing vulnerability for specific assets, identifying and prioritising management and adaptation responses, and providing an implementation plan. It informs the community and stakeholders about potential coastal hazard risks; identifies community and stakeholders' values as well as key coastal infrastructure and assets at risk; and provides a clear pathway for Town of Cottesloe to address coastal hazard risks over time. Ultimately, the CHRMAP provides strategic guidance for coordinated, integrated and sustainable land use planning and management decision-making by the Town of Cottesloe. The CHRMAP also guides necessary changes to the Town of Cottesloe Local Planning Strategy, Local Planning Scheme and other relevant strategies and local planning policies.

2.2 Objectives

The overall objectives of this CHRMAP were to:

- Improve understanding of coastal features, processes and hazards in the study area.
- Identify significant vulnerability trigger points and respective timeframes for the relevant sediment cells to mark the need for immediate or medium-term risk management measures.
- Identify assets (natural and built) and the services and functions they provide situated in the coastal zone.
- Gain an understanding of asset(s)' vulnerability.
- Identify the value of the assets that are vulnerable to adverse impacts from coastal hazards.
- Determine the consequence and likelihood of coastal hazards on the assets, and assign a level of risk.
- Identify possible (effective) risk management measures (or 'actions') and how these can be incorporated into short and longer-term decision-making.
- Engage stakeholders and the community in the planning and decision-making process.

2.3 Scope

The CHRMAP identifies assets and values at high risk from coastal erosion and flooding in the study area. It proposes risk management measures to reduce these risks to acceptable levels, focusing on short-term actions but also providing strategic guidance for medium and long-term measures. The CHRMAP has focussed on preserving assets and values which provide public benefit, although private at-risk assets are also identified. This is achieved by following the process as outlined in Figure 2-1.

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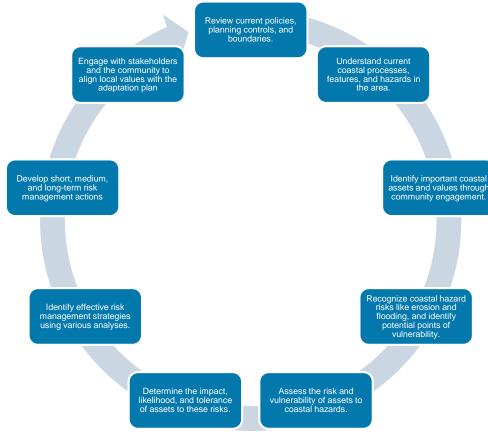


Figure 2-1 CHRMAP process

2.4 Local Context

The Town of Cottesloe's coastline spans approximately 4km from North Street to Vlamingh Memorial in the south and includes the iconic Cottesloe Beach and popular swim spot, Grant Street Beach. The Town's coastline is visited by residents and visitors alike, with beaches in the north popular for swimming and sunbathing, while the southern portion of the coastline is frequented by board riders and dogwalkers. The adjacent foreshore reserves support a variety of recreational and commercial land uses, including substantial built infrastructure situated in close proximity to the shoreline. Such infrastructure includes the Cottesloe and North Cottesloe Life Saving Clubs, Indiana Teahouse, restaurants and cafes, playgrounds, footpaths and several carparks, which may be subject to the impacts of coastal hazards at present or into the future.

The study area has a mixed sandy and rocky coastline, consisting of sections of 'sandy', 'rocky' (generally 'hard rock') and 'mixed sandy and rocky' coast per the definitions in SPP2.6, as well as 'hardened' shorelines being controlled by coastal structures. Much of the Town's coastline comprises rock platforms overlain by a sandy beach backed by remnant sand dunes. Nearshore reefs are present along much of the coastline and exposed rock is present, particularly during the winter months.

The wave climate in the Town is seasonal, with on average, higher wave energy during the winter months of May to October. The study area is afforded protection from offshore wave conditions by Rottnest Island to the

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west and fringing limestone reef structures scattered adjacent to the coastline. Cottesloe groyne can provide local sheltering from inshore waves, depending on the wave-direction.

Longshore sediment transport within the study area has been shown to be mainly northward from September to April, associated with prevailing currents over the summer period. A southward movement of sediment is usually observed during the winter months of June and July. The result is a net northward movement of material annually (CZM & Damara 2008). Nearshore structures can obstruct this sediment movement. The most notable example of this is the Cottesloe groyne, which exhibits accretion of sediment at its northern side in winter and alternatively erosion at the same site during summer.

Cross-shore sediment movement is also seasonal, with sporadic periods of swell pushing sediment onto the shore, steepening the beach profile. Mid-year, the beach is reformed by the energy of winter storms eroding the beach face and redepositing sediment to form sandbars just offshore. These formations become stable towards the end of winter and act as a buffer, preventing wave breaking at the shore and the substantial shifting of sediment that can cause long-shore transportation and further erosion towards the spring and summer.

2.5 Existing Planning Controls

Planning in Western Australia is guided and regulated by the State Planning Framework, which ranges from overarching strategic planning strategies to specific planning policies and supportive guidelines. Figure 2-2 explains the framework, which includes planning at the state, regional, and local levels and demonstrates how strategic planning is implemented through statutory planning controls (e.g., local planning schemes) and local planning policies. This Framework sits within the Planning and Development Act 2005. The relationships of the various policies are presented in Figure 2-3.

The planning documents within this Framework were reviewed to determine which are relevant to coastal hazard planning in the project area. This review helped to: assess the adequacy of the existing planning documents for addressing coastal hazards; identify gaps that needed to be addressed through the CHRMAP process (such as planning controls that are required or need amending to enable implementation of CHRMAP recommendations); identify any potential planning issues that may constrain the CHRMAP process; and ensured that the adaptation plan aligns with state, regional and local planning frameworks.

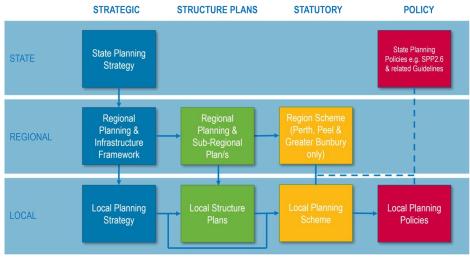


Figure 2-2 State Planning Framework for Western Australia

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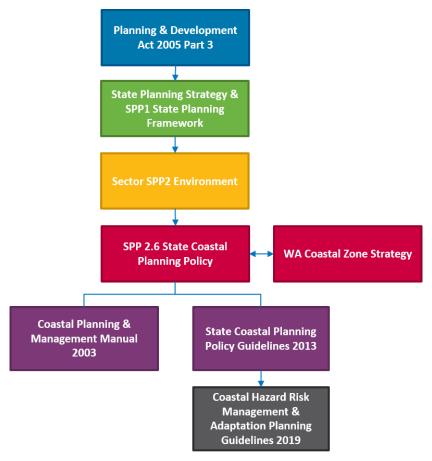


Figure 2-3 Policy Relationships

2.6 State Planning Policies and Strategies

The following state and local planning documents have been reviewed. Information relevant to the CHRMAP has been included below and are discussed further in the Establish the Context Report (Appendix A):

- State Planning Strategy 2050
- The WA Coastal Zone Strategy 2017
- State Planning Policy 2.6 State Coastal Planning Policy, and associated Guidelines
- Coastal Hazard Risk Management and Adaptation Planning Guidelines 2019
- State Planning Policy 3.4: Natural Hazards and Disasters
- Metropolitan Region Scheme
- Perth and Peel @3.5 million and Sub-Regional Planning Framework
- Town of Cottesloe Local Planning Strategy
- Town of Cottesloe Local Planning Scheme No.3 (LPS 3)

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- Local Planning Policy No.2 Wearne Redevelopment, Lot 87 (8) Warton Street, Cottesloe (LPP2)
- Restricted Foreshore Centre Zone Design Guidelines for Setbacks
- Cottesloe Foreshore Masterplan

2.7 Community and Stakeholder Engagement

Key to the success of the CHRMAP project was to ensure that the adaptation plan is underpinned by community and stakeholder values and knowledge. To this end, a Community and Stakeholder Engagement Plan was developed in order to identify relevant stakeholders and determine the structure and pathways for their engagement throughout the CHRMAP process. The plan was intended to be fit-for-purpose, and commensurate with the size and scope of the CHRMAP – so as to avoid consultation fatigue within the community. This plan was prepared in accordance with the requirements of, and for consistency with, the International Association of Public Participation (IAP2) documentation. A summary of the resultant engagement activities, participation and findings is presented in Table 2-1.

