An aerial photograph of a coastal region. On the left, a densely populated town with many houses and buildings is visible. To the right of the town is a large, green golf course. Further right is a long, sandy beach that curves along the coastline. The ocean is a deep blue, and the water near the shore is a lighter turquoise color. In the background, there are dark, forested hills.

Emu Point to Middleton Beach Coastal Hazard Risk Management Adaptation Plan - Implementation Plan

December 2019



ACKNOWLEDGEMENT

The CHRMAP process acknowledges the traditional custodians of the study area, the Minang people of the Noongar Nation. We recognise their cultural heritage, beliefs and relationship to the land, which continues to be important to Noongar people today. The ancestors of the Noongar people saw the shorelines of Albany rise and fall and they were able to adapt to an ever-changing landscape. We acknowledge the input of Aboriginal community members into this plan and pay our respects to Elders past, present and future.

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Front cover image source: City of Albany

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Summary

The City of Albany (The City) has undertaken development of a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) to provide strategic guidance on coordinated, integrated and sustainable planning and management for key coastal assets in the Emu Point to Middleton Beach area.

The study area has experienced historic storm erosion and is at risk of future erosion and inundation due to storm events and predicted sea level rise. This is significant in the context of the Emu Point to Middleton Beach area, as the community has identified area highly valued for economic, social and environmental reasons.

The CHRMAP has been developed for the City based on the Western Australian Planning Commission (WAPC) CHRMAP guideline document (WAPC, 2014), which provides a risk management approach to dealing with forecast impacts from coastal hazards. This approach will enable the community of Albany to proactively plan for change and manage impacts over the long-term.

This Implementation Plan is based on extensive technical background research and investigations, community and stakeholder values and inputs, recognition of strategic planning and governance interventions available to the City and the need for culturally and economically acceptable outcomes.

Seven highly valued assets have been identified by this report as requiring adaptation in the short term (0-10 years), whilst the remaining assets within the 100 year hazard lines are likely to be at risk of erosion in long term (up to 100 years) and broader adaptation pathways are identified in this report to reduce coastal impacts of erosion.

The recommended adaptation options for the assets requiring short term management are as follows:

- MU1 Beach: Sand nourishment.
- MU2 Foreshore: Avoid further development.
- MU2 Big4 Middleton Beach: Staged relocation of assets.
- MU2 Big 4 Middleton Beach: Protect - seawall.
- MU3 Griffiths Street Properties: Managed retreat, relocate assets.
- MU3 Emu Beach Holiday Park and Dual Use Path: Managed retreat of assets in the southern portion.
- MU3 Emu Beach Holiday Park and Dual Use Path: Renovation/expansion of groynes (geotextile sand container).
- MU3 Emu Beach Holiday Park and Dual Use Path: Upgrade Existing Protection Structures.
- MU4 Emu Point Foreshore Reserve: Maintain and enhance nearshore system – seagrass regeneration.
- MU4 Emu Point: Revetment and parkland development.
- MU5 Oyster Harbour Southeast Beach: Sand nourishment.

This Implementation Plan also recommends key strategic planning, statutory planning, and policy or governance interventions that are relevant to all assets, including those at risk over the longer-term. The City of Albany will need to implement these options regardless of the final adaptation option chosen per at-risk asset.

The triggers for action and planning timelines provide guidance and a degree of flexibility, as the approach to coastal erosion and inundation are likely to change over time.

This Implementation Plan is supported by the Coastal Hazard Risk Management and Adaptation Plan report which provides detailed background information to this document.

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1. Introduction

1.1. Our Coast is Changing

Coastal zones are vulnerable to adverse impacts from nature – specifically - inundation (waves and water surging from the coast) and erosion (the loss of beach and vegetation). The risk to people and property is influenced by the level of preparedness of the community to events and its capacity to recover after events. National and international coastal planning practices are increasingly adopting a risk management approach to deal with the potential adverse impacts of coastal hazards, ensuring that coastal hazards are appropriately factored into decision-making processes in the coastal zone.

The coast between Middleton Beach and Emu Point is already vulnerable to these effects.

The State Government's coastal planning policy State Planning Policy No. 2.6 State Coastal Planning Policy (SPP2.6) supports a risk management approach and provides the framework for undertaking risk management and adaptation planning for coastal hazards in Western Australia.

1.2. What is a CHRMAP

A Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) is a plan developed in line with this risk management approach. The Emu Point to Middleton Beach CHRMAP (hereafter referred to as the CHRMAP) is designed to identify coastal inundation and erosion hazards for the area between Middleton Beach and Emu Point and recommends controls to manage and mitigate the risk over the short and long term.

This document provides a guide to the type of actions required to mitigate the risks, when they should be implemented and what the impact will be in terms of effectiveness and cost.

The CHRMAP identifies potential impacts based on technical modelling; the actual timeframes or significance of impacts may occur sooner or later than predicted over time, and some degree of risk will remain and must be accepted and managed. Risk management can be guided by the cost of implementation, the ability to fund that option, the effectiveness of the solution, the impact of the solution on future mitigation options and the values of the community of the day.

1.3. Key Terminology

CHRMAP documents are highly technical and full of plenty of jargon. To help interpretation of this document, we have included a handy Glossary of terms in Appendix 1. Nine key terms which are used regularly are defined as follows:

'asset' means a resource with economic or social value that an individual, corporation or government owns or controls with the expectation that it will provide a future benefit. Assets can be both man made (e.g. roads, buildings, utilities) or natural (e.g. beaches, dunes, bushland).

'development' the development or use of any land, including —

- any demolition, erection, construction, alteration of or addition to any building or structure on the land;
- the carrying out on the land of any excavation or other works;

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

'event' any occurrence of a particular set of circumstances that can have an adverse impact(s) on the environment. The event can be certain or uncertain, and be a one-off occurrence or a series of occurrences of a particular set of circumstances.

‘flood’ an overflow of a large amount of water beyond its normal limits, especially over normally dry land.

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

‘risk’ is specified in terms of an hazardous event or circumstances and the consequence that may flow from it. Risk is measured in terms of a combination of the likelihood of an event occurring and the consequence of that event occurring.

‘risk assessment’ the overall process or method for evaluating risks associated with a specific coastal hazard and includes risk identification, risk analysis and risk evaluation.

‘vulnerability’ the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. Systems that are highly exposed, sensitive and less able to adapt are vulnerable.

1.4. Study Area

This CHRMAP concentrates on the coast between Middleton Beach (Wooding Point) and Emu Point (Oyster Harbour Beach) (see Figure 1 & 2). This area comprises a variety of well recognised areas or assets used by local, regional and tourist populations.

The study area has been divided into 5 Management Units (MU) which each have characteristics that respond similarly to the coastal environment. The Management Units are shown in Figure 3.

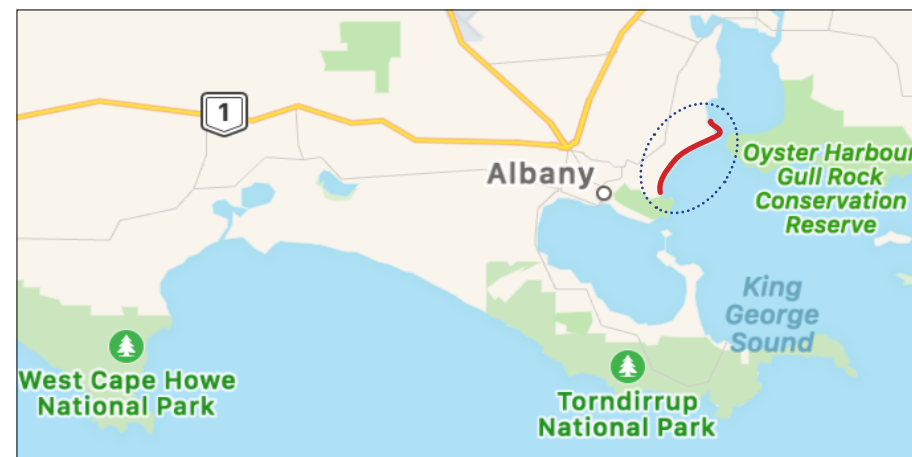


Figure 1 - Regional Location



Figure 2 – Study Area

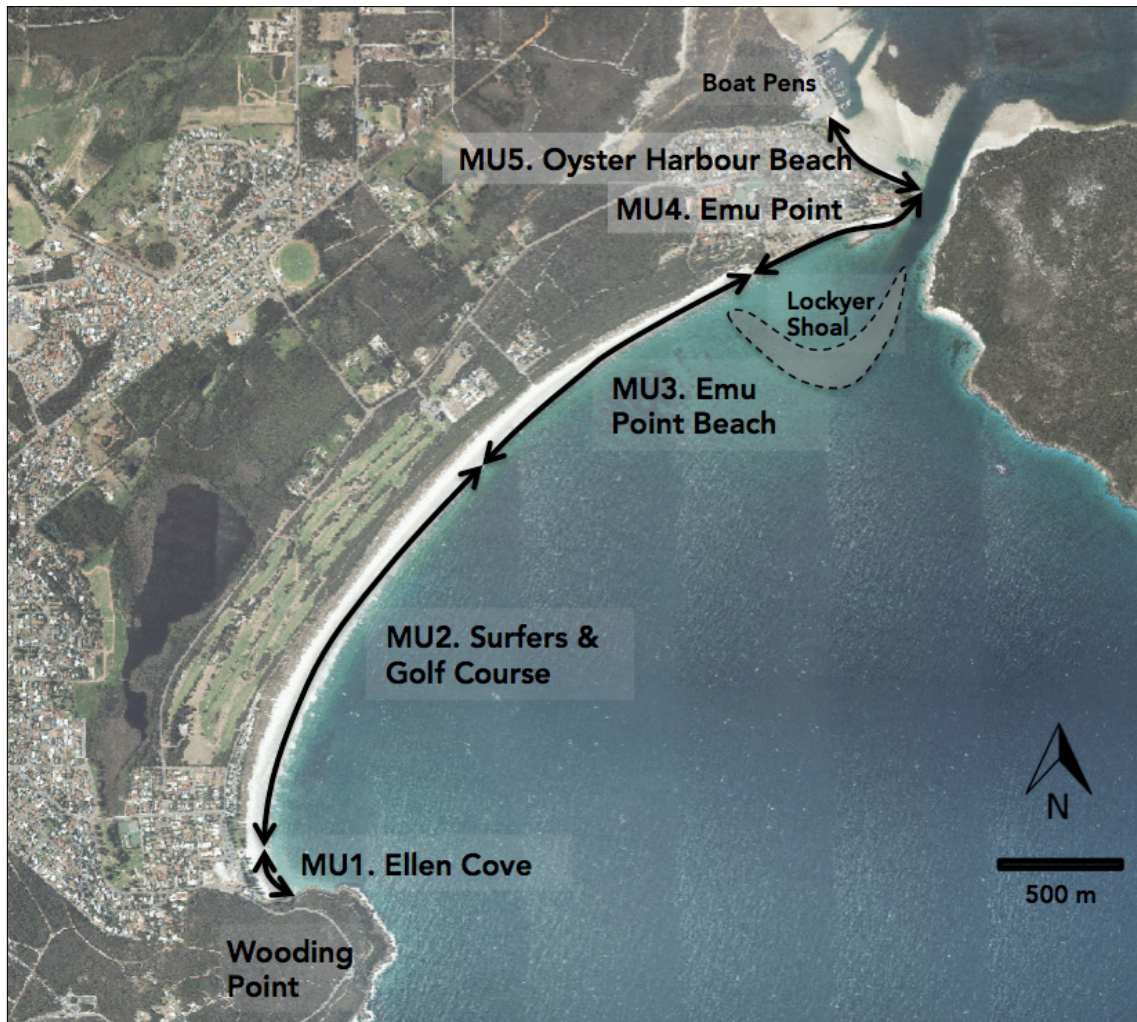


Figure 3 - Emu Point to Middleton Beach Study Area Management Units

1.5. Purpose of this CHRMAP

Impacts from inundation and erosion are already being experienced locally with significant historical coastal erosion resulting in the construction of various seawall, revetment and breakwater (rock wall) structures. If no action is taken the impacts will become more severe and will begin to effect assets including access to the beach, footpaths, roads, services and homes.

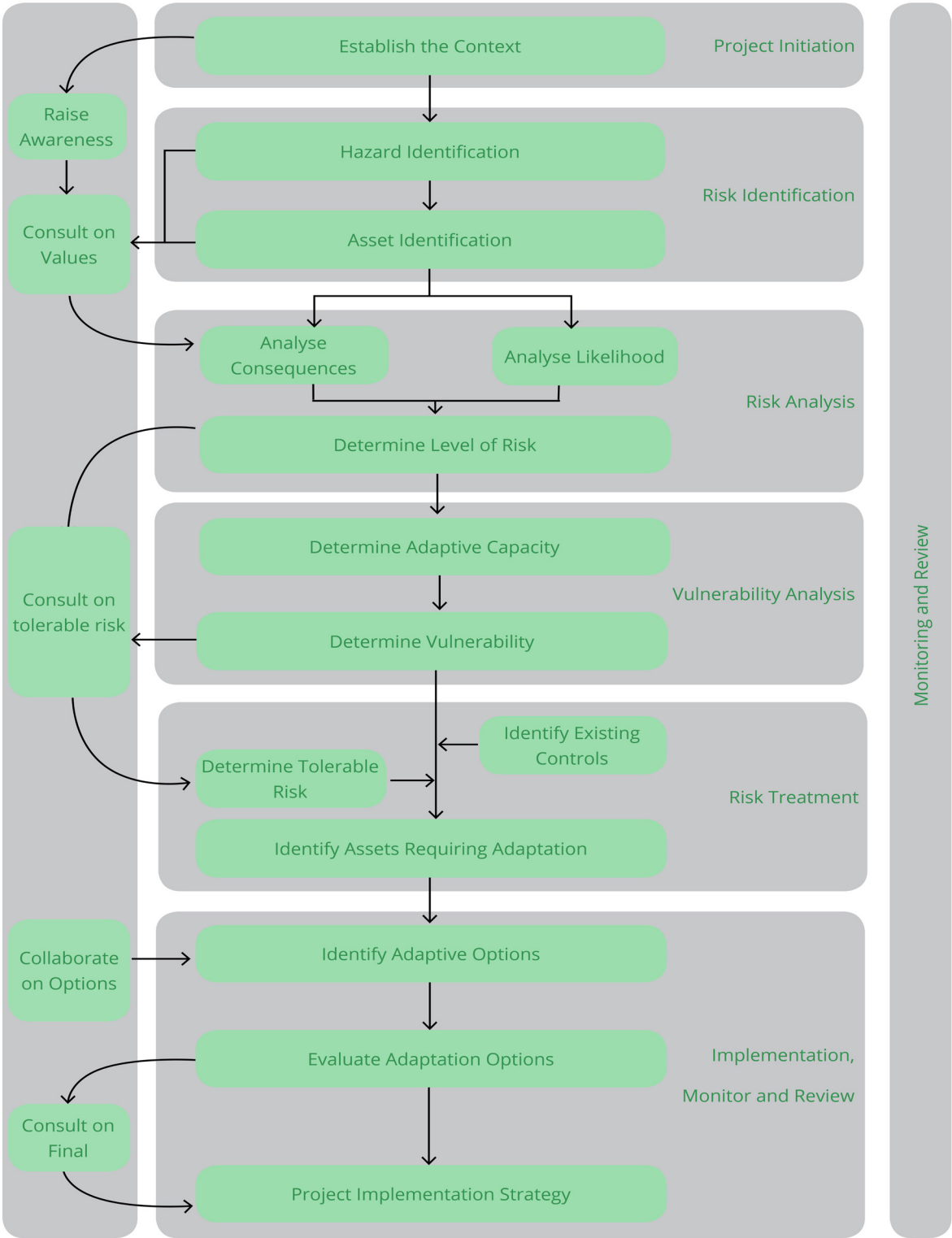
This CHRMAP provides guidance on what actions need to be taken and in approximately what time frame to best adapt to the changing environment without loss of valued assets or risk to life or property. The level of impact and the timing of impact can only be approximate, however, the predicted impacts *will* occur if no action is taken. As such this Implementation Plan refers to approximate timeframes of short, medium or long term based on estimated timing of impacts, but more accurately uses defined trigger distances to indicate when a decision must be made.



2. Background

This CHRMAP is the final stage in a detailed assessment of the study area. The assessment has considered the existing structures and landscapes within the area before considering the impact that inundation, erosion and a rise in sea levels would have on this highly-valued location. This Chapter provides a brief description of the technical studies and investigations which have been completed to reach the recommendations in this Implementation Plan. Background documents can be found in the detailed Coastal Hazard Risk Management and Adaptation Plan. A flowchart of the process is shown in Figure 4, and whilst this appears fairly complicated, the process is typical of these plans across Western Australia, and also very typical of any other risk and asset management assessment process.