Table 2-1 Summary of engagement activities

Activity	Timing	Participants	Key Finding
Targeted Stakeholder Conversations	2022	6	The importance of the environment in its natural state was a theme, and the ability to use the area to recreate was highly valued. Clubs with members particularly valued social aspects since members use the area as a connection, enhancing health and wellbeing. Iconic nature, heritage, cultural features were identified as values for the area. Erosion is identified as a concern, since beach sand is important, for recreational use, 'Sculptures by the Sea', surf clubs.
Aboriginal Engagement Session	2022	4 cultural representatives	Mudurup Rocks were seen as a very important historical, heritage, cultural site to local Aboriginal people, a place where ceremonies are held. It was felt rock area should not be interfered with.
Pop-up Information Session	2022	68	Information sessions included displays about the project and affected areas, people viewed the information and chatted to the project team to gather more information about the project.
Coastal Values Survey	2022	131	Most appreciated the natural assets associated with the beach. Important places within the coastline are identified as Main Beach, North Cottesloe Beach, coastal paths, Cottesloe Groyne, dining out venues, cafes, Grant Street Beach. North beach zone identified as more active compared to south zone. Walking and swimming, being in nature were the most valued activities, and were valued as either very important or important for health and wellbeing. Sand erosion exposing rocks were identified as concerns.
Community Scenarios Workshops	2023	45	Two workshops to inform the community of the project and projected impact from coastal processes, as well as gather feedback about asset prioritisation, the perceived consequences of coastal hazards and the preferred adaptation strategies and management options along the coastline.

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Activity	Timing	Participants	Key Finding
Draft CHRMAP	2024	N/A	Draft CHRMAP will be placed on the CHRMAP website for public comment.

2.8 Success Criteria

The values collated from the engagement were used to generate the success criteria for the CHRMAP. These values are key to the whole CHRMAP and help drive the selection of adaptation options. The success criteria are:

- Preserve and protect the Town's beaches and natural assets such as vegetation and dunes.
- Ensure the natural environment is protected and sustained in its current condition or an improved condition.
- Maintaining the natural state of any underdeveloped areas is important.
- Preserve and consider the cultural significance of Mudurup Rocks.
- Preserve the function and opportunity for all types of water-based and land-based activities, particularly those that help to improve the health and well-being of people.
- Preserve and accommodate the existing surf lifesaving clubs as these facilities were seen as a hub of water and land-based activities that also helped to improve social connection and mental wellbeing.
- Continue to provide public amenities at the coast, such as parks, restrooms parking and access paths.
- Ensure that areas for community events and access to remain within the coastline. Provide and maintain spaces and infrastructure for community events, arts and entertainment.
- Minimise impacts on existing private property.
- Consider treatments for coastal areas that have current inundation and erosion issues. Preserve the current uses of the beach areas.
- Develop solutions to coastal processes that are sustainable (financially, socially and built form) and locally responsive
- Revisit regularly with community and key stakeholders their values in relation to development adjacent the foreshore.

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3 RISK IDENTIFICATION

A Risk Identification Chapter Report (Appendix B) was prepared to identify the coastal hazards in the study area that need to be considered in the CHRMAP. Hazard maps were produced defining the erosion and inundation extents for present day, 2033, 2048, 2073 and 2123.

A key policy objective of SPP2.6 is the provision of a coastal foreshore reserve. The coastal foreshore reserve is essentially a 'space' between the ocean and private land. It should accommodate a range of functions and values such as geomorphological integrity, biodiversity, heritage, public ownership, and access. The component of the coastal foreshore reserve to allow for coastal processes should be sufficient to mitigate the risks of coastal hazards by allowing for landform stability, natural variability, and climate change. The coastal foreshore reserve is a critical input into the coastal hazard risk management and adaption planning framework outlined in SPP 2.6. The assessment considers allowances for coastal erosion and storm surge inundation in parallel.

The Town's coastline features a mixture of sandy, rocky, and artificially hardened shorelines. It is acknowledged that the hazard identification component of the present study was undertaken to provide a broad understanding of exposure that can support government planning at a regional level - and will be superseded once site-specific studies become available. Results derived from this study should not be over-interpreted at a micro-scale due to the assumptions applied and the limitations in model resolution. More detailed risk assessments and analysis may be required for the development of detailed engineering measures for specific sites. Erosion response across the study area may differ to the predictions of this study. Further investigations are a recommendation of this CHRMAP.

3.1 Erosion Hazard Assessment Method

A desktop review of available information was undertaken, including:

- Metocean conditions,
- Coastal processes,
- Existing coastal monitoring and management, and
- Existing coastal hazard information.

The coastal hazard identification approach was developed based on the following policies and guidelines:

- State Planning Policy 2.6 State Coastal Planning Policy (SPP2.6) which provides a clear method for the evaluation of hazards in tidal areas.
- Coastal Hazard Risk Management and Adaptation Planning Guidelines (CHRMAP Guidelines; WAPC, 2019).

SPP2.6 stipulates the following components be considered when evaluating the coastal erosion risk:

- Storm erosion in response to storm waves and loss of beach material.
- Historic shoreline movement that highlights the chronic/long-term evolution of the coast. This could be contributed by littoral drift processes, larger scale morphological movements, long-term water level/wave dynamic variations (~18.6 years tidal cycle, interannual climate oscillations e.g., La Niña effects, Pacific Ocean decadal Oscillation etc.) and climate change impacts.
- Direct response to future sea level rise.

SPP2.6 indicates the methods for determining the allowance for erosion for a sandy open coastline. The standard method from SPP2.6 was used, which considers erosion allowances relative to the present Horizontal Shoreline Datum (HSD). The HSD is defined as the active limit of the shoreline under storm activity. It is the

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line from which the erosion hazard allowance is applied from. In this assessment HSD has been determined by the elevation of the 100-year ARI Peak Steady Water Level. The erosion hazard study was carried out by the following steps:

- Classification of the coast as Rocky, Mixed Sand and Rock, or Sandy coast.
- Identify HSD
- Simulate storm erosion for the 100-year ARI storm (S1).
- Allowance for the current risk of storm erosion (S1) estimated by SBEACH numerical model.
- Evaluate historic shoreline movement trends based on historic vegetation lines (S2).
- Evaluate sea level rise impacts for the project timeframes (S3).
- Calculation of the uncertainty allowance as per SPP2.6
- Evaluate total erosion values for each coastal management zone and for the project timeframes.
- Mapping of erosion hazard lines defined by HSD+S1+S2+S3+uncertainty

3.2 Inundation Hazard Method

SPP2.6 requires the allowance for inundation to be the maximum extent of inundation calculated as the sum of extreme storm inundation (S4) plus the predicted extent of sea level rise at 2123. A detailed numerical modelling approach was used to assess coastal inundation with calibration to existing studies and information.

The allowance for the extent of coastal inundation has been calculated as the maximum extent of storm inundation during the 500-years average recurrence interval (ARI) storm event. This was defined as the peak steady water level calculated based on analysis of available measured water level data, plus an allowance for wave set-up.

3.3 Hazard Results

A key outcome of the coastal hazard assessment was the confirmation that coastal erosion is a significant hazard in the study area (Figure 3-1 and Figure 3-2). The inundation assessment, however, confirmed there are no expected inundation impacts, and as such inundation did not need to be considered further throughout the CHRMAP.

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Figure 3-1 Erosion hazard lines for MU1.

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Figure 3-2 Erosion hazard lines for MU2

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4 VULNERABILITY ANALYSIS

Assets at risk of coastal erosion were identified and assigned a vulnerability rating. The vulnerability results are presented in full in the Vulnerability Analysis Chapter Report (Appendix C). A summary of the results is presented below.

4.1 Asset Classifications

Assets are grouped according to classification for ease of interpretation. For the purposes of this report, Water Technology has grouped assets in line with Local Planning Scheme zones into categories: Public and Community, Environmental, Residential, Developed Foreshore Reserve, Commercial, Roads, and Heritage sites

Public and Community

This includes, Seaview Golf Course, Structures on beach, Cottesloe Groyne at Mudurup Rocks, Beach Street Groyne, Cottesloe concrete seawall, Local Centre, Town Centre, Public purposes – Special Uses.

Environmental

This includes Beach, Foredune, Undeveloped foreshore, Local Parks and Recreation.

Residential

This includes Residential, Residential Office.

Developed Foreshore Reserve

This includes Foreshore Centre, Restricted Foreshore Centre, Public Carparks near coast/beach, Beach access, Local Parks and Recreation near coast/beach, areas of lower-value foreshore amenity such as paths, seating, playgrounds etc.

Commercial

This includes Hotels, Ocean Beach Hotel owned properties, Development.

Roads

This includes Scenic drives along coast, Local Roads, Regional Roads.

Heritage

This includes Aboriginal heritage sites from DPLH database.

4.2 Identified Assets

Table 4-1 presents the identified assets by management unit and category.

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Table 4-1 Summary of Vulnerable Assets, grouped by Management Unit & Planning Horizon.

Planning Horizon	2023 (present)	2033 (+10 years)	2048 (+25 years)	2073 (+50 years)	2123 (+100 years)	
Asset Classification Group		Management Unit 1 – MU1				
Public and Community (m²)	4,649	5,122	5,917	7,022	10,792	
Environmental (m²)			0			
Residential (m²)	0	0	0	0	44,220	
Developed Foreshore Reserve (m²)	20,861	31,988	51,084	74,191	82,523	
Commercial (m²)	2,502	2,502	2,502	2,502	12,685	
Roads (m²)	0	0	611	12,208	46,463	
Heritage (m²)	13,583	17,009	22,708	31,852	33,513	
Asset Classification Group		Mana	gement Unit 2	– MU2		
Public and Community (m²)	758	758	857	3,792	23,089	
Environmental (m²)	5,332	8,177	11,652	12,629	13,826	
Residential (m²)	0	0	0	5,356	39,217	
Developed Foreshore Reserve (m²)	15,410	25,560	40,423	58,825	63,660	
Commercial (m²)			0			
Roads (m²)	501	1,374	6,294	22,064	52,240	
Heritage (m²)	472	1,195	2,290	6,513	32,569	

4.3 Analysis Method

A vulnerability assessment defines the degree of impact coastal hazards are likely to have on coastal assets over the planning timeframe. The vulnerability of coastal assets to coastal hazards is related to its exposure to the hazard, its sensitivity to that exposure, and the ability of the asset to be modified or adapted to manage this exposure. This is displayed diagrammatically in Figure 4-1; the input components are displayed in blue.

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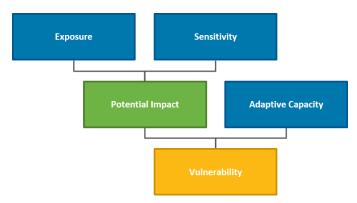


Figure 4-1 Vulnerability assessment components (reproduced from Allen Consulting, 2005)

The **exposure / likelihood** of identified assets represents the likelihood of coastal hazards impacting on an asset. That is, the chance of erosion and / or storm surge inundation impacting on existing and future assets and their values.

The sensitivity / consequence is an asset's responsiveness to a coastal hazard. This could be a gradual or stepped change response to discrete events (WAPC, 2019). The sensitivity can be applied to the asset itself, or to the asset's function and the criticality of the service it provides.

Risk level, or **potential impact**, is calculated as the **product** of exposure and sensitivity (Figure 4-2). It provides a classification of the potential impact of coastal hazards on identified assets, which was determined for each project timeframe.

The adaptive capacity is the asset's ability to adjust/adapt to the identified hazard. It was determined based on the potential for the system to be modified to cope with the impacts from coastal hazards. Assets with high adaptive capacity can easily be adapted. For instance, beach and dune systems often have higher adaptive capacity than coastal infrastructure and residential land.

Vulnerability is calculated as the product of potential impact (risk level) and the adaptive capacity (Figure 4-2). As per WAPC (2019), four levels of vulnerability are considered in this study which should be assessed for each of the planning timeframes considered by this CHRMAP. **Vulnerability** ratings are Extreme, High, Medium and Low.



Figure 4-2 Vulnerability relationship

4.4 Results

The assessment method was applied to all identified asset categories for each planning horizon for each MU to identify vulnerability ratings as presented in Table 4-2. The following key observations can be made from the results:

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Although residential properties are not reached by present day erosion hazard lines (some properties are identified under erosion hazard lines by 2073) they are rated as having high (MU1) and extreme (MU2) levels of vulnerability in the present day because they have low adaptive capacity.

- Public and Community properties are vulnerable to erosion at present, including Cottesloe groyne. North Cottesloe SLSC building(s) is vulnerable to erosion by 2033 and the golf club is vulnerable to erosion by 2123.
- Developed foreshore reserve, beach, foredune and Roads are vulnerable to present day erosion hazards.
- The Indiana Tea Rooms building is presently vulnerable to erosion risk, noting the existing seawall functions as expected.

All categories are at high or extreme vulnerability to erosion from present day, except Developed Foreshore Reserve. Essentially most categories are considered unacceptably vulnerable and require adaptation planning to consider the best way to treat the risk.