Figure 4 - CHRMAP Process Flowchart



2.1. Hazard Identification

The potential extent of erosion and inundation for this CHRMAP area has been based on a highly detailed hazard mapping exercise undertaken by Royal Haskoning DHV (2017) which was completed for each of the timeframes 2017, 2030, 2050, 2070 and 2120.

To understand the impacts of erosion and inundation, assessment of each hazard was undertaken independently. Hazard maps for each management unit are included in Section 3, relevant to each Management Unit.

Hazard identification was determined by considering the sum of the following key factors:

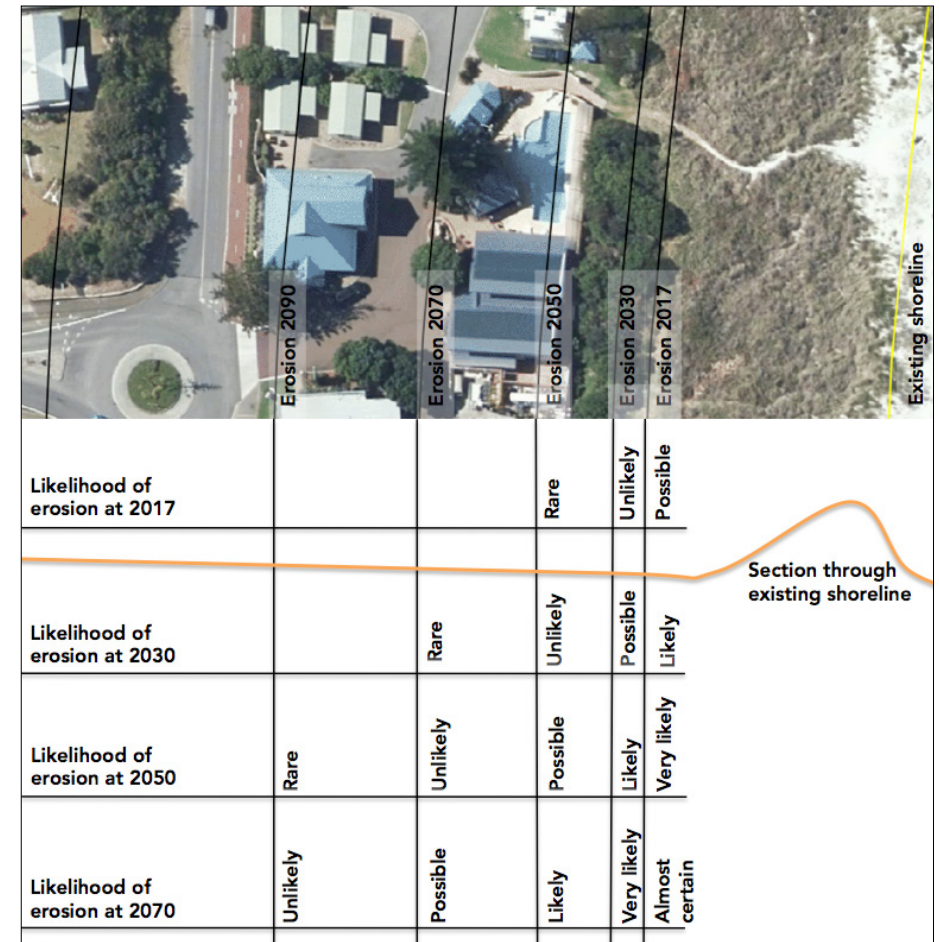
- Current risk of storm erosion
- Historic shoreline movement trends
- Future sea level rise
- Current risk of storm surge

2.2. Vulnerability

As each of the 5 management units (MU) have similar coastal behaviours within that specific management unit, the groupings help to localise the planning and treatments that may be required. Assets in the study area have been identified through research, observation and stakeholder engagement, for the purpose of evaluating the values associated with individual or collective assets.

The risk to each asset has been mapped and evaluated through modelling, to determine the likely timing of the asset becoming at risk. Generically, this filtering is illustrated in Figure 5, where the asset chosen is the site, including the swimming pool and adjacent buildings. This figure shows that risk is not 'fixed' at a given point in time, rather that the likelihood of risk increases over time, relative to the likely point of erosion at that time.

Figure 5 - Example likelihood of risk over time



Once assets in the study area were identified and the coastal processes appropriately modelled, the CHRMAP process considered the potential impacts on assets alongside the adaptive capacity (ability to respond) to the risk. This resulted in a vulnerability rating for each asset within the study area, described over time. An example is provided in Table 1 of two assets within the study area – the Beach (sand only) and the Foreshore Reserve at Ellen Cove. Each asset was considered independently, as can be seen by comparing how each performs against time and relative to either erosion or inundation.

In this example case, a buried seawall is factored in as this form of mitigation has been committed to as part of the Middleton Beach Activity Centre development.

Short term refers to the immediate implications as well as the period up to 10 years (from 2017).

Medium term refers to a period from 10 -50 years (2030 – 2070).

Long Term refers to a period beyond 50 years (2070 - 2120).

MANAGEMENT UNIT		ASSET	EROSION VULNERABILITY				EXISTING PHYSICAL CONTROLS
			2017	2030	2070	2120	
1	Ellen Cove	Beach	Extreme	Extreme	Extreme	Extreme	Impact of buried seawall expected to reduce the adaptive capacity to very low.
		Foreshore Reserve	***	***	Extreme	Extreme	*** Buried Seawall - Likelihood of erosion hazard mitigated to 2060 through the construction of a buried seawall as part of the Middleton Beach Activity Centre development.
		ASSET	INUNDATION VULNERABILITY				EXISTING CONTROLS
			2017	2030	2070	2120	
1	Ellen Cove	Beach	Low	Low	Low	Low	
		Foreshore Reserve	-	Low	Low	Low	

Table 1 - Example Vulnerability Assessment Table

2.3. Adaptation options

To guide the selection of adaptation options, SPP 2.6 identifies the hierarchy of controls which are required to be considered. SPP 2.6 preferences options which are at the 'Avoid' level of the spectrum, with 'Protect' the least favoured:

Avoid - Options which aim to eliminate the risk of coastal hazards by avoiding development within areas identified as being impacted by erosion or inundation. Avoid includes using planning tools to restrict development in the vulnerable area.

Managed Retreat - Options which allow for the progressive retreat of the shoreline and removal/relocation of development. Managed Retreat options include things like relocation of property and infrastructure.

Accommodation - Options which seek to enhance the adaptive capacity and resilience of assets to cope with the temporary impacts of coastal hazard events. These can include bringing in sand or pushing sand along the beach to eroding areas.

Protection - Options which seek to artificially protect the coast to reduce the likelihood of coastal hazards impacting on assets. This can include seawalls and groynes.

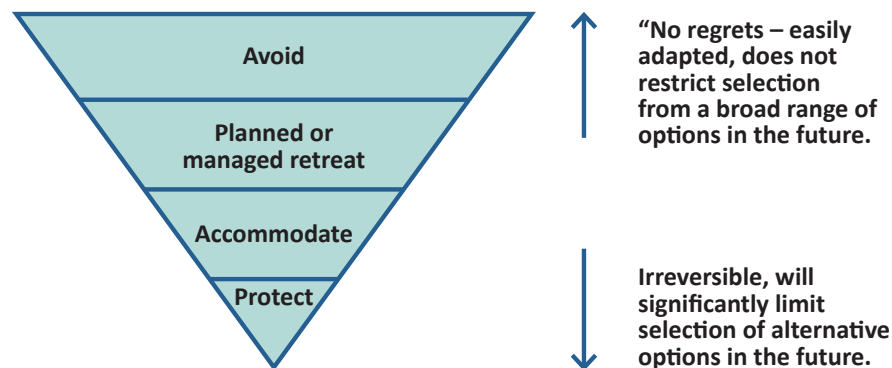


Figure 6 - The SPP 2.6 Adaptation Options Spectrum

2.4. Assessment of Options

A multi-criteria analysis (MCA) has been used to assess the positive and negative aspects of the possible adaptation options for each asset with high or extreme vulnerability at 2030, which is within a reasonable planning horizon.

MCA helps to identify and rank the important factors considered when choosing a particular option, by scoring individual factors, or criteria, and then collating the scores. The final score was based on agreed measures determined by community panel to define the option that had the best overall score.

The multi-criteria matrix was developed in consultation with the City and key community and stakeholder participants. The seven criteria considered were:

- Capital cost - considers the financial implication, including whether the City has the capacity to undertake the works independently or if it will require external funding/support, likely by state or federal government.
- Maintenance costs - identifies the financial liability to maintain the adaptation option over the full life of the option.
- Environmental impact - considers impacts on natural assets and the potential for subsequent environmental impact.
- Social/amenity impact - takes into consideration the community values which may be affected.
- Property impact - takes into consideration the risk to housing and businesses
- Reversibility - identifies the flexibility of an action to allow a broad range of future options in the context of the hierarchy of controls identified in SPP 2.6.
- Effectiveness - identifies the likelihood of the option in reducing the impact of coastal hazards.

In this MCA, the option with the lowest score (that best achieves the majority of the community's values) is the preferred option. Figure 7 illustrates how two options may score differently against each other. In this example, even though individual criteria such as Environmental Impact might preference Option 2, the combined score preferences Option 1. The preferred option may still include an analysis of the trade-offs and potential mitigation to reduce any negative impacts.

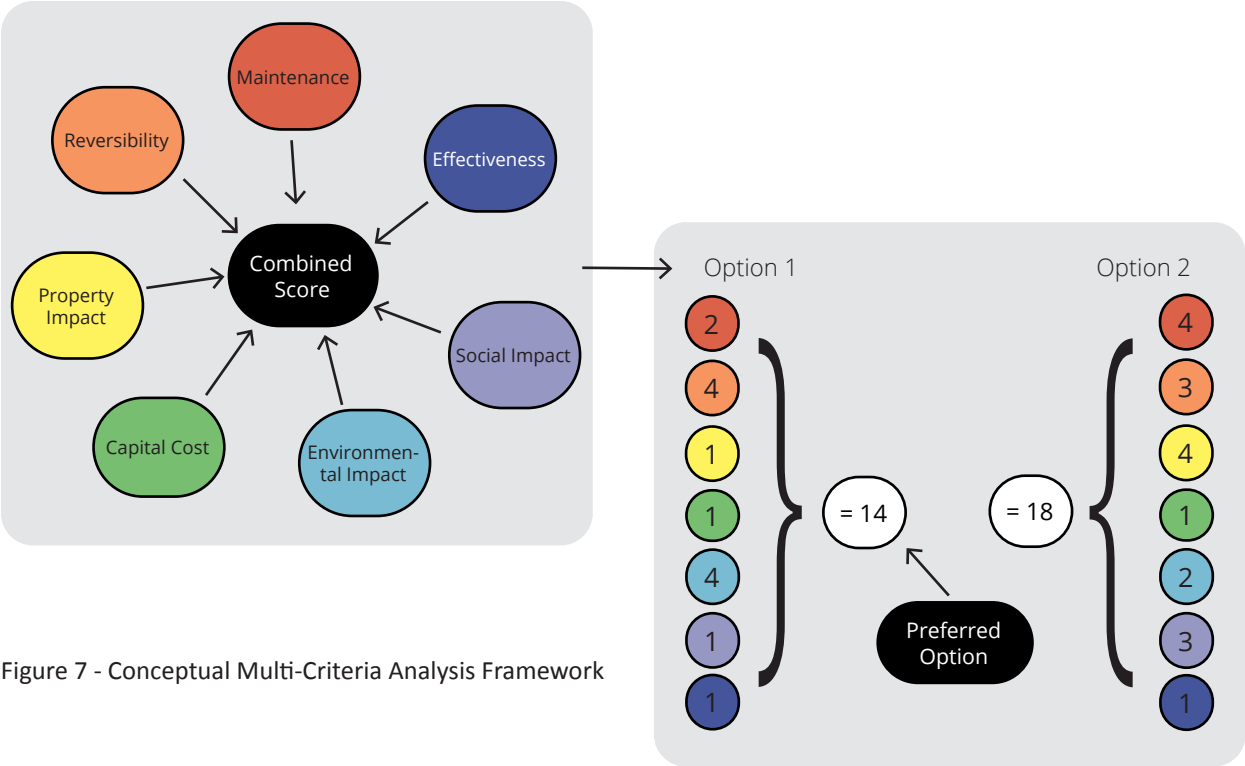


Figure 7 - Conceptual Multi-Criteria Analysis Framework

2.5. Implementation

The implementation actions recommended within this plan acknowledge the hierarchy of controls and are guided by the outcomes of the MCA. The actions recommended for implementation have been categorised as those that are considered to be worth pursuing in the short term (0-10 years), actions that should be reviewed in the medium term after a review of the impact of the short term options (10-50 years) and those that should be considered in the long term (beyond 50 years) after relevant catalyst trigger points are reached.

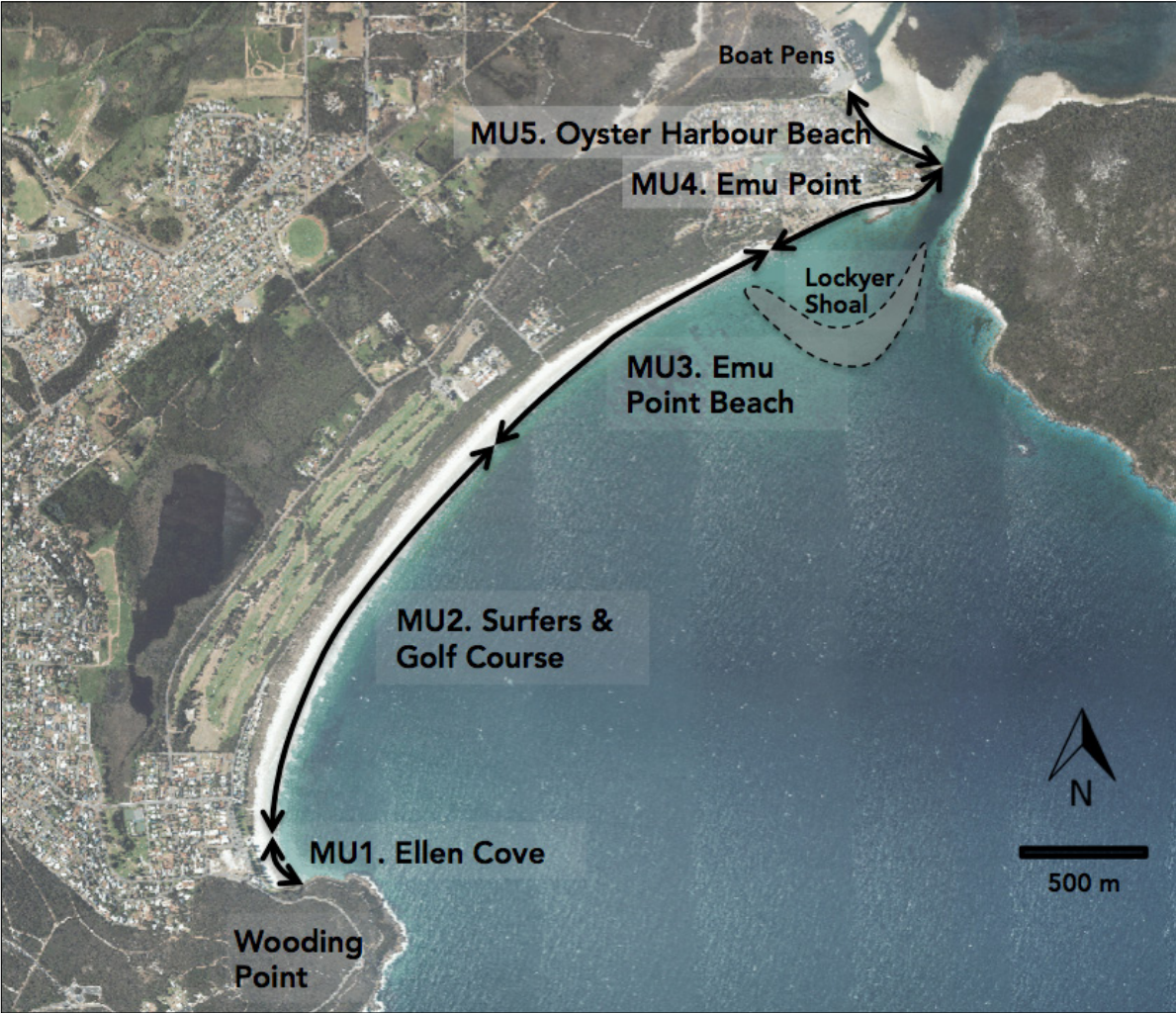
3. Management Areas and Erosion Vulnerability

Section 3 of this plan provides a brief description of each of the assets which have been assessed in the CHRMAP. The study area has been divided into the management units based on previous work undertaken by Royal Haskoning DHV (2017). The management units are illustrated in Figure 8.