Table 4-2 Erosion Vulnerability Ratings, grouped by Management Unit & Planning Horizon

Asset Classification Group	2023	2033	2048	2073	2123				
Management Unit 1 – MU 1									
Public and Community	Extreme Extreme Extreme Extreme								
Environmental									
Residential	High	Extreme	Extreme	Extreme	Extreme				
Developed Foreshore Reserve	Medium	Medium	Medium	Medium	Medium				
Commercial	Extreme	Extreme	Extreme	Extreme	Extreme				
Roads	Extreme	Extreme	Extreme	Extreme	Extreme				
Heritage	Extreme	Extreme	Extreme	Extreme	Extreme				
	Mana	gement Unit 2	– MU 2						
Public and Community	Extreme	Extreme	Extreme	Extreme	Extreme				
Environmental	Extreme	Extreme	Extreme	Extreme	Extreme				
Residential	Extreme	Extreme	Extreme	Extreme	Extreme				
Developed Foreshore Reserve	Medium	Medium	Medium	Medium	Medium				
Commercial			Not Applicable						
Roads	Extreme	Extreme	Extreme	Extreme	Extreme				
Heritage	Extreme	Extreme	Extreme	Extreme	Extreme				

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5 RISK EVALUATION AND TREATMENT

A Risk Evaluation and Risk Treatment Options Chapter Report (Appendix D) was prepared, assessing any available controls against the vulnerability ratings assigned during the vulnerability analysis. Any vulnerability rating of medium or above is considered unacceptable and therefore both MUs need to be considered for risk treatment options.

5.1 Risk Management and Adaptation Hierarchy

SPP2.6 provides a risk management and adaptation hierarchy to guide decision-making in coastal areas to be used by planning authorities and development proponents when considering adaptation options to minimise coastal hazard risks at the local level. The hierarchy, presented in Figure 5-1, indicates a clear preference against the adoption of 'protect' as a long-term adaptation pathway. This preference is re-emphasised in SPP2.6, the policy guidelines, the CHRMAP Guidelines and the WA Coastal Zone Strategy.

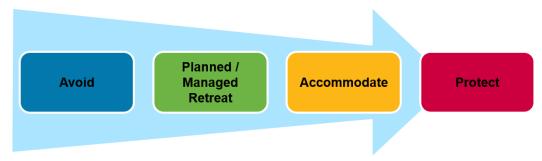


Figure 5-1 Coastal hazard risk management and adaptation planning hierarchy (adapted from WAPC, 2019)

Maintaining public access to the coast in developed areas is one of the main objectives of SPP2.6. The State legislative framework means that where the shoreline recedes beyond private property boundaries, public access and trespass issues are likely to arise. This situation implies that public authorities have two main adaptation options available to them for preserving public coastal access:

- Planned or Managed Retreat i.e., maintaining a foreshore reserve through public acquisition of private property: or.
- Protect i.e., preventing the shoreline from receding beyond private property boundaries by stabilising the current shoreline position using various protection measures.

Where public authorities cannot commit to either of these options over the long term, it is likely that public authorities will need to Accommodate, by modifying local planning frameworks to help ensure that new development is appropriately designed and located. Public authorities in this situation may also choose to consider the appropriateness of interim Protection measures to preserve public interests by delaying shoreline recession.

The CHRMAP process aims to minimise coastal hazards and maximise the beneficial use of the coast. Therefore, adaptation options should follow the following principles:

- Adaptation options should minimise coastal process interference and legacy issues.
- Coastal development must be sustainable in the long term and must balance the community, economic, environmental and cultural needs.
- Local Governments are responsible for managing risks to public assets and any assets they manage. They should also:

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- Develop local policies and regulations consistent with state legislation and policy.
- Facilitate building resilience and adaptive capacity within the local community.
- Work in partnership with the community to identify and manage risks/impacts.
- Management strategies that preserve the natural coastline and move development away from the active coastal zone in an orderly manner are considered ideal. Of particular relevance to the CHRMAP process is the user-pays principle, whereby those who benefit most from protection must provide the greatest financial contribution.
- Adaptation options should maintain future flexibility to build resilient coastal communities.
- A key adaptation option will be the use of planning instruments, including managed Retreat.

5.2 Multi-Criteria Analysis

Successful risk management and adaptation planning requires identifying and diligently assessing suitable risk treatment options to select the best strategy. The selected risk treatment option should mitigate risk to an acceptable level whilst maximising the values important to the stakeholders.

A Multi-Criteria Analysis (MCA) was undertaken to assess suitable adaptation options for the study area. The MCA assessment criteria were as follows:

- Effectiveness
 - Ability for the option to mitigate the coastal hazard
- Environmental Impact
 - Impact on existing native vegetation / dunes / coastal processes
 - Includes consideration of:
 - Any construction / clearing impacts
 - Impact of maintenance on the environment
- Social Impact
 - This considers stakeholder and community impacts from previous CHRMAP chapters
 - Incorporates feedback provided by engagement workshop attendees in Winter 2023
 - Potential impacts on Aboriginal and European heritage sites and values are considered in this criterion.
- Aesthetic Impact
 - The visual appeal of the option
 - Consideration of option aesthetics tying into the wider Town / Management Unit vision
- Cost
 - Upfront capital costs
 - Ongoing maintenance costs
 - Economic affects such as loss of businesses, income, value
- Future Adaptability
 - Whether the option is easily adaptable in future, such as for updated sea level rise actuals or projections
 - If the option limits the feasibility of selecting other options in the future

The MCA results are a rating from negative, neutral to positive. The adaptation options with a rating of zero and above were recommended for further investigation in a Cost Benefit Analysis (CBA; Table 5-1). Following

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review by the project Steering Committee it was decided to include three additional options for CBA analysis as they were supported by several people during the community and stakeholder engagement:

- Seawalls (PR3),
- Artificial reefs (PR4), and
- Offshore breakwaters (PR5).

Table 5-1 Multi-Criteria Analysis summary by Management Unit. Green indicates recommended for further investigation. Option codes refer to those used by WAPC, 2019.

Option	MU1 (North of Cottesloe Groyne, including Groyne)	MU2 (South of Cottesloe Groyne)
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	N/A	11
Leaving assets unprotected (PMR1)	2	2
Demolition / removal / relocation of asset from inside hazard area (PMR2)	6	6
Prevention of further development / prohibit expansion of existing use rights (PMR3)	7	7
Voluntary acquisition (PMR4)	5	5
Design assets to withstand impacts (AC1)	N/A	N/A
Beach nourishment or replenishment (PR1)	7	7
Groynes (PR2)	1	1
Seawalls (PR3)	-4	-4
Artificial reefs (PR4)	-4	-4
Offshore breakwaters (PR5)	-2	-2
Levy / Weir / Storm Surge Barrier (PR6)	N/A	N/A
Monitoring (NR1)	8	8
Protection Structure Audit (NR2)	6	6
Notification on title (NR3)	8	8
Emergency evacuation plans (NR4)	N/A	N/A
Do nothing (DN1)	-8	-8

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6 ASSESSMENT OF RISK TREATMENT OPTIONS

An Assessment of Risk Treatment Options Chapter Report (Appendix E) was prepared to analyse options using Cost-Benefit Analysis (CBA). A summary is provided below.

6.1 Cost-Benefit Analysis

The purpose of the CBA was to further examine the selection of adaptation options through economic analysis. In the previous project stage, potential adaptation options were assessed against a range of criteria, including cost. Options that may require significant financial investment and scored positively in the MCA were included in the CBA. A rigorous assessment of costs and benefits for each option assists with preferential selection to ensure that a selected adaptation option is economically defendable. The CBA has addressed valuing the loss of assets, managed retreat and physical protection options. Losses or costs are assessed at each project timeframe. Indirect costs that another user might consider to be a loss are not considered. For example, costs associated with Special Control Area (SCA) title notifications, emergency planning or development restrictions are not considered.

The cost-benefit of each option is presented in net present value (NPV) terms. NPV is a standard economic analysis to compare options with time-variable costs and benefits. It allows for the adjustment of all future economic considerations to present day dollars for a more direct comparison. This relates to the time-value of money, as planned expenses in the future are, in a sense, cheaper than equivalent costs today, because the money required for a future expense could be spent elsewhere today to provide value over time (i.e., it can be invested now to generate a return). An expense that occurred today could not be invested elsewhere. In this case, all cashflows are costs, so options with a lower net present value are considered better investments from a financial standpoint.

The real discount rate chosen for this project was 4% with sensitivity analyses at 7% and 2%. This decision was based on similar assessments (DPMC, 2016; Transport for NSW, 2022; Baird, 2020; APH, 2018; Abelson and Dalton, 2018), the very long timeframe of analysis, and concerns that valuing future spending too low is at odds with resilient coastal planning principles.

The discount rate essentially converts all future costs back to today's dollar value for comparison (in the NPV). For example, a project with a cost of \$1 million per year for 10 years would discount to an NPV of roughly \$7.5 million, whereas a project that only has a single outlay of \$10 million in 10 years' time would have an NPV of roughly \$5.4 million, both discounted at 7%. A project that costs \$10 million today would have an NPV of \$10 million. This example shows the importance of when a cost is realised.

The CBA has been performed over the project timeframe – notionally 2023 to 2123, to match the project planning timeframe and meet the requirements of the CHRMAP. It should be noted that the uncertainty around the CBA estimates and assumptions made grows with time. Estimates beyond 2040 should be viewed as indicative trends only. Long-term adaptation pathways should always be monitored and updated over time.

The adaptation options recommended for further analysis following the MCA, and considered suitable for CBA, were:

- Planned/Managed Retreat Voluntary acquisition of residential, commercial, public, tourism and environmental areas over various timeframes per MU as identified by the hazard mapping.
- Protect Beach nourishment: Placement of sand within the beach profile and/or dunes to activate beach coastal processes and provide a sediment supply along the whole length of the relevant MU.
- Protect Groynes: Construction of groynes to stop or restrict the movement of sand around the end of the structure, to provide protection to assets behind the beach/foreshore reserve. They are primarily effective where there is longshore sand supply or when partnered with beach nourishment.

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Protect – Seawalls: Construction of a seawall usually along an entire section of shoreline. Where a beach is to be retained, this risk treatment option should generally be accompanied with beach nourishment.

- Protect Artificial reefs: Construction of a submerged artificial reef offshore, to dissipate wave energy impacting the shore by causing waves to break on their seaward side and reducing wave energy on the leeward side. Artificial reefs do not block waves and during storm events water depths over the reef may be sufficient to allow waves to pass over the reef without breaking, reducing their effectiveness in protecting the beach from erosion. They are primarily effective when partnered with beach nourishment.
- Protect Offshore breakwaters: Construction of an emergent offshore barrier to effectively block wave energy by absorbing wave impact on their seaward side. They create a lower wave energy section of beach immediately in its lee, which is characterised by a salient where sand accretes in the low energy environment. They are primarily effective when partnered with beach nourishment.

The remaining adaptation options from WAPC (2019) which received a positive MCA score were not considered suitable for CBA and have been costed using traditional budgeting techniques.

6.2 Results

The CBA has been used as an additional tool to assist decision-making when assessing adaptation options with which to proceed. However, the reality that only some of the WAPC adaptation options are suitable for CBA, and the uncertainty in the effectiveness of those that are not suitable, means that the CBA results need to be used cautiously whilst considering the rest of the information identified during the CHRMAP project.

Review of the CBA results showed that the ranking of options for each MU by NPV depended on the discount rate. If options stayed in the same ranking for all three discount rates there would be a much stronger argument for selection of a single option with which to proceed.

For erosion, across both management units (MU1 and MU2) PR1 Beach Nourishment is recommended for implementation following further investigations to confirm assumptions and consider analysis of smaller sections of coast, noting:

- PR1 Beach Nourishment is recommended based on the results of the MCA and CBA combined. Best value for NPV 7% discount rate and has a positive benefit/cost ratio for all rates.
- PR1 Beach nourishment could also later be transitioned to both PR2 Groynes and PR3 Seawall if required.
- PR3 Seawall is not recommended as it would likely mean significant loss of the beach. Should the objectives of this MU change in the future PR3 Seawall may be suitable in the long-term as PR3 performs well across NPV 4% and 2% discount rates. It may suit smaller sub-sections of the MU, particularly if combined with PR1 Beach Nourishment.
- Assumes 2023 implementation with treatment of 1700m of shoreline for whole of MU1.
- Assumes 2047 implementation with treatment of 2100m of shoreline for whole of MU2.

A key assumption for the PR1 Beach Nourishment option is that a suitable sand source is available (grain size, volume, cleanliness and proximity). Further investigations are required to confirm the assumptions used in the analysis to develop a more accurate scope for the recommended options.

For both MUs the year of implementation has allowed for protection of some foreshore reserve as well as development further inland. This acknowledges the underlying qualitative value of the vegetated foreshore reserve in line with the objectives of SPP2.6. If these areas were considered of very high importance in MU2 the implementation of protection options could be considered earlier. Alternatively if these areas were considered less important to this study area implementation could be delayed until more landward assets become unacceptably vulnerable. The existing estimate on the timeframe for implementation in MU2 shows that there is time to consider these competing priorities in more detail following further investigations to develop

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the options. Filling of any existing data and/or knowledge gaps (e.g. suitable sand source, costing assumptions) is considered critical in confirming the recommended options before processing with implementation. Likewise, the enforcement of planning regulations (e.g. limiting further development seaward of the hazard lines and limiting intensification) and undertaking ongoing monitoring of coastal processes is considered essential. Future CHRMAP reviews will be required to either confirm or change the recommended option before its recommended implementation timeframe.

Other non-CBA options also form part of the recommended management approach and are presented in Section 7, which also provides further detail for the investigations and implementation of options.

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7 IMPLEMENTATION

An Implementation and Monitoring Chapter Report (Appendix F) was prepared to present recommended actions to progress coastal hazard adaptation planning for Cottesloe. A summary is provided below.

7.1 Implementation Strategy

It is recommended the Town execute a staged implementation strategy to incorporate the CHRMAP's strategic recommendations into its operations as outlined in Table 7-1.

Table 7-1 CHRMAP implementation strategy.

Milestone	Adaptation Actions	Adaptation Hierarchy
Prior to CHRMAP endorsement	Continue to accommodate development under the current planning framework with conditions requiring removal or relocation of the development once the Horizontal Shoreline Datum (HSD) is within the relevant S1¹ distance of the most seaward point of the development, in accordance with the CHRMAP Guidelines.	Planned/ Managed Retreat; Accommodate
CHRMAP Endorsement	Continue to accommodate development under the current planning framework with conditions requiring removal or relocation of the development once the HSD is within the S1 distance¹ of the most seaward point of the development. The Town shall update available mapping online to include the relevant data from the CHRMAP, including the HSD and S1 values for locations subject to erosion.	Planned/ Managed Retreat; Accommodate
Scheme Amendment / LPP Endorsement	Assess development against the amended planning framework which supports the adaptation hierarchy under the CHRMAP Guidelines, specifically:	Avoid; Planned/ Managed Retreat; Accommodate
	 Prohibit subdivision or rezoning of land which has been identified as being subject to erosion over the 100-year planning timeframe; Prohibit development within the S1 distance of the HSD; Accommodate development not identified as being impacted by erosion in the short-term (S1) with conditions for the managed retreat of the development once the most seaward point of the development is within the short-term erosion zone (HSD plus S1 erosion). 	
Protection Measures Implemented	Accommodate subdivision / development where protection measures have been undertaken in accordance with the CHRMAP and/or any other relevant assessment endorsed by a suitably qualified coastal engineer.	Accommodate; Protect

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¹ S1 is the erosion distance from acute storm erosion from a 100-year ARI storm event. This is seen as the present-day erosion risk and varies along the beach. Details and distances are presented in Risk Identification Chapter Report (Appendix B).