The management units define sections of the coastline which share similar characteristics and provides a framework for monitoring and management.

This section reads from south at Middleton Beach north to Emu Point, with each management unit described and assets which are vulnerable in the short term highlighted along with the predicted erosion vulnerability over time.

Figure 8 - Management units



3.1. MU1 Ellen Cove

Management Unit 1 (Ellen Cove) extends southward from the Albany Surf Life Saving Club (ASLSC). It includes the Middleton Beach Activity Centre (MBAC) which was recently rezoned Special Use Area (SU25) in the City of Albany Local Planning Scheme No.1. For the purpose of this CHRMAP it has been assumed that development of the MBAC precinct is imminent and will occur as per the draft Foreshore Management Plan (RPS 2018).

This section of shoreline is in the lee of Wooding Point headland. The shoreline is strongly influenced by the headland, resulting in a curving alignment and is relatively well sheltered.

The beach is relatively stable and artificially maintained by occasionally removing imported sand to provide recreational amenity. The beach is backed by a grouted rock wall. The individual assets are identified in Figure 9 and the hazard maps for this area are shown in Figure 10. Table 2 provides a summary of each asset's vulnerability within the site and a brief description of how the vulnerability may be expressed in the eyes of the community. Table 2 also identifies whether the asset is likely to experience vulnerability in the short, medium or long term.

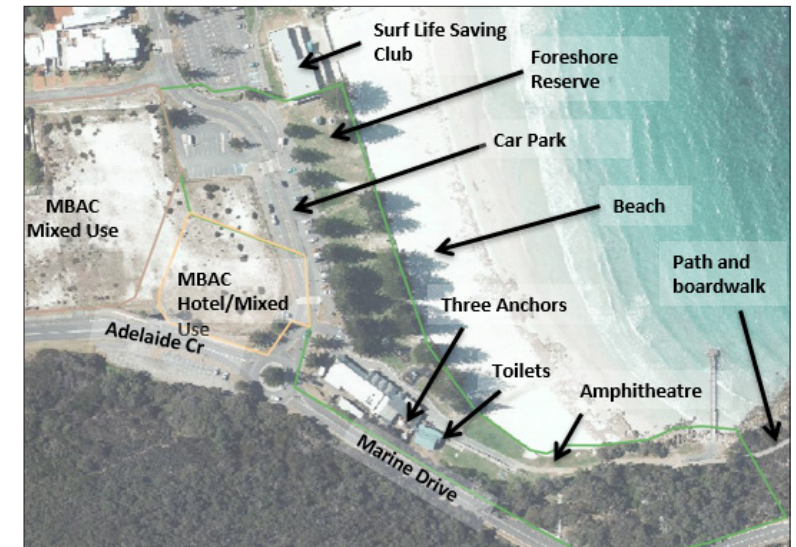


Figure 9 -
MU1 Asset
Map

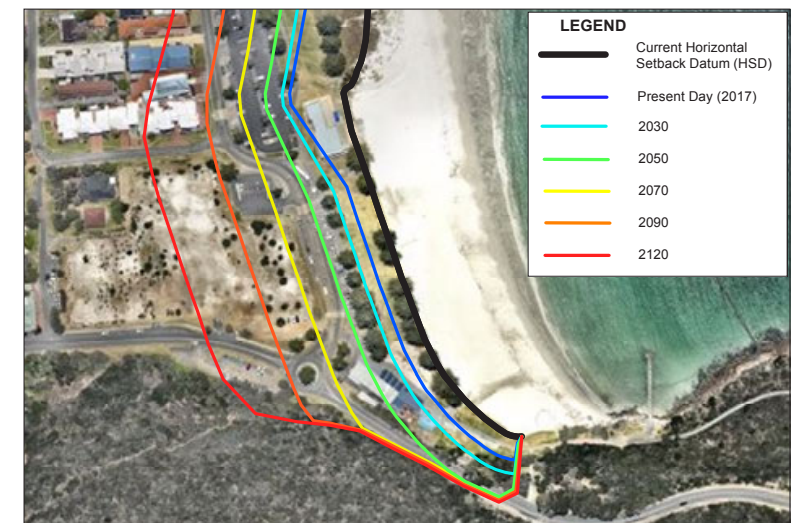


Figure 10 -
MU1 Hazard
Map

Table 2 - MU1 Ellen Cove Asset and Vulnerability over Time

MANAGEMENT UNIT	ASSET	EROSION VULNERABILITY				COMMENT	TIME FRAME
		2017	2030	2070	2120		
MU1 - Ellen Cove	Beach (sand only)	Extreme	Extreme	Extreme	Extreme	Extreme erosion vulnerability, due to the very low adaptive capacity resulting from the proposed buried seawall. Beach may erode more quickly leaving limited 'beach'. A promenade along the top of the wall will provide ongoing access to the waterfront.	Short
	Foreshore Reserve	***	***	Extreme	Extreme	*** Buried Seawall - Likelihood of erosion hazard mitigated to 2060 through the construction of a buried seawall as part of the MBAC development as detailed in the draft foreshore management plan. After this period, a retrofit of the coastal protection could provide protection for the ensuing period. Ongoing maintenance of the seawall structure is assumed.	Medium
	Toilets	***	***	Extreme	Extreme		
	Three Anchors	***	***	Extreme	Extreme		
	Marine Dr/ Adelaide Cres	***	***	Medium	High		
	MBAC Hotel/ Mixed Use	***	***	Extreme	Extreme		
	MBAC Mixed Use	***	***	Extreme	Extreme		
	Albany Surf Life Saving Club	***	***	Extreme	Extreme		

3.2. MU2 Surfers and Golf Course

Management unit 2 (Surfers Beach and the Albany Golf Course) extends from the Albany Surf Lifesaving Club at Ellen Cove to the northern boundary of the golf course. This section of shoreline has been increasing in width in recent years. Because it has the greatest exposure to storm events, it is susceptible to storm erosion, however it has the ability to rebuild and naturally repair. In the short-term it is expected to be stable with a large natural foreshore buffer to shoreward assets.

The individual assets are identified in Figure 11 and the hazard maps for this area are shown in Figure 12. Table 3 provides a summary of each asset's vulnerability within the site and a brief description of how the vulnerability may be expressed in the eyes of the community. Table 3 also identifies whether the asset is likely to experience vulnerability in the short, medium or long term.

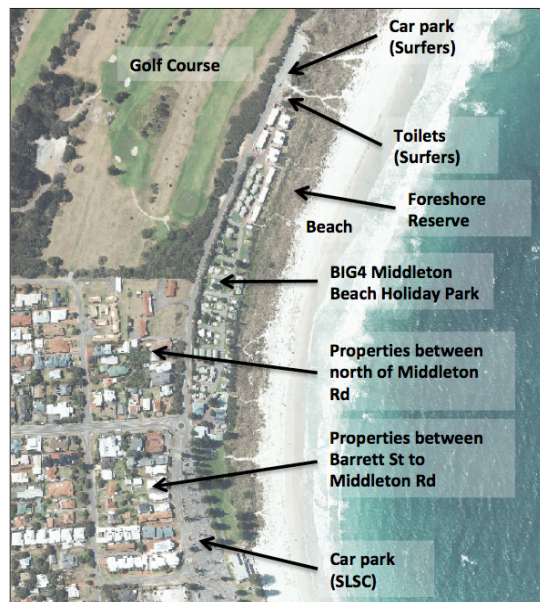


Figure 11 - MU1 Asset Map

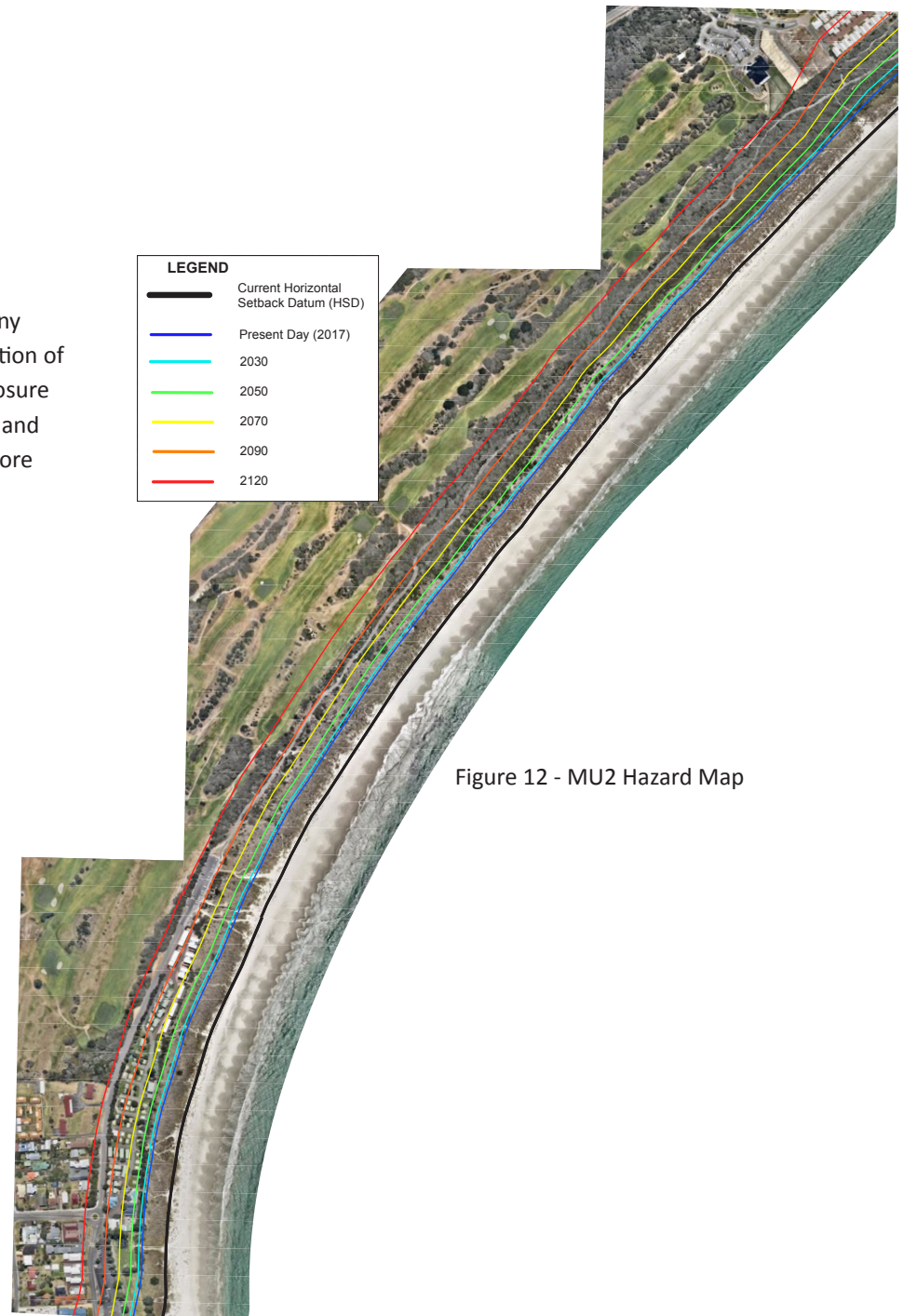


Figure 12 - MU2 Hazard Map

Table 3 - MU2 Surfers and Golf Course Asset and Vulnerability over Time

MANAGEMENT UNIT	ASSET	EROSION VULNERABILITY				COMMENT	TIME FRAME
		2017	2030	2070	2120		
MU2 - Surfers and Golf Course	Beach	Low	Medium	Medium	Medium	Medium erosion vulnerability. Beach may erode subsequent to large storm events, reducing walking access.	Short
	Foreshore Reserve	Medium	High	High	Extreme	Medium to High erosion vulnerability. Beach may erode subsequent to large storm events, reducing walkability.	Short
	Carpark (ASLSC)	Low	Low	Medium	High	Likelihood of erosion hazard is low until 2070 due to the distance, vegetation and topography. After this period the risk is likely to escalate unless direct mitigation is planned.	Medium
	Properties between Barret St to Middleton Rd	-	-	Extreme	Extreme		
	Properties north of Middleton Road	-	-	Extreme	Extreme		
	Big 4 Middleton beach Holiday park	Medium	High	Extreme	Extreme	Medium to High erosion vulnerability in the short term. The capacity of the shoreline to rebuild and repair will need to be considered against the risk to property/damage from large storm events.	Short
	Flinders Pd north	-	-	High	Extreme	Likelihood of erosion hazard is low until 2070 due to the distance, vegetation and topography. After this period the risk is likely to escalate unless direct mitigation is planned.	Medium
	Carpark- Surfers	-	-	Low	Low		
	Toilets- Surfers	-	-	Extreme	Extreme		
	Golf Course	-	-	Low	Low		

3.3. MU3 Emu Point Beach

Management Unit 3 (Emu Point Beach) extends from the northern boundary of the golf course to the Emu Point revetment. This section of shoreline is strongly influenced by the Lockyer Shoal. It transitions from a stable growing shoreline to the eroded area adjacent to the Emu Point revetment. It is possible that the erosion adjacent to the revetment is beginning to reach an equilibrium, with a reduction in recent years. This section of shoreline is relatively sheltered from normal storm events. However, it can be subject to significant erosion during less frequent storms with a more southerly aspect.

The individual assets are identified in Figure 13 and the hazard map for this area is shown in Figure 14. Table 4 provides a summary of each asset's vulnerability within the site and a brief description of how vulnerability may be expressed in the eyes of the community. Table 4 also identifies whether the asset is likely to experience vulnerability in the short, medium or long term.



Figure 13 - MU3 Asset Map

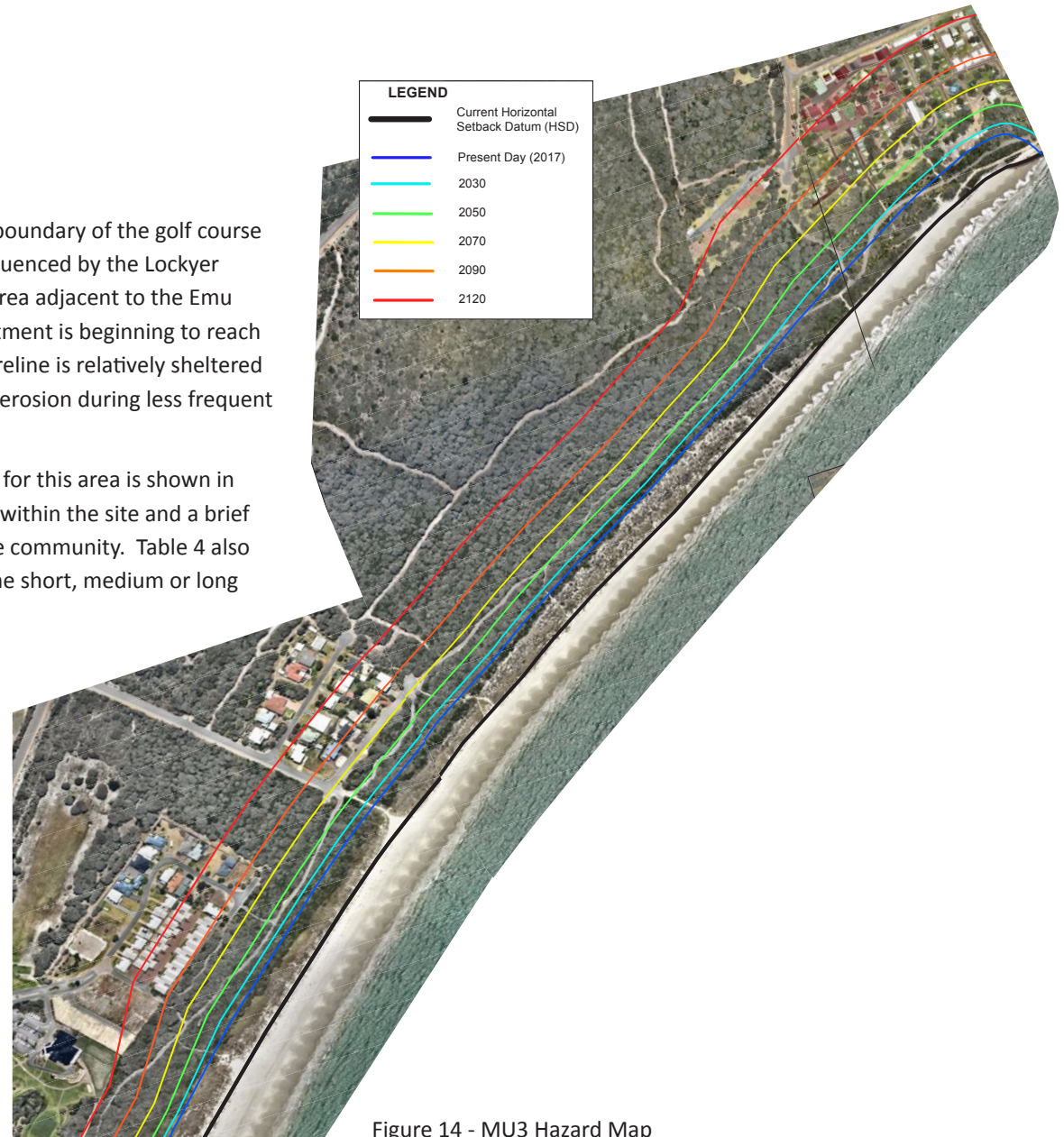


Figure 14 - MU3 Hazard Map

Table 4 - MU3 Emu Point Beach Asset and Vulnerability over Time

MANAGEMENT UNIT	ASSET	EROSION VULNERABILITY				COMMENT	TIME FRAME
		2017	2030	2070	2120		
MU3 - Emu Point Beach	Beach	Low	Medium	Medium	Medium	Medium erosion vulnerability. Beach may erode subsequent to large storm events, reducing walking access.	Short
	Foreshore Reserve	Medium	High	High	Extreme	Medium to High erosion vulnerability. Beach may erode subsequent to large storm events, reducing walking access.	Short
	Properties on Barry Court	–	–	Extreme	Extreme	Likelihood of erosion hazard is low until 2070 due to the distance and topography. After this period, a managed retreat could be implemented.	Medium
	Properties on Griffiths Street	–	Extreme	Extreme	Extreme	Extreme erosion vulnerability, due to the asset's very low adaptive capacity. Griffiths Street itself is the asset which will be first affected by erosion, severing legal access to these properties.	Short
	Developable Land	Low	Low	Low	Low	Likelihood of erosion hazard is low throughout the 100 year period due to the distance, vegetation and topography.	Long
	Emu Beach Holiday Park	Low	Low	Medium	High	Camping grounds, caravan sites and out buildings may be impacted in the short term if renovations to the seawall are limited to the original construction locations. Further structures and infrastructure coastward of the Central Road are vulnerable from 2070.	Medium