7.2 Recommended land use planning instruments

There is a direct relationship between coastal hazard exposure and development. How buildings and assets are designed and located determines their exposure, ultimately impacting risk to people and property. Therefore, the policy instruments that govern development are an important tool to use in reducing risk exposure. The following measures are recommended:

- The introduction of a Special Control Area (SCA) into the Town's local planning scheme is considered the most appropriate statutory planning mechanism to holistically address coastal erosion. An amendment to the local planning scheme will be required to introduce the SCA over all zoned land located seaward of the 2123 coastal processes setback line.
- A local planning policy (LPP) can be prepared by a local government in accordance with Schedule 2 of the Planning and Development (Local Planning Schemes) Regulations 2015. The purpose of a LPP is to guide the development and use of land in relation to a particular matter. LPPs allow a level of discretion and flexibility to be applied in the decision-making process given they are a due regard planning instrument.
- Freehold land identified as being at risk of coastal erosion should have a notification registered on its certificate of title to ensure current and future landowners are aware of the potential for the land to be impacted by coastal processes.

Additional instruments that can be considered for implementation include:

- Updates to the Local Planning Strategy to reference SPP2.6 and avoid the identification of at-risk land for further intensification of development through rezoning or subdivision.
- Preparation of a foreshore management plan to provide a strategy to deliver the recommendations of the CHRMAP for foreshore reserves throughout the Town.
- The use of restrictive covenants to restrict development in high-risk areas or limit the use of certain protective barriers which may contradict the recommendations of the CHRMAP.
- Introduction of special area rates to equitably distribute costs associated with protection options across beneficiaries.
- The application of SPP2.6 in the structure planning process where the comprehensive redevelopment of land remains an option.
- Internal processes and systems to ensure coastal hazard information and data is readily available and accessible to landowners, prospective buyers and the real estate industry.

The intent of these instruments aligns with guidance provided in the WA Coastal Zone Strategy, noting that private parties are responsible for managing risks to their private assets and incomes, which might arise from coastal erosion and inundation hazards.

There is an identified need to establish a response within the town planning legislative framework to manage the risks of coastal hazard to an acceptable or tolerable level. Any changes to the land use planning framework to reflect the identified risks would be undertaken after a detailed investigation into proposed coastal protection measures, as the specific coastal protection measure may alter the land use instrument required. The Town should prepare an amendment to the Local Planning Scheme to include provisions relating to the coastal erosion hazard zone.

7.3 Funding options

There exist revenue-raising mechanisms available for obtaining funds to assist implementation. Funding mechanisms that should be considered include:

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- Operating budget, general rates and coastal management fund.
- Special area rates / differential rating.
- Levies.
- Lease land management.
- State grants.
- Federal grants; and
- Beneficiary pays.

7.4 Monitoring and Review

Monitoring is essential to managing coastal hazards, tracking when coastal hazards reach trigger points, understanding the coastline evolution, capturing changes to vulnerabilities and measuring the success of coastal management actions. Coastal monitoring will be required throughout the whole planning timeframe to inform ongoing implementation and to increase the knowledge base for subsequent CHRMAP revisions and targeted investigations. Should any option be modified, or other coastal projects be undertaken (such as maritime, or recreation/tourism projects) where coastal hazard risk management is not the primary focus, they should be subject to the same CHRMAP principles and require their own monitoring program appropriate to their location, size and objectives.

The following monitoring activities are recommended to record the evolution of coastal trigger points:

- 1. Continue the 6-monthly beach and dune surveys the Town has been undertaking since 2014. The beach survey may also be continuous along the coast using LiDAR (or other appropriate technique) to enhance the understanding of coastal processes and beach responses. Additionally, surveys should be undertaken immediately following severe storms producing significant beach erosion. These are useful for recording historical events, confirming the presence of bedrock, and calibrating models. Beach profile datasets should include the location of the Horizontal Shoreline Datum (HSD). The beach profiles must extend from the edge of the coastal cadastral boundary down to the Lowest Astronomical Tide (LAT). The survey datasets should be centralised into a database, which includes previous historical beach profiles and quality control information such as survey date, datum, survey mark, beach material encountered (rock vs sand) and methods used.
- Corresponding monitoring photos should be taken at the same time as beach surveys, and the remote shoreline imagery undertaken by the Town since 2014 should continue.
- 3. Regular monitoring of existing coastal management structures (Protection Structure Audit NR2) e.g., seawalls and beach groynes. These should be undertaken with consistent methodology to allow comparison between inspections. These can be commenced immediately, and the initial assessment would identify an appropriate review schedule for each structure, or if there is an issue with an asset. Monitoring would then be incorporated into the Town's existing asset management reporting systems.

Additionally, the ongoing state and federal monitoring should continue:

- Shoreline vegetation movement analysis from aerial photos undertaken by DoT.
- Water level, wave monitoring and bathymetric survey undertaken by DoT,
- Wind recording by BOM.

7.4.1 Trigger Points

Ongoing monitoring shall be used to inform when certain triggers are close to be being exceeded. The CHRMAP consider four types of trigger points, as follows:

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Proximity trigger: Where the most landward part of the Horizontal Shoreline Datum (HSD) is within the Storm Erosion Allowance (S1) of the most seaward point of a public asset of interest or private property lot boundary. Due to the high value of the foreshore reserve, the foreshore reserve may be considered to be "the most seaward point". If individual assets have a specific distance-based trigger relating to the HSD then the beach and dune survey activities described above should be used to collect topographic data that can be used to map the updated HSD position.

- Access trigger: Where a public road is considered no longer available or able to provide legal access to the property
- Utilities trigger: When water, sewage, communications or electricity to the lot is no longer available as they have been removed/decommissioned by the relevant authority due to coastal hazards.
- Damage trigger: Any property within the hazard zone and within a dedicated Special Control Area, that is damaged by a coastal hazard shall require LGA approval before being repaired. The review process should involve re-fit of minor or moderately damaged assets to accommodate coastal hazards in the future, or removal and redevelopment outside the hazard zone for damaged assets.

This list follows a sequential / prioritisation order. That is, a "proximity trigger" is recommended over a "damage trigger".

7.4.2 CHRMAP Review

This CHRMAP should be updated at least every 10 years to maintain currency and should be a "living document". An earlier review should be considered when the following occur:

- Substantial storm events generating severe coastal hazards approaching or exceeding the CHRMAP projections.
- Significant changes to land-use planning such as complex amendments to a Local Planning Scheme or the full review of the Planning Scheme.
- New information becomes available which substantially affects the summary of local community values and assets (natural or built). This may typically occur when consulting the community regarding other documents such as the Local Planning Scheme or Foreshore Management Plan, or the occurrence of a significant storm event.
- New information becomes available (filling of existing data gaps) that has the potential to alter the recommended protection measure from the CHRMAP. For example, should further investigations show that no economically viable local sand source is available, alternative recommendations other than beach nourishment might be required.
- Hazard modelling for the study area is updated given any of the following:
 - recent data collection,
 - planning changes,
 - updates in climate change science, specifically local sea level rise projections,
 - coastal engineering methodology,
 - changes to the CHRMAP success criteria by coastal land managers, or
 - triggers are reached.
- Coastal management operations within the study area should consider the status of both short and longterm adaptation strategy progress, including assessment of the performance and review of any identified strategies.