3.4. MU4 Emu Point

Management Unit 4 (Emu Point) extends from the start of the revetment to the entrance to Oyster Harbour. This section of shoreline is defined by a number of existing coastal protection structures (rock revetment, breakwater/headland, training wall and groyne). The shoreline is controlled by the structures and the risk to assets is dependent on the structures' integrity.

The individual assets are identified in Figure 15 and the hazard maps for this area are shown in Figure 16. Figure 17 shows the hazard lines if the existing structures were removed. Table 5 provides a summary of each asset's vulnerability within the MU and a brief description of how the vulnerability may be expressed in the eyes of the community. Table 5 also identifies whether the assets are likely to experience vulnerability in the short, medium or long term.

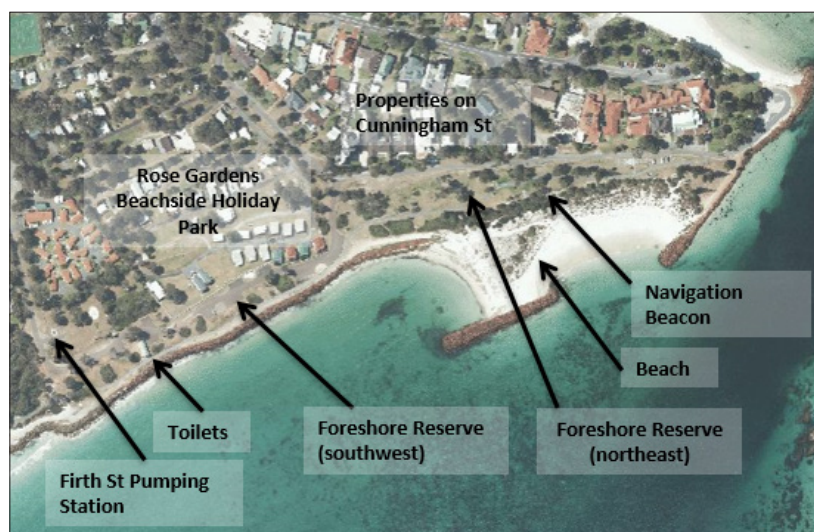


Figure 15 - MU4 Asset Map

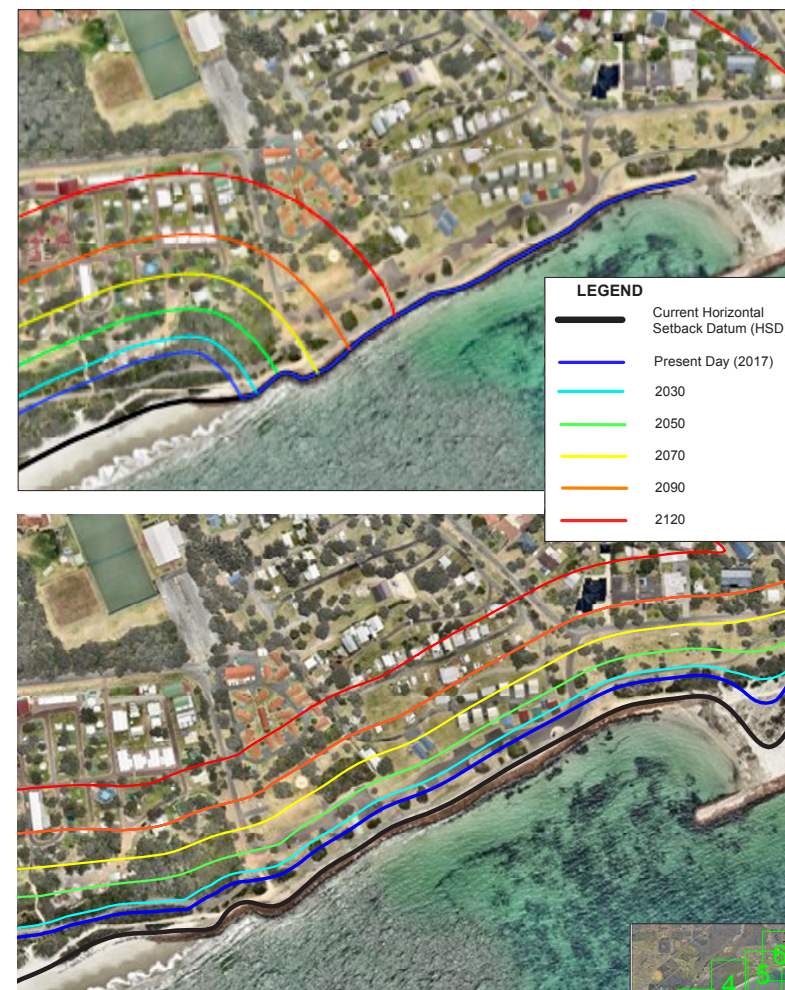


Figure 16 (above) - MU4 Hazard Map with existing structures

Figure 17 (below) - MU4 Hazard Map without existing structures

Table 5 - MU4 Emu Point Asset and Vulnerability over Time

MANAGEMENT UNIT	ASSET	EROSION VULNERABILITY				COMMENT	TIME FRAME
		2017	2030	2070	2120		
MU4 - Emu Point	Beach	–	–	High	High	Detached breakwater headland - based on current condition structure is expected to mitigate likelihood of coastal erosion over the next 25 years. Routine maintenance is required.	Medium
	Foreshore Reserve (northeast)	–	–	Extreme	Extreme		
	Foreshore Reserve (southwest)	–	Extreme	Extreme	Extreme	Extreme erosion vulnerability, due to the poor condition of the revetment seawall.	Short
	Toilets	–	Extreme	Extreme	Extreme		
	Firth Street Pumping Station	–	–	Extreme	Extreme	Emu Point Rock Revetment - based on current condition the structure is expected to mitigate the immediate likelihood of erosion. After this period, a retrofit of the coastal protection could provide protection for the ensuing period.	Medium
	Rose Gardens Beachside Holiday Park	–	Low	Medium	Medium		
	Properties on Cunningham Street	–	–	Extreme	Extreme	Detached breakwater headland and southern groyne - based on current condition structure is expected to mitigate likelihood of coastal erosion over the next 25 years. Routine maintenance is required.	Medium
	Navigation Beacon	–	–	High	High		

3.5. MU5 Oyster Harbour Beach

Management Unit 5 (Oyster Harbour Beach) extends from the entrance to Oyster Harbour to the Emu Point Boat Pens. This section of the shoreline is sheltered from the ocean storms and is a low energy environment. The shoreline is influenced by locally generated waves. The presence of the swimming facility causes shelter from waves resulting in a bulge in the shoreline and adjacent erosion requiring periodic importing of sand to maintain a stable beach profile. The beach is backed by a grouted rock wall.

The individual assets are identified in Figure 18 and the hazard maps for this area are shown in Figure 19. Figure 20 shows the hazard lines if the existing structures were removed. Table 6 provides a summary of each asset's vulnerability within the site and a brief description of how vulnerability may be expressed in the eyes of the community. Table 6 also identifies whether the asset is likely to experience vulnerability in the short, medium or long term.

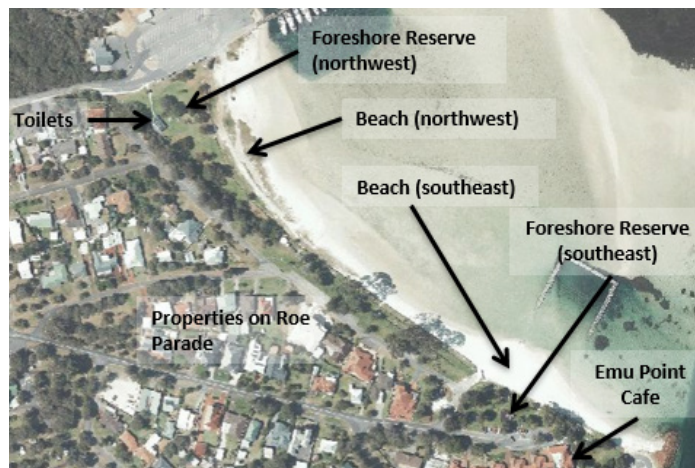


Figure 18 - MU5 Asset Map



Figure 19 - MU5 Hazard Map with existing structures

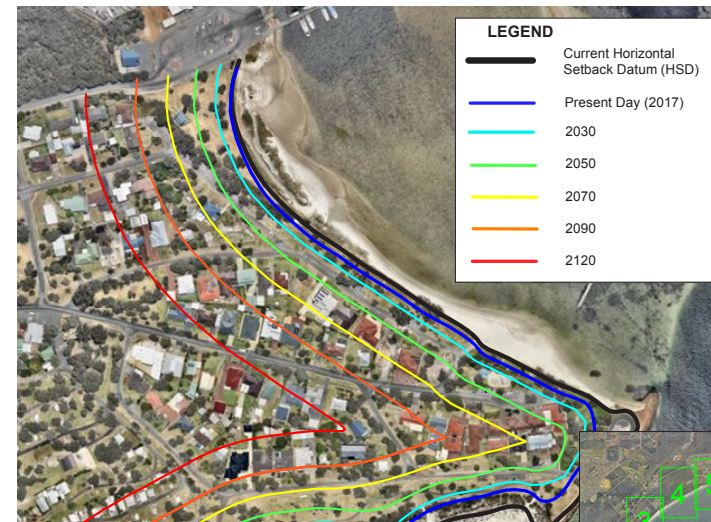


Figure 20 - MU5 Hazard Map without existing structures

Table 5 - MU5 Oyster Harbour Beach Asset and Vulnerability over Time

MANAGEMENT UNIT	ASSET	EROSION VULNERABILITY				COMMENT	TIME FRAME
		2017	2030	2070	2120		
MU5 - Oyster Harbour Beach	Oyster Harbour	Medium	Medium	High	High	Training wall, northern groyne and grouted retaining wall - based on current condition of existing protection structures it is expected to mitigate the likelihood of coastal erosion in the medium term. Routine maintenance is required.	Medium
	Beach (northwest)	Medium	Medium	High	High	Grouted retaining wall - based on current condition of the grouted retaining wall structure it is expected to mitigate the likelihood of coastal erosion over the next 15 years. Routine maintenance is required.	Medium
	Beach (southeast)	Extreme	Extreme	Extreme	Extreme	Extreme erosion vulnerability, due to the very low adaptive capacity resulting from the vertical seawall.	Short
	Foreshore reserve (northwest)	-	-	Extreme	Extreme	Grouted retaining wall - based on current condition of the grouted retaining wall structure it is expected to mitigate the likelihood of coastal erosion over the next 15 years. Routine maintenance is required.	Medium
	Foreshore reserve (southeast)	-	-	Extreme	Extreme	Training wall, northern groyne and grouted retaining wall - based on current condition of existing protection structures it is expected to mitigate the likelihood of coastal erosion over the medium term. Routine maintenance is required.	Medium
	Emu Point Cafe	-	-	Extreme	Extreme		
	Properties on Roe Parade	-	-	Extreme	Extreme	Grouted retaining wall - based on current condition of the grouted retaining wall structure it is expected to mitigate the likelihood of coastal erosion over the next 15 years. Routine maintenance is required.	Medium
	Toilets (near boat pens)	-	-	Extreme	Extreme		

4. Short Term Adaptation Recommendations

This section provides a recommended pathway for the protection of assets that are vulnerable in the short term and require immediate action. In the context of this study, short term refers to assets which are at risk immediately as well as the period up to 10 years (from 2017). The section discusses each asset in order through the Management Units from south to north

4.1. Overarching Recommendations

It should be noted that all assets within the study area become more vulnerable over time. This requires consideration of other management and adaptation planning options that may be relevant to all assets. This section summarises the key strategic planning, statutory planning, and policy or governance interventions that the City of Albany will need to implement regardless of the proposed adaptation option chosen per asset.

Recommendation 1: Local Planning Strategy – Investigation Area

The City is currently preparing its Local Planning Strategy, which provides an excellent opportunity to identify the vulnerability in this study area in the strategic planning framework. This will help to guide ongoing planning and development in the area, and provide an important signal to landowners and developers that the land in the study area has associated risks. This is an important first step to including known vulnerability in the statutory planning framework.

Recommendation 2: Local Planning Scheme Special Control Area

It is recommended that the City of Albany undertake a planning scheme amendment to include the vulnerable zone (the modelled hazard area to 2120) in a Special Control Area. This special control area will provide a signal to landowners

when buying the land, and will also enable notification to landowners if they seek a development approval.

The following requirements of the Special Control Area are recommended:

1. Specific development requirements:
 - a. Minimum setbacks from the shoreline; and
 - b. Minimum floor levels which would be higher than expected sea level and inundation impacts, using a broad range of methods and controls to achieve required Finished Floor Levels; and
 - c. The development of infrastructure running perpendicular to the coast, with main point of supply away from the coastline; and
 - d. Any assets within the shoreline setback area to be supplementary to the main development or sacrificial.

An event dependant approval could be granted which requires removal of assets if assets are rendered condemnable and acknowledging that the City is not responsible for demolition and/or maintenance of the development. Property bonds could supplement this requirement.

2. All new development approved to have a notification placed on the title ensuring current and future owners are aware of the risks associated with the development. This notification should state that 'This lot is located in an area likely to be subject to coastal erosion and/or inundation over the next 100 years'. Property bonds could supplement this requirement.
3. In the medium term, this Special Control Area could begin to introduce changes to zoning of vulnerable lands held in private ownership to a foreshore reserve.

It is recognised that this recommendation has the potential to cause concern amongst the community, especially for landowners, which is a natural response from citizens trying to protect property values. However, it must be noted that there is no obligation on Government to compensate land lost due to erosion, and it is much more proactive for the City to identify land at risk in the future and take appropriate action. For landowners who may be considering purchasing or developing lands, it is important to note that they should not assume any funds will be forthcoming to support future retreat.

Recommendation 3: City Infrastructure Asset Planning

It is recommended that the City ensure that all future infrastructure assets placed in the vulnerable zone either be sacrificial or have a design life that ensure the asset will be redundant before the risk become likely to almost certain.