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7.5 Key Considerations

The timeframes envisaged in the coastal adaptation pathways are not absolute. These timeframes are related to the current state of local land planning, coastal processes knowledge and climate projections, as outlined in the CHRMAP. Therefore, the timeframes are typically not aligned on "worst-case" scenarios but instead consider risk-adjusted and/or consensus-based adjustments and quantifications. Other options may be envisaged, particularly if land planning practices, coastal processes knowledge or climate projections are changed. Therefore, the implementation pathway will evolve overtime.

The options have been selected based on information gathered through all the previous CHRMAP project stages. Although the MCA and CBA have been key gateway decision points for selecting many options. The preparation of the MCA and CBA required interpretation and approximations, particularly regarding the criteria and cost quantifications, and have limitations. Also, the proposed options have been developed only at a conceptual level and applied across the whole MU to draw comparisons between several options.

The CHRMAP options should be the subject of further investigations, surveys, policy review, environmental impact investigation, development approval and authorities endorsement, local stakeholder and community engagement, preliminary design, detailed design, costing and any other applicable preparation work required prior to be implemented. The options should be optimised and modified following such additional investigations.

An example of this could be changes to Management Unit boundaries, to optimise option effectiveness and to reduce costs. It is recommended that further work is undertaken to identify priority sections of MU's and consider the use of composite treatment options in these MU's. This may see some sections of the current MU's being managed in different ways rather than one option for each MU. Appropriate supporting analysis is needed to propose preferred treatment options on smaller sections of coastline than the MU's presented in this CHRMAP as the cost benefit analysis has considered these boundary extents and quantities. It is anticipated the current MU's could be further split based on the projected hazard extents and predominant foreshore use.

It may also be practical to develop a staged implementation approach to some of these management actions to test their effectiveness and to refine design of subsequent stages. Some interim management options may also be progressed, such as the placement of dune fences and re-vegetation to reduce erosion rates and loss of windblown sand.

7.5.1 Further Investigations

Information gaps identified in the CHRMAP should be addressed early. Some of these gaps can be closed by the collection of data. Other information gaps can be closed during the preliminary and/or detailed design phase when specific or detailed analysis of available data, information, modelling, and projections are carried out. The following investigations are recommended:

- 1. Preparation of an Asset Management Plan to identify existing infrastructure and recreational facilities in the coastal erosion hazard zone and provide direction to:
 - a. Progressively relocate non-critical assets (PMR2) away from the coastal hazard zone once they reach the end of asset life or replace assets with suitably durable and/or sacrificial infrastructure. This may include vulnerable recreational car parks; recreational amenities such as public ablutions; barbeque/picnic/shade areas; playground and other recreational equipment; and access structures such as ramps, stairs and paths and fences, etc.
 - b. Plan for the relocation of critical service infrastructure outside of the coastal hazard zone once they reach the end of asset life, or at a minimum, modify the service infrastructure asset so that it does not run parallel to the coastline where possible and can be progressively removed when exposed to intolerable risk levels.

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Investigate opportunities for leaseback of land and land swaps in the context of planned and managed retreat. Seek legal advice regarding the basis of agreements with landholders and whether opt-ins can be time constrained.

- 3. Investigate opportunities for demarcating Special Control Areas, and for introducing development restrictions.
- 4. Sand source feasibility study Both MU's have recommended sand nourishment as the preferred option. The availability of suitable sand for beach nourishment works is unfortunately not well understood in the study area. It is recommended that a sand source feasibility study is undertaken to determine the capacity and cost of local sand supplies. This study should consider both land-based and marine sand sources as well as evaluate potential environmental impacts and approvals required. Cost estimates used in this CHRMAP have assumed that a reliable source of sand in reasonable proximity to the study area may be available. If this assumption is incorrect, costs may increase and affect the CHRMAP recommendations.
- 5. More detailed investigation of coastal hazards and the feasibility of treatment options at priority locations such as the North Cottesloe Surf Life Saving Club and the section of coast immediately north of the Cottesloe groyne. Targeted CBA and BDA analysis should be undertaken for prioritised sections of coast following the collection of suitable data and information.
- Foreshore Management Plans (FMPs) Updated foreshore management plans for the study area may increase the protective capacity of the natural dune system. Foreshore management plans should address:
 - a. The requirements of SPP2.6 and its supporting documentation.
 - b. The findings of this CHRMAP noting protection via sand nourishment has been recommended. Focus should be given to protection of the coastal foreshore reserves, and the existing land use and development east of Marine Parade.
 - Potential environmental issues such as biodiversity and environmental impacts and detail a weed management strategy for the coastline.
 - d. Incorporate findings of Asset Management Plans as appropriate.
 - e. Include review of existing beach access points, ensuring appropriately fenced and signed paths, and signage for dune repair.
 - f. Develop an education strategy for coastal and environmental management. The strategy should work to inform the community about the CHRMAP and FMP and their findings and use suitable engagement methods such as infographics and FAQ's. The education strategy should also include appropriate on-ground signage and information for beach access.
 - g. Monitor impacts of general beach access on nesting habitats and migratory bird species in dune areas.

7.5.2 Surf Life Saving Clubs

Throughout the engagement activities undertaken during this CHRMAP project the important nature and role of the Cottesloe and North Cottesloe Surf Life Saving Clubs to the local and broader community has been clearly and repeatedly raised by community members.

SPP2.6 (WAPC, 2013) recognises that Surf Life Saving Clubs and their facilities may need to occur within an area identified to be potentially impacted by physical coastal processes within the 100-year planning timeframe. SPP2.6 requires they be considered within a CHRMAP framework, identified in a strategic plan and co-located with other public recreation and coastal node facilities. Any proposed development will be assessed on a case-by-case basis against the SPP2.6 Policy Measures and in consultation with other relevant agencies and community.

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7.5.2.1 North Cottesloe Surf Life Saving Club

The North Cottesloe Surf Life Saving Club is co-located with other public buildings some of which are leased for private commercial business such as cafes/restaurant. These buildings are projected to become directly vulnerable to coastal erosion around 2033. As such it is recommended that these facilities are investigated in more detail as a priority site for the Town. Should protection via beach nourishment be implemented by the Town for MU1 then these buildings will also be protected. Alternatively further investigations could consider an alternative location for these facilities or targeted protection measures.

7.5.2.2 Cottesloe Surf Life Saving Club

The Cottesloe Surf Life Saving Club is projected to become directly vulnerable to coastal erosion around 2073, but only if no active management occurs to the section of coast immediately north of the Cottesloe groyne. As such it is recommended that these facilities are investigated in more detail after key decision making occurs for MU1. If protection is implemented, then the Club facilities will also be protected. It is recommended that the section of coast immediately north of the Cottesloe groyne are investigated in more detail as a priority site for the Town, following confirmation of the condition and remaining design life of the relevant coastal protection structures.

7.6 Implementation Plan

Medium (25 – 50 years) and long-term (50 – 100 years) implementation provides a strategic consideration of how the Town will adapt to long-term climate change impacts. Therefore, medium- and long-term implementation are not described in detail in the CHRMAP. Longer-term responses include:

- Continuing to action the revised planning instruments implemented in the short-term.
- Providing temporary/interim hazard protection may also become more costly and a change in adaptation pathway could be required. For example, as sea level rise progresses, it is possible that options using sand or rock resources to protect assets near the coast may become economically unsustainable.
- Implementing planned managed retreat if protection is found not to be feasible.