The City's current spatial database is a logical location for such a management tool as it can be spatially referenced to respond to include the vulnerable zone (up to the modelled area to 2120), or the same area as shown in the Special Control Area. This will ensure that hard assets such as seating, pathways, toilets, playgrounds etc, as well as soft assets such as landscaping, be developed in such a way as to continue enjoyment of the coastal zone for as long as possible whilst also reducing or removing the risk associated with assets.

Recommendation 4: Resilience Planning and Monitoring

A number of the at-risk assets could include management options that are already ongoing City of Albany management processes. These options were 'Maintain and Enhance Beach System'; a beach scraping and sand nourishment option, and 'Maintain and Enhance Dune System'; a dune rehabilitation and protection option.

The City of Albany has committed to ongoing resilience management of the coastal system which would include both of these options at appropriate times. The ongoing dune rehabilitation is subject to securing grants, which the City will continue to apply for, support and manage.

The two options were scored comparatively. Maintain and Enhance Dune System was the preferred option with lower scores across all criteria. This aligns with community preferences for more natural options.

It is recommended that the City develop a system of assessment for priority resilience planning, which may include an ongoing schedule, as well as an event response criteria and action plan. This plan should include or should form part of a monitoring plan which should address the entire study area. It is also recommended that the City use this plan to support ongoing grant applications through grant bodies such as Coastwest. The development of this plan may be supported by the Federal Coastal Management Plan Assistance Program or the State Coastal Management Plan Assistance Program.

Recommendation 5: Sand Nourishment Investigation

A number of the at-risk assets include possible sand nourishment (importing sand from elsewhere) as a management option, however, it is acknowledged that the availability of sand for nourishment is not well understood. This plan recommends that the City undertake a sand availability analysis to determine the capacity of local sand supplies, including the feasibility of both terrestrial and marine sand sources.

It should be noted that costings in this CHRMAP have assumed a reliable source of sand in proximity to Albany, and if this is not the case the costs associated with sand nourishment could be greatly increased.

Recommendation 6: Rates Levy Investigation

Where management options proposed have the potential to protect private business or private leasehold interests, notably at Middleton Beach and Emu Point, it is recommended that the City investigate the establishment of a Specified Area Rate to support the ongoing maintenance and future replacement of protection structures. This rate could be applied to those properties who will directly benefit from the proposed or existing management option and is thus an equitable method of funding for protection options.

Recommendation 7: Lease Land Management

The City is the asset manager for a number of lease lands within the study area, some of which are identified as vulnerable in the short term.

As and when these leases come up for renewal, the City will need to consider the current day likelihood of vulnerability and carefully determine both the length of time and the suitability of granting lease extensions.

It is noted that there are a number of developments that can continue for many years in their current form. However, it may be possible to retrofit suitable design outcomes if renovation is proposed, relocate the asset outside of the vulnerable zone if the asset is considered to be beyond its suitable design life, or include conditions on the lease to require removal of infrastructure or relocation dependant on specific and agreed events or catalysts (triggers).

Recommendation 8: Purchase of Property Investigation

As noted in Recommendation 2, it is suitable to begin contemplating the gradual increase of the foreshore reserve in the vulnerable zone in the medium term. Such a decision could potentially result in an obligation on the City to acquire lands under current legislation (Injurious Affection).

It is recommended that the City investigate, as an alternative, the opportunity to acquire land as it become available on the public market. Such property could then be converted to a leasable asset and continue to be utilised up to the time when the risk becomes likely/very likely. Lease clauses may include immediate relocation of tenants. This option would result in a more flexible approach to adaptation over time, with assets being the long term responsibility of the City rather than private landowners.

Recommendation 9: Emergency Management Plan

Notwithstanding any of the above recommendations it is also recommended that the City prepare an emergency management plan to cover unexpected events, significant coastal erosion and resulting emergency asset repair or removal. This plan could be undertaken in line with Recommendation 4 and include resilience planning and monitoring activities.

The development of an emergency management plan may be supported by the Federal Coastal Management Plan Assistance Program or the State Coastal Management Plan Assistance Program.

4.2. Asset Based Recommendations

This section describes the recommended adaptation action proposed for each specific asset which is identified at risk in the short term. Each asset is briefly described and then a summary of recommendations is provided. A complete summary of all recommendations is included in Section 6 of this document.

This section introduces the concept of ‘triggers’. Triggers are an indicator of increasing risk to an asset and are consistent with the ‘S1’ factor from SPP 2.6 - the extreme storm erosion factor - which was established for the study area through detailed modelling undertaken by Royal Haskoning DHV (2017). For this reason, the trigger is not the same in every location.

This plan specifies the trigger distance for each asset.

A trigger distance is a very reliable measure of advancing risk. It does not have the same limitation as predicting the ‘time’ when risk will definitely occur. If implemented correctly, the use of well communicated triggers could have the dual benefit of enabling all members of the community to monitor coastal risk as well as continuing to inform the community at large of coastal hazards.

To clearly identify trigger points, it is recommended that a physical marker be established for all trigger distances, at the specified location *adjacent to the asset identified at risk* in accordance with the S1 hazard line. A marker pole such as those used to identify flood-ways would be a highly visible solution.

Flexible Adaptation

It should be noted that the CHRMAP process preferences the most flexible adaptation pathways; the pathways that provide for the broadest possible decision making at the time when a decision becomes necessary.

For this reason, recommended options favour Avoid and Planned Retreat where these are available. Notwithstanding, when an avoid or retreat option is recommended, many other options remain valid. This is the direct benefit of preferencing more flexible adaptation options, because it retains the greatest possible decision making available for the time when the trigger has been met.

Regardless of the recommended option, planning should continue to be undertaken on all valid options until the point a decision is to be made. Every option recommended remains subject to detailed design and investigation, which will confirm the specific design and design life, the likely impacts to adjacent areas and detailed costings.

Recommendations 1-9 provide a number of tasks that can be undertaken independent of the asset based recommendations which will continue to provide greater levels of certainty regarding particular options.

This CHRMAP will also require regular review, at which time the recommended pathway should again be considered.

4.3. MU1 Beach

Recommendation 10: MU1 Beach - Sand nourishment

As part of the LandCorp development at Middleton Beach, a buried seawall has been proposed and is now funded. To maintain a sandy beach in front of the wall, the supporting adaptation option recommended is sand nourishment.

It is recommended to maintain and enhance the beach system in front of the proposed Middleton Beach Activity Centre (MBAC) seawall after storm events. There may be a need to bring sand in from other areas if sufficient sand is not available in close proximity. Figure 21 shows an example of this management option in action and Figure 22 illustrates the recommended option. Figure 23 illustrates the actions proposed aligned with the trigger.

This option will require ongoing spending related to plant and equipment and requires relevant plant to be available in a timely manner. It also requires clear access for the plant to get onto the beach.

It is anticipated the costs will be several thousand dollars per annum and \$0.5 million over the lifetime of the adaptation option. The recommended action will need to be implemented as and when the trigger is reached. The trigger for this action is when there is a dry sandy beach width of less than 20m from erosion scarp or high-water line to the retaining wall. Given the values associated with this wide sandy beach, progressing this option more often with smaller volumes may maintain the existing enjoyment of the beach for greater periods of time, albeit with the disruption caused by the plant and equipment accessing the beach.

Implementation of this adaptation pathway should be undertaken in accordance with the existing Foreshore Management Plan (FMP), with updates to the foreshore management plan undertaken during its next review to ensure the sand nourishment adaptation pathway is adequately provided for.

Erosion hazards for other assets have been mitigated through the construction of a buried seawall as part of the MBAC development. The seawall design is considered to be suitable until approximately 2060 and there is potential that the design life may be prolonged by major refurbishment depending on the condition of the structure at this time. After 2060, major refurbishment or a new structure may be required, or a plan for managed retreat be implemented.

It was noted by stakeholders of the MCA process that at the end of the construction life of the seawall, an alternative option may need to be considered. Assets such as the foreshore, the Three Anchors tavern and cafe and the Surf Club were identified as very high value and important to the community of Albany, as well as significant to tourism activity.



Figure 21 - Typical image of Sand Nourishment



Figure 22 - MU1 Recommended Adaptation Option

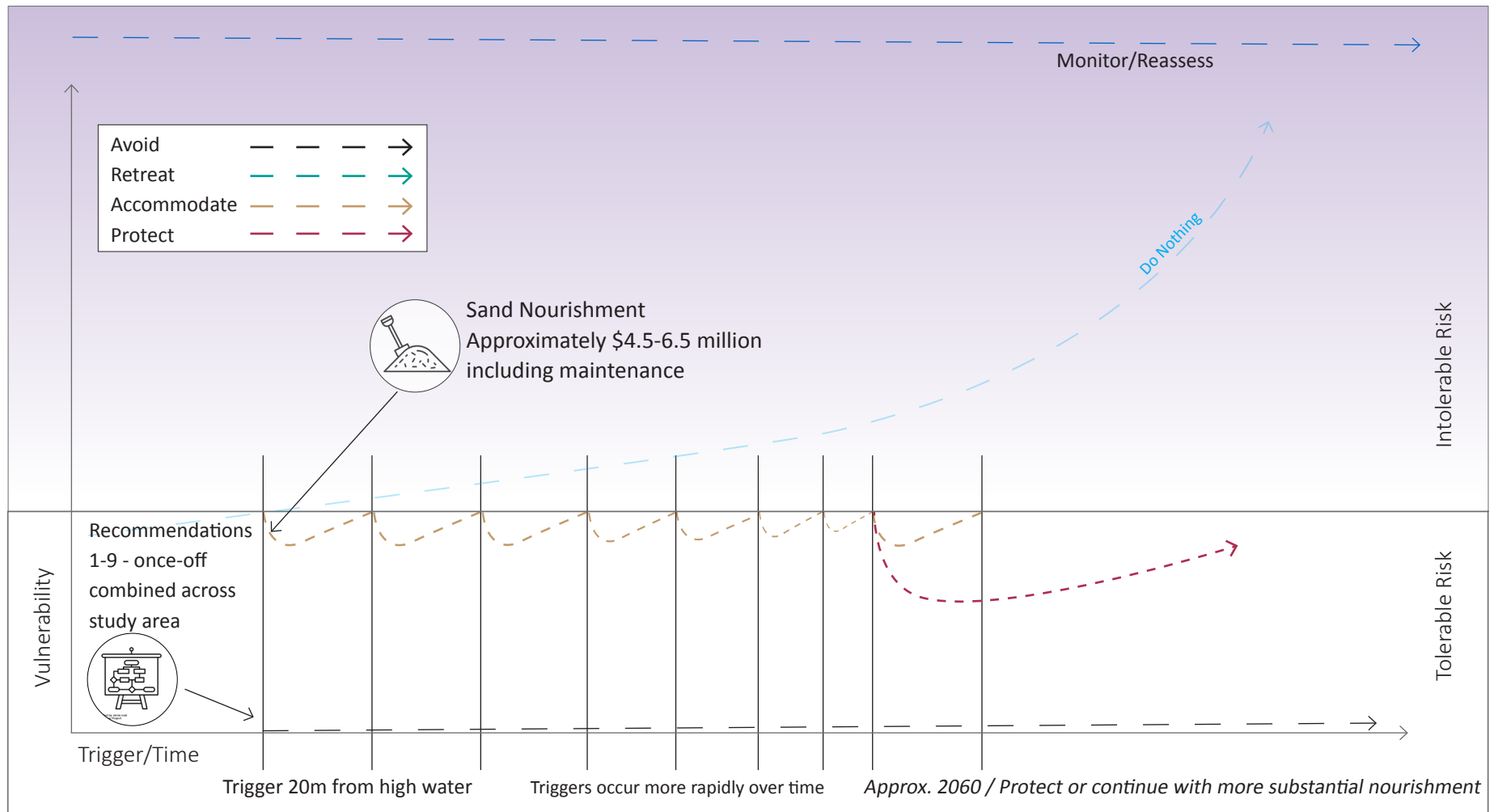


Figure 23 - MU1 Beach Adaptation Pathway

4.4. MU2 Foreshore

Recommendation 11: MU2 Foreshore - Avoid Further Development

The Middleton Beach foreshore (Surfers and Golf Course area) consists almost entirely of natural foreshore, with some coastal access points and Flinders Parade set back outside of the 100 year risk area.

This asset is primarily a public asset and has limited opportunity for any form of development. The overall MCA score preferred 'Avoid Further Development', which implies a longer term management option of avoiding further development for the assets at-risk in the *longer* term, such as Flinders Parade, the toilets, car parks, and parts of the Golf Course. Initially the area is covered under Recommendation 1, 2 and 4 of this plan.

As these assets are primarily owned by the City of Albany, it is possible that over time when these assets are replaced in line with normal asset replacement timeframes (Recommendation 3), assets could be relocated outside of the vulnerable area, allowing for extended use of the coastline over time with limited (or less) impact to community access. Prior to any asset replacement program or maintenance, a comprehensive foreshore management plan should be prepared.

This option will require ongoing costs related to resilience actions as well as monitoring at approximately two year intervals in spring and after any significant storm erosion event. Relocation of assets in line with Recommendation 3 should be implemented as and when a trigger is reached. The trigger for this action is when the distance from the Horizontal Shoreline Datum from an asset is 35m or less.

Figure 24 illustrates an example of this management option and Figure 25 illustrates the recommended option. Figure 26 illustrates the actions proposed aligned with the trigger.

Given the long term nature of this planning option, the costs are likely to be extended out across normal asset replacement timeframes and be of no additional cost to the City.

Figure 24 - Avoiding further development

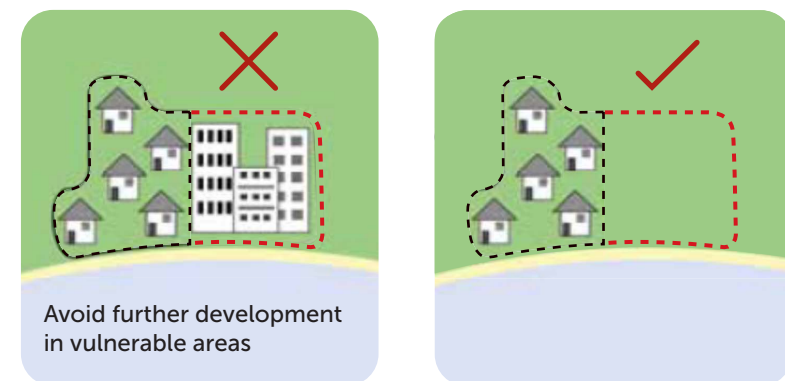




Figure 25 - MU2 Foreshore Recommended Adaptation Option

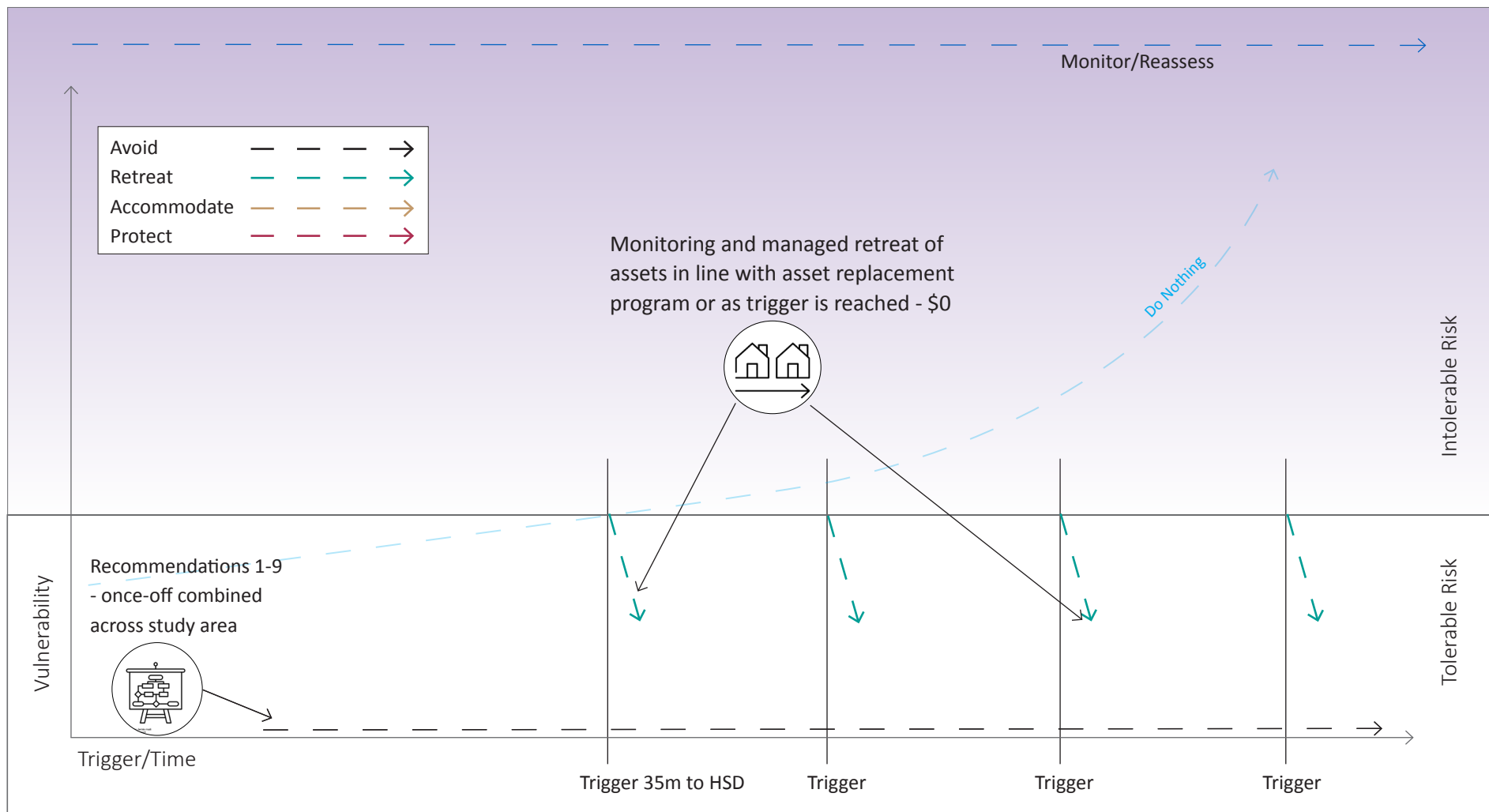


Figure 26 - MU2 Foreshore Adaptation Pathway

4.5. MU2 Big 4 Middleton Beach

Recommendation 12: MU2 Big 4 Caravan Park, Managed Retreat - staged relocation of assets at Big 4 Holiday Park.

Recommendation 13: MU2 Big 4 Caravan Park, Protect - seawall.

The Big 4 Middleton Beach Caravan Park is recognised as an important tourism destination in Albany. The site is leased from the City of Albany to a private organisation.

Throughout the MCA scoring, participants noted how significant tourism is to the City of Albany economy, local employment as well as general local amenity. The asset is also adjacent to an established park area to the north of the Surf Club and car park.

Whilst the community preferenced 'avoid further development' in this location, if the asset is significantly damaged by coastal events, avoiding development does not effectively remove the existing risk. This option may not maintain longer term community values without an additional management option.

Based on the MCA criteria developed by the community, Managed Retreat is considered the next most suitable option.

It is currently predicted that the asset is only 'likely' to experience erosion by 2050, whilst it has high vulnerability by 2030 due to the location of the existing built assets. It is recommended that the City and the leaseholder work together to plan for staged retreat of assets and work toward an agreed level of risk and exit timeframe. It is also recommended that the City work with the leaseholder to prepare a comprehensive foreshore management plan to support ongoing foreshore management.

Nearby locations may be considered for relocation of the assets to make for an easier transition whilst providing for continuity of business activities. An investigation into nearby locations should be undertaken as early as possible, allowing adequate planning time for all parties. Specifically, there is an opportunity to use land adjacent to the golf course or a redesign within the golf course to enable those assets most at risk to be relocated.

There is also an opportunity to continue to allow for accommodation within the current site through the siting of less permanent uses such as unpowered camp sites and parklands on the seaward area of the site, provided there is an appropriate emergency management plan for responding to extreme storm activity. Should the lessee propose to extend the lease, any new lease should include conditions relevant to the risk observed at the site.

Notwithstanding the recommended option, the City acknowledges that the Big 4 Middleton Beach Caravan Park is an important local tourism asset. It is recommended that the City continue to work with key stakeholders to progress planning, design and costing of a seawall option in this location as an alternative to the retreat from the site.

Combined with the work being undertaken by the City of potential relocation sites, the investigations to support this design will better enable the City and key stakeholders to make decisions about the use of the land until such time as the asset is facing immediate risk.

Figure 27 illustrates an example of this option and Figure 28 illustrates the recommended option. Figure 29 illustrates the alternative option which the leaseholder is currently investigating.

In this location, the recommended trigger for action is when the distance from the Horizontal Shoreline Datum from an asset is 35m or less. However, as the shoreline is currently quite stable and comprises a beach that has recovered well after severe storms, monitoring should be undertaken every two years in spring, and after any significant storm erosion event, to understand any increase (or decrease) in risk.

Figure 30 illustrates the actions proposed aligned with triggers.

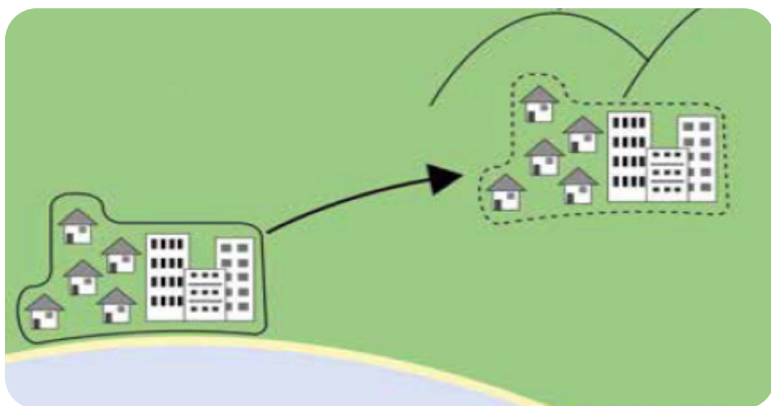


Figure 27 - Relocating assets (GHD)



Figure 28 - MU2 Big 4 Middleton Beach Recommended Adaptation Option - managed retreat



Figure 29 - MU2 Big 4 Middleton Beach Recommended Adaptation Option - seawall and pathway

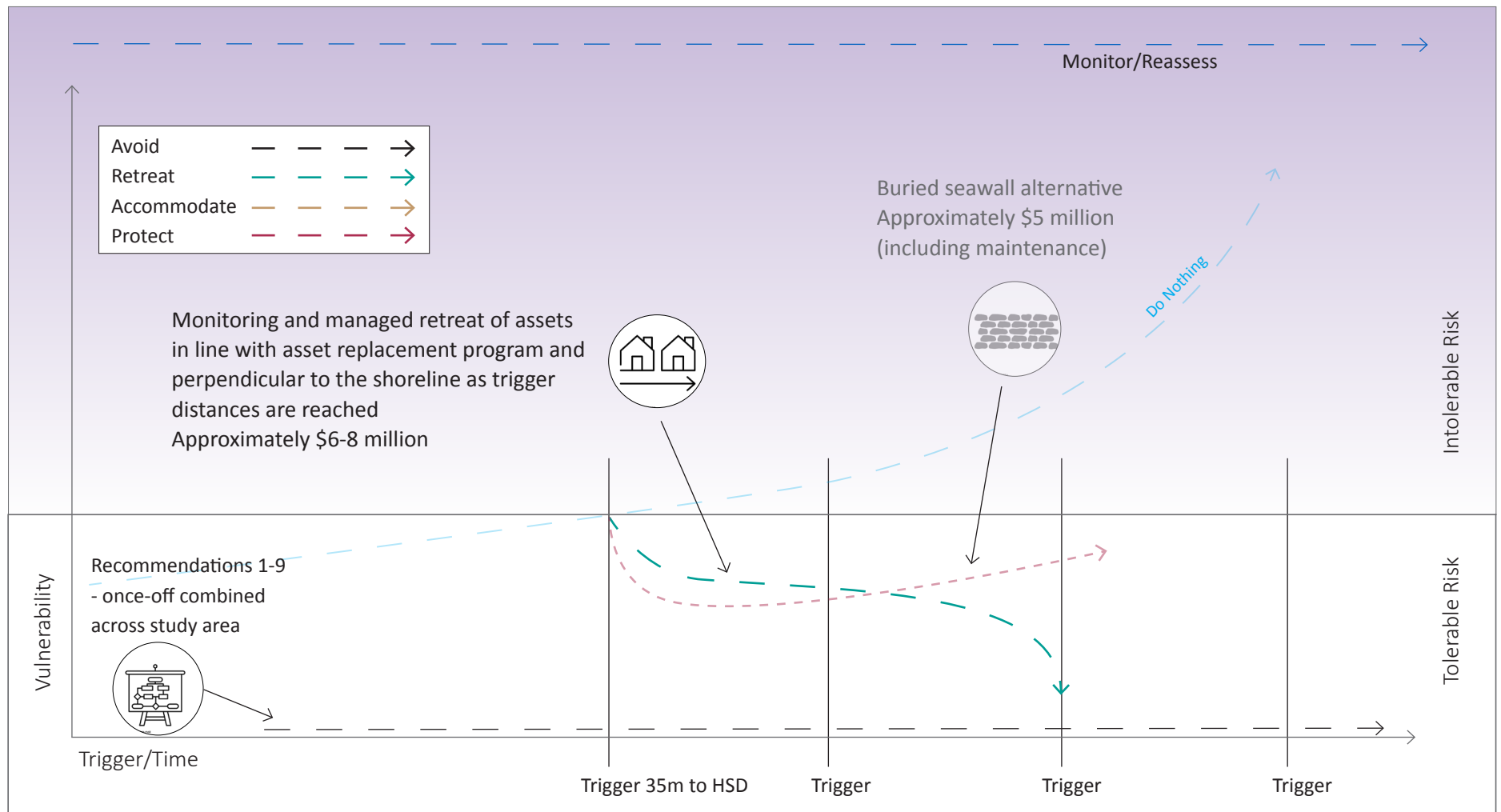


Figure 30 - MU2 Big 4 Middleton Beach Adaptation Pathway

4.6. MU3 Properties on Griffiths Street

Recommendation 14: MU3 Properties on Griffiths Street - Managed Retreat Relocate Properties from Griffiths Street

A number of privately owned residential properties exist within Management Unit 3, however, it is the first row of houses on Griffiths Street that are the most vulnerable. This is due to the access road itself being at risk; when the road and services are damaged, legal access to the lots will be affected and the properties will be impacted.

The Griffiths Street properties (front row), are only marginally more impacted than adjacent properties on Barry Court and Dillon Close. However, these properties have longer term access and short term alternatives available. Notwithstanding, the option preferred for the Griffiths Street asset, implies that same option would also be implemented for the adjacent private properties over the longer term.

The overall score preferenced during the MCA was 'Sand Nourishment'. It is noted that in the case of this asset, the 'Sand nourishment' option may be suitable in the short term, but is likely to be ineffective for longer term protection. The sand nourishment option may not maintain longer term community values without an additional management option being considered.

Managed Retreat is considered the next most suitable option, being both highly effective and providing for substantial flexibility over the long term. Adequate time is available to coordinate strategic planning for the retreat, and through implementing Recommendations 1, 2 and 8, the City will be in a position to determine the preferred managed retreat mechanism (reservation under the scheme or staged property purchase).

In this location, the trigger for action is when the distance from the Horizontal Shoreline Datum from an asset is 40m or less. Monitoring should be undertaken every two years in spring and after any significant storm erosion event to understand increased likelihood of risk and determine if more expeditious relocation is required. Consideration should extend to properties on Barry Court and Dillon Close through this ongoing analysis.

A comprehensive foreshore management plan should be prepared to support this option.

Figure 27 illustrates an example of this option and Figure 31 illustrates the recommended option. Figure 32 illustrates the actions proposed aligned with triggers.