Long-term adaptation strategies/pathways have been recommended for each MU for erosion that will allow for the continuous function of local communities whilst accommodating the increasing burden of coastal hazards. The long-term strategy informs future planning instruments, supports monitoring, recommends planning reviews and underpins collaboration between coastal land managers, stakeholders and the community.

The two primary coastal management actions for mitigating erosion hazards at Town of Cottesloe are:

- Planned / Managed retreat (PMR4 Voluntary Acquisition): Use the planning instruments and long-term plan to systematically move assets with low adaptive capacity out of the hazard zone.
- Protect (PR1 Beach Renourishment): Undertake works as necessary to prevent erosion to assets. This is anticipated as relatively small scale works initially to maintain approximately the same level of beach and foreshore amenity currently experienced (Figure 7-1). If significant storm damage occurs or preemptive works are preferred larger scale works with additional foreshore vegetation rehabilitation could occur. If more frequent management works are undertaken the sandy beach could be rebuilt as required with small beach width amounts and volumes.

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Figure 7-1 Beach nourishment underway at Sunshine Coast, QLD

The detailed implementation plan for MU1 and MU2 is presented in Table 7-2 with recommendations presented in order of priority. The focus should be on implementing land use planning; undertaking investigations and monitoring; and relocating assets as they become exposed to erosion hazards. Most importantly, a sand sourcing study shall confirm the availability and cost of suitable sand in the area to implement the recommended beach nourishment activities. Subject to the results of the sand sourcing feasibility study the medium-term pathway recommended is protection via beach renourishment. There is time to monitor and confirm assumptions. Beach nourishment without associated structures currently presents as the best value option to achieve the project goals. Following further investigations, protection with structures at prioritised locations could be possible.

The recommendations are based on currently available information. Recommendations that are included in this document are made based on the assumptions provided throughout this document, recognising the gaps in information that still need to be resolved, and a multi-criteria analysis based on technical, economic, social and environmental criteria.

Future investigations are required to confirm they are suitable, including further consultation with stakeholders and the community. Subsequently a likely outcome is that a combination of options may be the preferred approach in some locations. The recommendations are based on the analysis presented in this report. Additional considerations may be incorporated into future analyses.

All recommendations still need further research. The CHRMAP provides the basis for which for the Town may access grant funding to undertake this work; after which, recommendations may be updated, improved, or confirmed. This process requires ongoing engagement with affected communities.

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Table 7-2 Implementation plan with recommendations in priority order.

Recommendation	Notes	Responsibility	Trigger	Cost (if known) and Funding	Short- term	Before 2050	2050- 2125
INVESTIGATION 1 Update Foreshore Management Plans (FMPs)	 Prepare an updated Foreshore Management Plan (FMP) An updated FMP could help increase the protective capacity of the natural foreshore dune system. Updates should address the requirements of SPP2.6 and incorporate the findings of this CHRMAP Increased protective capacity by better management of beach and dune ensures better erosion resilience. 	■ LGA	■ Completed CHRMAP	\$60,000OperationalGrants	MU1 and MU2	Continue	Continue
INVESTIGATION 2 Detailed investigation of coastal hazards and feasibility of treatment options at priority locations such as North Cottesloe Surf Life Saving Club, coast immediately north of Cottesloe groyne	Site specific details of coastal hazards could help increase the protective capacity of the assets.	■ LGA	■ Completed CHRMAP	\$30,000OperationalGrants	MU1		
INVESTIGATION 3 Sand Source Feasibility Study	 Determine the capacity and cost of local sand supplies, including both land-based and marine sources. Likely requires repetition over Medium-term. 	■ LGA	■ Completed CHRMAP	\$75,000Operational Grants	MU1 and MU2		
Monitoring (NR1)	 Bathymetric survey to monitor nearshore zone approximately every 5 years. Six monthly beach profile surveys along the entire extent of the Town's shoreline, extending from the top of primary dune or fixed infrastructure to the approximate depth of closure offshore. 	LGACan seek support and assistance from DoT	Completed CHRMAPSevere storm event(s)	\$20,000 annuallyOperationalGrants	MU1 and MU2	Continue	Continue
Notification on title (NR3)	Item cost for investigations and implementation plans.	LGACan seek support and assistance from DPLH, WALGA	■ Completed CHRMAP	 \$100,000 (Plus 1% annual maintenance of \$1,000) Operational Grants 	MU1 and MU2		
Protection Structure Audit (NR2)	 Item cost to inspect coastal asset condition, influence on sediment transport and remaining design life on all coastal management structures. Includes rubble mound rock groynes at Beach Street and Cottesloe Beach, seawalls at Cottesloe Beach. 	■ LGA	■ Completed CHRMAP	 \$30,000 (Plus 10% annual maintenance of \$3,000) Operational Grants 	MU1 and MU2	Continue	Continue
Demolition / removal / relocation of asset from inside hazard area (PMR2)	 Preparation of Asset Management Plan to 2048 for public-built assets. Maintenance assumes ongoing allowance for foreshore reserve. Removal / Relocation of assets as required. 	■ LGA	 Audit of assets within 2048 erosion hazard zone and identification of assets where damage would be unacceptable 	(Plus 1% annual maintenance of	MU1 and MU2	Continue	Continue

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WATER TECHNOLOGY WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Recommendation	Notes	Responsibility	Trigger	Cost (if known) and Funding	Short- term	Before 2050	2050- 2125
Prevention of further development / prohibit expansion of existing use rights (PMR3)	 Item cost for investigations and management plans. Investigate opportunities for leaseback of land and land swaps in the context of planned and managed retreat. Seek legal advice regarding the basis of agreements with landholders and whether opt-ins can be time constrained. 		■ Completed CHRMAP	 \$60,000 (Plus 1% annual maintenance of \$600) Operational Grants 	MU1 and MU2	Continue	Continue
Leaving assets unprotected (PMR1)	 To 2048 for low-value public assets. Assumes a clean-up rate following damage/loss. No private land acquisition included. Maintenance assumes ongoing allowance for foreshore reserve. 	■ LGA	 Storm damage Audit of assets within 2048 erosion hazard zone and identification of assets where damage would be unacceptable 	\$130,000(Plus 3% annual maintenance of \$3,900)Operational	MU1 and MU2	Continue	Continue
Recommended Medium Term option to address Erosion is Protection with Beach Nourishment (PR1)	 Assumes suitable sand source available (grain size, volume, cleanliness, proximity). 2047 implementation is projected for MU2 and 2073 implementation for MU1, so there are no priority actions in short-term. 	■ LGA	MonitoringUpdated CHRMAP	 Approximate capital cost of \$19.14M for MU1 and \$8.45M for MU2 at NPV 4% for Annual maintenance estimate of approximately \$0.4M. Operational Grants Direct beneficiaries 		MU2	MU2, MU1

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APPENDIX A ESTABLISH THE CONTEXT CHAPTER REPORT







APPENDIX B RISK IDENTIFICATION CHAPTER REPORT







APPENDIX C VULNERABILITY ANALYSIS CHAPTER REPORT







APPENDIX D RISK EVALUATION AND RISK TREATMENT OPTIONS CHAPTER REPORT







APPENDIX E ASSESSMENT OF RISK TREATMENT OPTIONS CHAPTER REPORT







APPENDIX F IMPLEMENTATION AND MONITORING CHAPTER REPORT





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