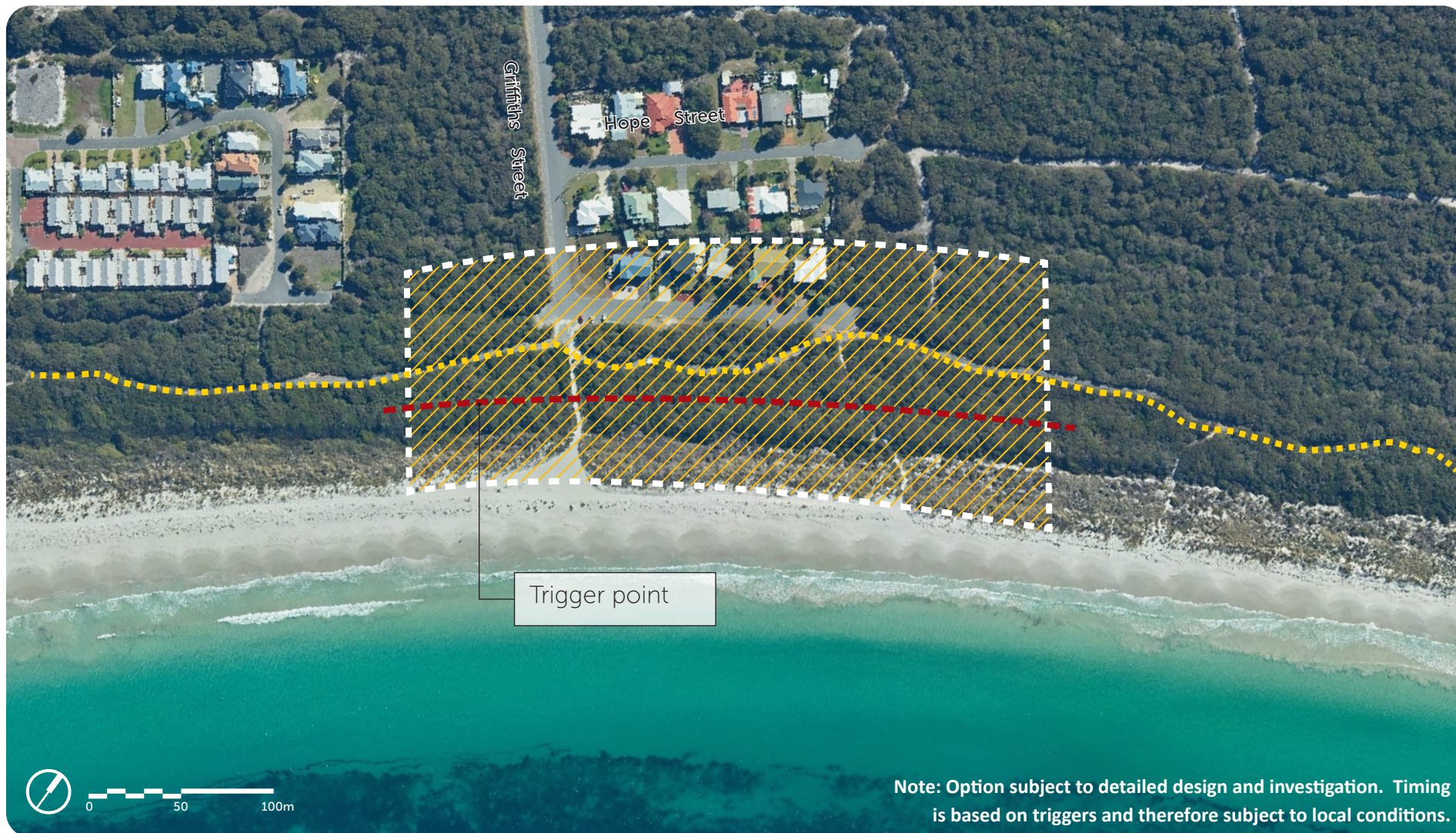


Figure 31 - MU3 Griffiths Street Recommended Adaptation Option

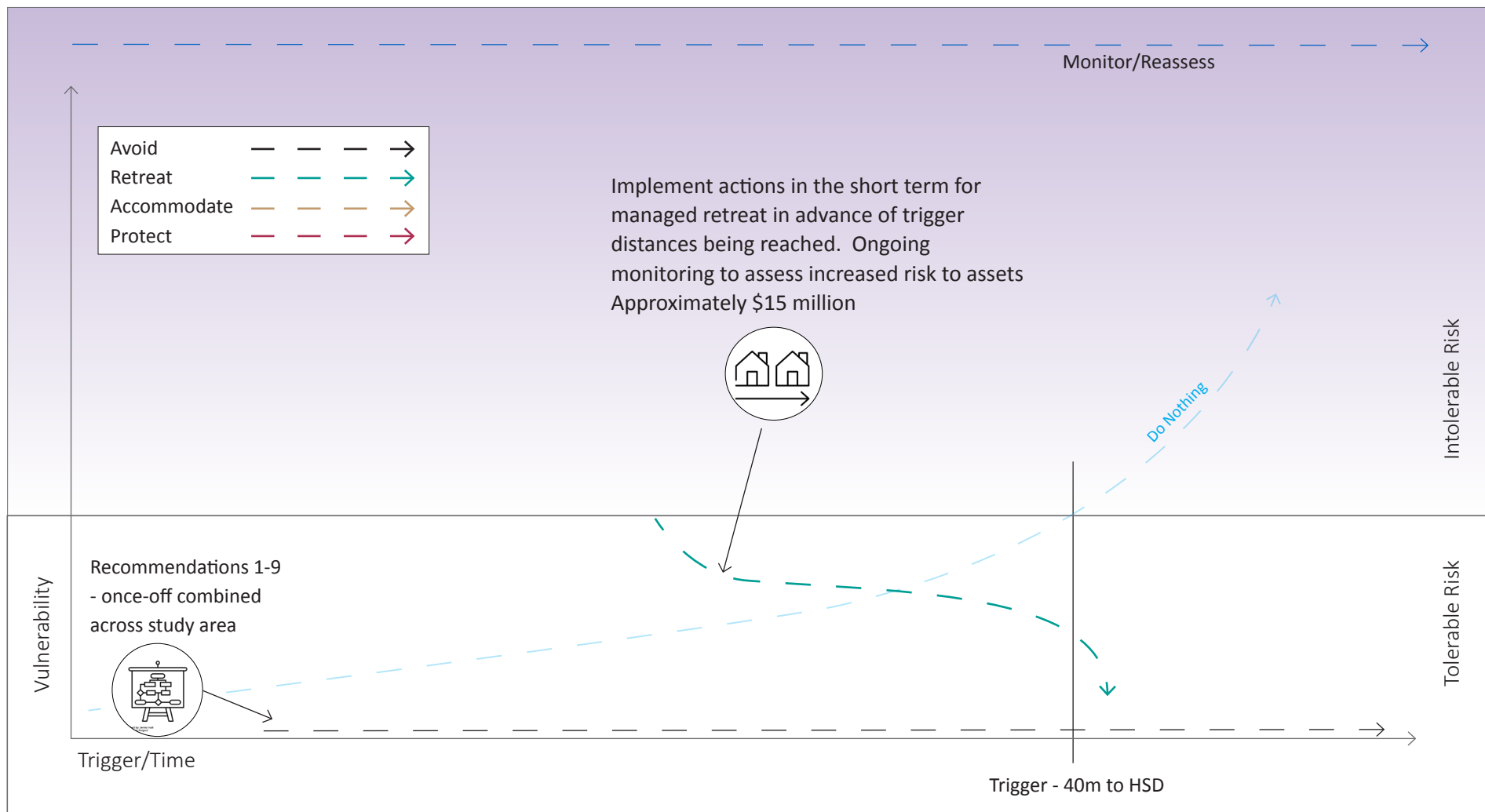


Figure 32 - MU3 Griffiths Street Adaptation Pathway

4.7. MU3 Emu Beach Holiday Park and Dual Use Path

Recommendation 15: MU3 Emu Beach Holiday Park - Managed Retreat of assets in the southern portion

Recommendation 16: MU3 Emu Beach Holiday Park - Renovation/Expansion of Groynes (geotextile sand container)

Recommendation 17: MU3 Emu Beach Holiday Park - Upgrade existing protection structures

The Emu Beach Holiday Park has had partial revetment protection for some time, but with a highly undesirable waterfront experience and ongoing risk to assets. The Emu Beach Holiday Park was previously considered one part of a larger foreshore area, but its location slightly away from the existing wall and its leasehold status implies that it would be unlikely to achieve State or Federal funding support for an extension of the revetment. This would thus require local funding through rates or levies.

In addition, its current layout, as well as the period at which it becomes most at risk (beyond 2050), provide time for numerous options within the existing site to allow continued use of the available site whilst also improving the coastline and coastal experience of the park.

In respect of the broader community sentiment regarding structures along this stretch of beach, managed retreat as assets require replacement is the most suitable option. This is recommended in conjunction with the removal of the sandbag revetment, the redesign of the tail of the sea wall to try and minimise scouring (the erosion which occurs after protection is removed), and the continued trial of the sandbag groynes on the nearby shoreline. There may be some initial increase in erosion when the tail of the sea wall is terminated.

Section 4.8 refers to the enhancement of the nearshore system (seagrass replenishment in Lockyer Shoal), which will also benefit this location by enhancing the resilience of the beach system.

Within Recommendation 15 there remains an opportunity to continue to allow accommodation within the southern portion of the current site through the provision of less permanent uses such as unpowered camp sites and parklands on the foreshore area provided there is an appropriate emergency management plan for responding to extreme storm activity. The removal of the failing sandbag revetment will most likely result in a much improved foreshore and far greater beachfront accessibility for the park.

It is recommended that the City and the leaseholder work together to plan for staged retreat of assets within the southern portion of the site and work toward an agreed level of risk. It is also recommended that the City work with the leaseholder to prepare a comprehensive foreshore management plan to support ongoing foreshore management.

Should the lessee propose to extend the lease, any new lease should include conditions relevant to the risk observed at the site.

Notwithstanding the recommended option, the City acknowledges that the Big 4 Emu Beach Holiday Park is an important local tourism asset. It is recommended that the City continue to work with key stakeholders to progress planning for the upgrade of the existing seawall/revetment in this location as an alternative to retreat from the site.

Investigations to support this design, combined with the work being undertaken by the City regarding foreshore management, will better enable the City and key stakeholders to make decisions about the use of the land until such time as the asset is facing immediate risk.

In this location, the trigger for action is when the distance from the Horizontal Shoreline Datum from an asset is 40m or less. Monitoring should be undertaken every two years in spring, and after any significant storm erosion event, to understand any increase in risk.

The sandbag groynes were installed as a trial to assess protection of the beach within this area. The evidence suggests there has been some benefit in the retention of sand without causing adjacent erosion (Royal Haskoning DHV 2017) and there has been no observable negative impact to the beach or coastal vegetation. As such it is recommended that the trial continue with renovation of the present structures and placement of new trial groynes in the area.

The existing pathway should be realigned to follow a new southern boundary of the Holiday Park at the time when the shared path requires asset replacement.

Figure 33 illustrates the recommended option and Figure 34 illustrates the alternative approach. Figure 35 illustrates the actions proposed aligned with triggers.

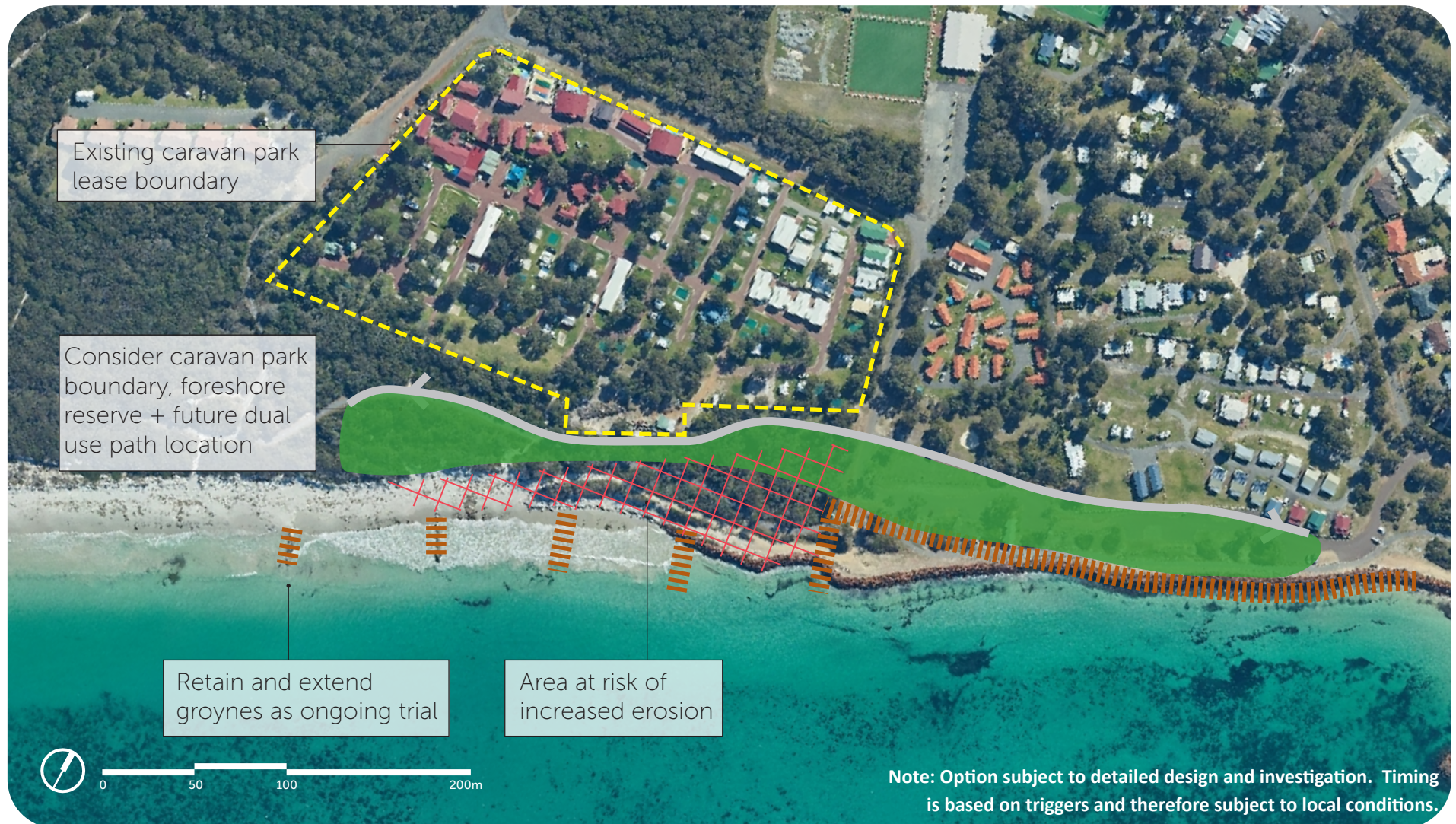


Figure 33 - MU3 Emu Point Caravan Park Recommended Adaptation Option - managed retreat and expansion of groynes



Figure 34 - MU3 Emu Point Caravan Park Recommended Adaptation Option - upgrade existing protection structures

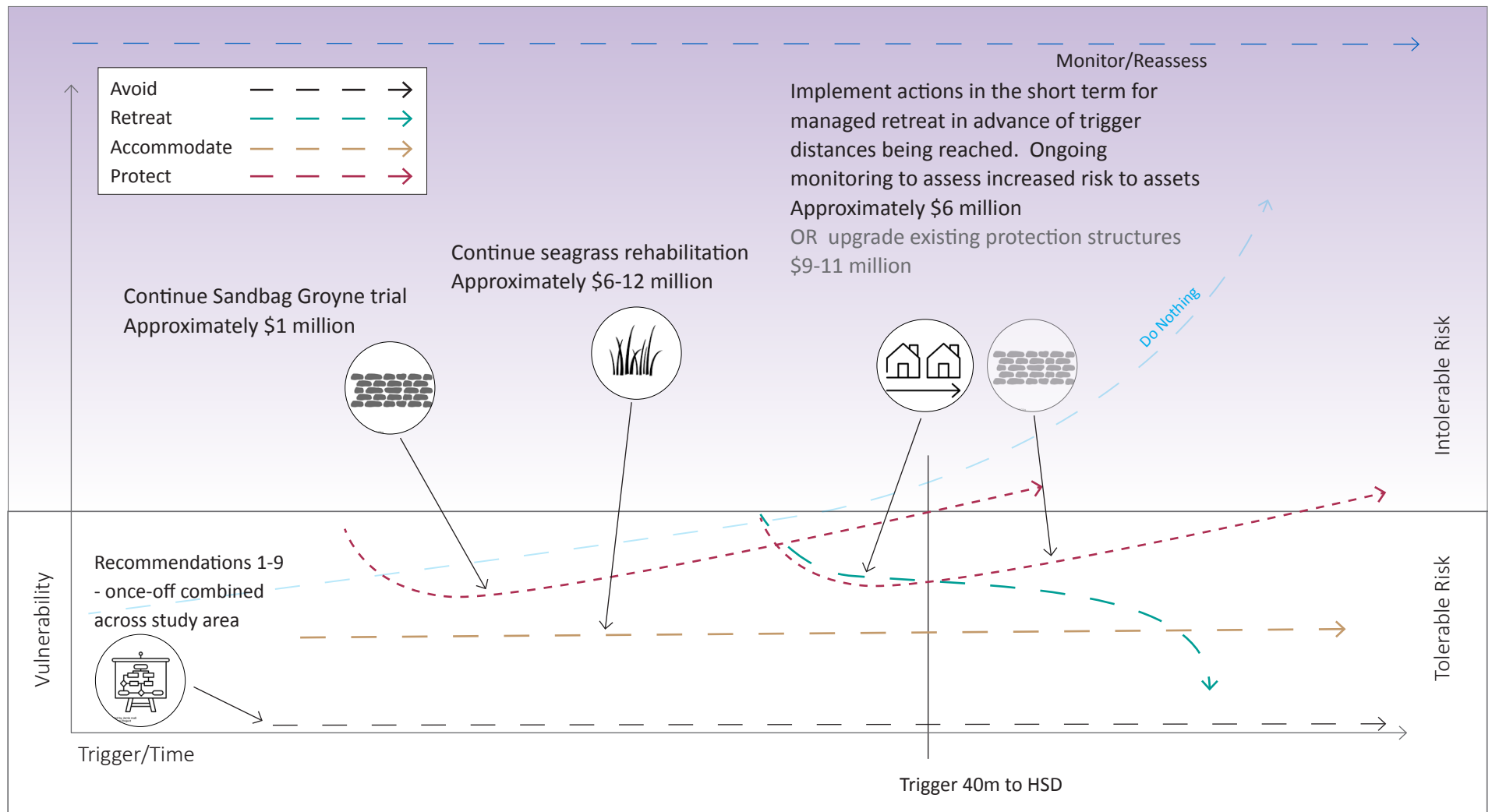


Figure 35 - MU3 Emu Beach Holiday Park Adaptation Pathway

4.8. MU4 Foreshore Reserve

Recommendation 18: MU4 Foreshore Reserve - Seagrass replenishment program be continued and enhanced

Recommendation 19: MU4 Foreshore Reserve - Revetment be upgraded along with redevelopment of Foreshore park and removal of sandbag revetment

The Emu Point Foreshore Reserve comprises a number of man made and natural assets. Past adaptation actions have resulted in structures that are widely acknowledged as having a negative impact, whilst the foreshore parkland that is protected by those structures is highly valued by the community.

Due to the significant number of assets within and behind the immediate vulnerability line, there is an ongoing implication that protection in this location will continue to be required over the medium term, even though in the long term consideration may be given towards a retreat option.

The overall MCA score preferred 'Maintain and Enhance the Nearshore System' (seagrass rehabilitation). It is noted that in the case of this asset, the preferred option alone is not sufficient to control the shore line and reduce the risk to the landwards assets.

This has implications in the future if the seagrass is repeatedly damaged - rendering the coastline behind it vulnerable and without back-up protection. Any seagrass rehabilitation should be supported by ongoing investigations into methods to enhance the capacity of the system to naturally rejuvenate following storms, noting that the system takes some 50 years to naturally recover. Ideally, investigations would consider ways to shortcut the natural recovery process.

This option may not maintain longer term community values without an additional management option.

Notwithstanding, the rehabilitation of the Lockyer Shoal area is considered to be positive, and should be encouraged as it will assist in absorbing the impact of minor to moderate storm erosion events and post storm recovery.

Although seagrass regeneration and offshore placement of sand will protect the beach and ease pressure on the maintenance of other structures, it is also recommended that the seagrass rehabilitation be undertaken alongside repair and upgrade of the existing revetment structure. This option was the preferred score under the MCA as an alternative to the seagrass rehabilitation, and effectively maintains the status quo.

The southern end of the revetment requires detailed design to remove the tail of the wall and mitigate against substantial scouring. The MCA process preferred a foreshore upgrade in addition to the replacement wall, which is also included in the cost estimation. A comprehensive foreshore management plan should be prepared to support this option.

The trigger for this action is imminent, as portions of the structure are already in poor condition. Figure 36 and 37 illustrate the recommended options. Figure 38 illustrates the actions proposed aligned with triggers. Beyond construction, ongoing maintenance must be allowed for to ensure design life can be achieved (included in the cost estimate). At the end of the design life, retreat will need to be reconsidered in the context of updated technical analysis of the coastal processes.



Figure 36 - MU4 Foreshore Reserve Recommended Adaptation Option - Seagrass Regeneration



Figure 37 - MU4 Foreshore Reserve Recommended Adaptation Option - Revetment

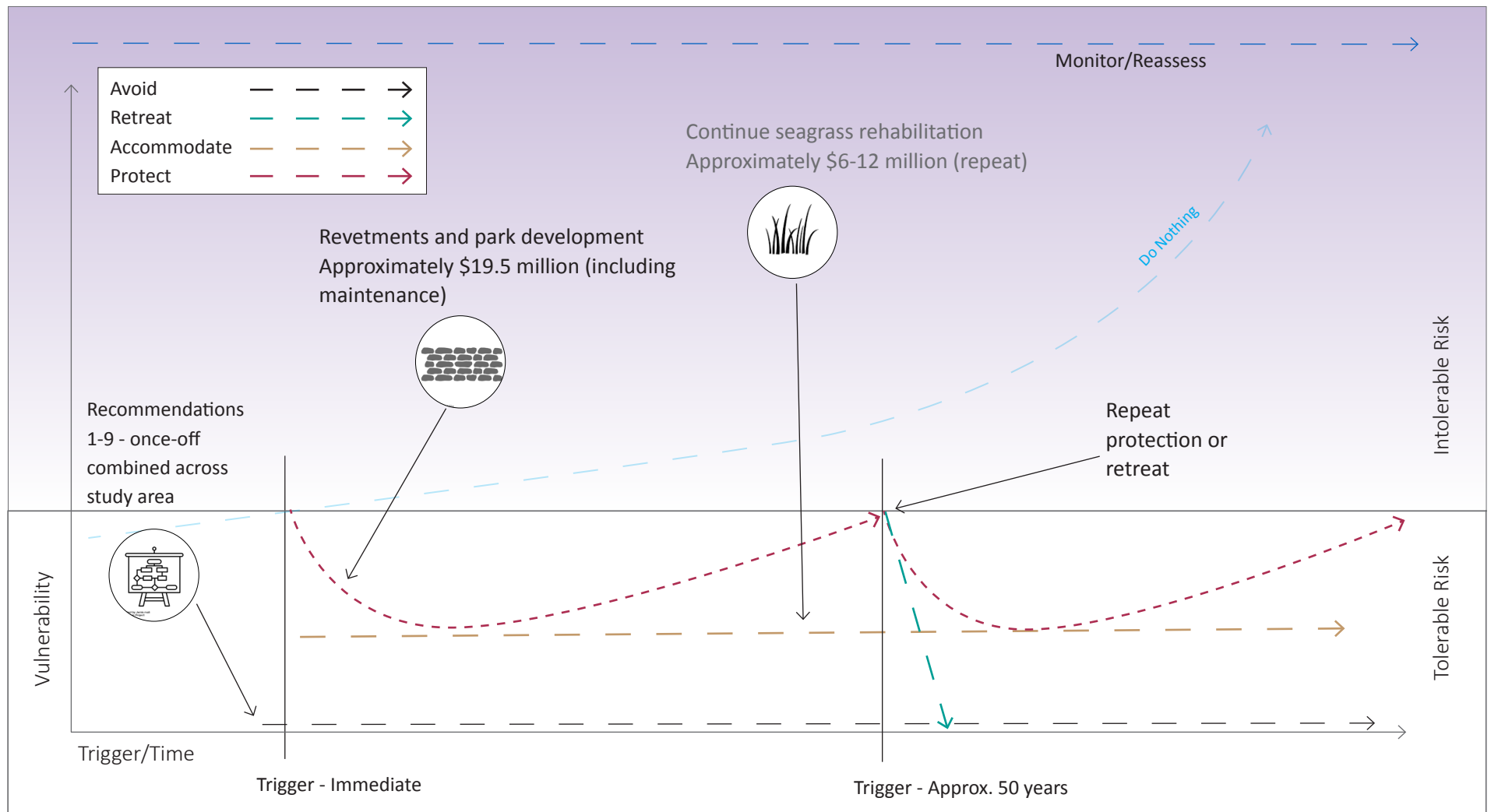


Figure 38 - MU4 Foreshore Reserve Adaptation Pathway

4.9. MU5 Oyster Harbour Southeast Beach

Recommendation 20: MU5 Oyster Harbour Beach - Sand Nourishment

The Oyster Harbour Beach Management Unit is markedly different from the balance of the study area as it is an estuarine environment with shallower water depths and different coastal processes. The shoreline is already managed by seawall structures and the swimming structure also behaves somewhat like an offshore breakwater without the requisite (reliable) effectiveness.

The overall MCA score preferred 'Sand Nourishment'. Table 8 shows the combined scores across criteria. It is noted that in the case of this asset, the 'Sand Nourishment' option may be suitable in the short term, but may become ineffective for longer term protection. This option may not maintain longer term community values without an additional management option being considered. Monitoring should be undertaken throughout the year, and after any significant storm erosion event, to understand any increase in risk.

In the short term, sand nourishment should continue to be implemented. A foreshore management plan should be prepared to support this option.

This option will require ongoing costs of plant and equipment and requires relevant plant to be available in a timely manner. It also requires clear access for the plant to get onto the beach.

It is anticipated the costs will be several thousand dollars per annum and \$2 Million over the lifetime of the adaptation option. The recommended actions will need to be implemented as and when the trigger is reached. In this location the trigger for action is when there is a dry sandy beach width of less than approximately 10m from erosion scarp or high-water line to the retaining wall at the widest section of the beach.

It is noted that in some areas the beach is already narrower than 10m. In these locations, the trigger would be the loss of useable beach, and some exercise of judgement will need to be made regarding this on a case-by-case basis.

Figure 39 shows an example of this management option in action, Figure 40 illustrates the recommended option and Figure 41 illustrates the action proposed aligned with the trigger.

Figure 39 - Typical image of Sand Nourishment at Oyster Harbour Beach





Figure 40 - MU5 Oyster Harbour Beach Recommended Adaptation Option

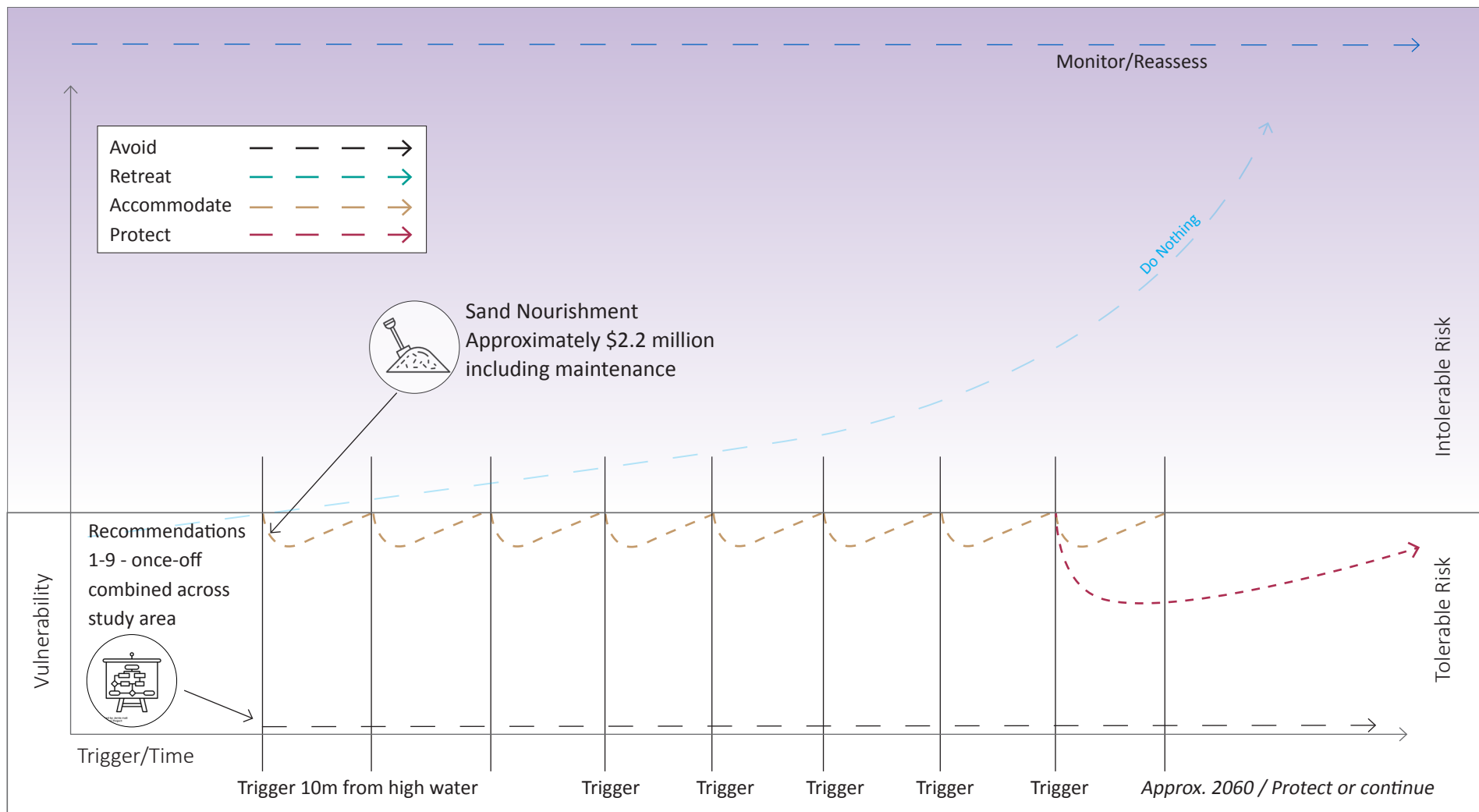


Figure 41 - MU5 Oyster Harbour Beach Adaptation Pathway

5. Medium to Long Term Adaptation Pathways

The focus for longer-term timeframes is to identify broad pathways for future adaptation. Medium term pathways consider actions required from 10-50 years from now (to 2070), whilst long term pathways require action beyond 50 years (2070-2120). Simplistically the four broad pathways are the four option categories from the hierarchy of controls: avoid, managed retreat, accommodate and protect.

Long term planning should focus on maintaining as much flexibility as possible, ensuring the community and stakeholders continue to have the opportunity to support appropriate adaptation options at a later date. Particular focus should be placed on enabling avoid and retreat options in the future, even if it is not acted upon immediately.

5.1. Avoid

This long-term adaptation pathway is relevant to areas within the study area that currently appear 'under-developed'. Deterrents to development should be implemented through strategic planning and then legislative frameworks, such as those which are included in Recommendations 1, 2, 3 and 7. As recommended in Section 4.1, this avoid pathway can be progressed across Management Units.

With the exception of the areas already discussed in this plan, no new built structures should be permitted within the area seaward of the 2050 hazard lines unless it is sacrificial or has a short life cycle. Any infrastructure upgrades to paths, bollards, car parks etc. should consider the expected useful life of the facility before any works are undertaken. The cost of upgrade and cost of replacement following severe storm events should be considered in an emergency management plan and be compared to the cost of construction of new infrastructure outside of vulnerability zones.

5.2 Managed Retreat

Managed retreat can include small scale activities of staged retreat for lower-cost assets such as bollards, seating, bins and shelters as they reach the end of their normal design life (so as to reduce the cost burden) as suggested by Recommendation 3. Over the longer-term managed retreat can include substantial activities such as the removal of infrastructure or buildings including those which are currently identified as at-risk beyond 2050.

Within the study area, the longer-term vision may see assets such as toilets, parking areas and the Albany Surf Lifesaving Club relocated further back from the shore if and when major renovations or structural changes to the buildings is required. The pump station at Firth Street and the navigation aid should be considered for relocation if the assets require renewal.

5.3 Accommodate

The accommodate pathway continues to be valid, albeit that the options can be relatively ineffective and expensive over the long term. Planning guidelines may be more effective, however the preference should be to avoid or retreat rather than accommodate in the long term.

5.4 Protect

Where possible the City should minimise the implementation of protect measures, noting that protection measures have finite life cycles and the implementation of protection at a given point in time does not mean that protection is permanent. This can be seen in the current study area.

Where protection is implemented, the City should be clear on the longer term intent for the protected area, and should consider long term funding requirements including possible Specified Area Rates to ensure a beneficiary-pays system. Protect options must be supported by fully funded maintenance programs.



6. Recommendations

This section provides a summary of the adaptation pathways proposed by the Implementation Plan. Table 6 summarises the individual recommendations, highlights responsibility, the approximate cost, the relevant trigger and the required timeframe. The timeframes used are immediate (now), short term (within 10 years), medium term (10-50 years) and long term (beyond 50 years). All timeframes for asset actions are approximate, as the trigger point is the key determinant of action.

With regard to cost, it should be noted that each individual option would require a detailed cost assessment based on final design/source material. There is a degree of variability in some of the adaptation options, and contingency is built in for each; nevertheless, it has not been possible to reduce all costs to a single number.

Where maintenance is required, this has been included in the overall costs over a 100 year period. Protection measures should not be implemented if maintenance schedules cannot be adhered to, as this places undue risk on future populations.

Likewise, the identified triggers should be subject to ongoing monitoring and review. In the first instance, monitoring should be in accordance with the Monitoring Plan which can be found on page 155 in CHRMAP report. However, regular review of the overarching hazard models should also occur. It is recommended that the City continue to monitor changes in international scientific understanding, and maintain a working relationship with the Department of Planning, Lands and Heritage as well as the Department of Transport's Coastal Infrastructure Business Unit in this regard.

A review of immediate actions recommended in the CHRMAP should be undertaken within 1 year to confirm progress. A provision sum has been included to allow this review to be progressed. A full review should be undertaken within 10 years and in conjunction with ongoing reviews of the City's Local Planning Strategy and Local Planning Scheme.

Table 6 - Summary of CHRMAP Recommendations

#	RECOMMENDATION	RESPONSIBILITY	TRIGGER	TIME FRAME
1	Local Planning Strategy – Investigation Area	Development Services	2019	Immediate
2	Local Planning Scheme Special Control Area	Development Services	When Scheme Review is undertaken or by 2021 as a Scheme Amendment	Short
3	City Infrastructure Asset Planning	Infrastructure and Environment	2019	Immediate
4	Resilience Planning including monitoring	Infrastructure and Environment	2020	Short/ Ongoing
5	Sand Nourishment Investigation	Infrastructure and Environment	2019	Immediate
6	Rates Levy Investigation	Corporate Services	2025	Medium
7	Lease Land Management	Corporate Services	2025	Medium
8	Purchase of Property Investigation	Corporate Services	2020	Short
9	Emergency management Plan	Infrastructure and Environment	2020	Short
10	MU1 Beach - Sand nourishment	Infrastructure and Environment	Dry sandy beach width < 20m from erosion scarp/ high-water line to wall	Short/ Ongoing
11	MU2 Foreshore- Avoid Further Development			Short/ Ongoing

12	MU2 Big 4 Caravan Park, Managed Retreat- staged relocation of assets at Big 4 Holiday Park (or 13 below)	Corporate Services	Distance from HSD to significant foreshore assets of 35m or less	Medium
13	MU2 Big 4 Caravan Park, Protect- seawall (or 12 above)	Infrastructure and Environment		Medium
14	MU3 Properties on Griffiths St- Managed Retreat Relocate Properties from Griffiths St	Corporate Services & Development Services	Distance from HSD to significant foreshore assets of 40m or less	Medium
15	MU3 Emu Beach Holiday Park- Managed Retreat of assets in the southern portion	Corporate Services		Medium
16	MU3 Emu Beach Holiday Park- Renovation of Sand Bag Groynes	Infrastructure and Environment	As soon as practical	Short
17	MU3 Emu Beach Holiday Park- Upgrade existing Protection Structures	Infrastructure and Environment	Distance from HSD to significant foreshore assets of 40m or less	Medium
18	MU4 Foreshore Reserve- Seagrass replenishment program be continued and enhanced	Infrastructure and Environment	As soon as practical	Short/ Ongoing
19	MU4 Foreshore Reserve-Revetment be upgraded along with redevelopment of Foreshore park and removal of sandbag revetment.			Short
20	MU5 Oyster Harbour Beach- Sand Nourishment		Dry sandy beach width < 10m from erosion scarp/ high-water line to wall	Short/ Ongoing
-	Progress Review	Major Projects	2020	Short



7. Interpretations

In this Plan, unless the context otherwise requires:

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

‘acceptable’ means the risks that do not need further treatment. The expression acceptable level of risk refers to the level at which it is decided that further restricting or otherwise altering the activity is not worthwhile. E.g. additional effort will not result in significant reductions in risk levels.

‘adaptation’ means an adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation is the means for maximising the gains and minimising the losses associated with coastal hazards over the planning timeframe.

‘coastal compartment’ means length of shoreline bounded by broad scale changes in geology, geomorphic structures/landforms or changes in the aspect of the shore

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

‘coastal or foreshore management plan’ is a local scale plan, designating areas for various purposes such as public access, car parks, toilets and surf lifesaving club rooms, and providing advice on management needs. Foreshore management plans tend to deal with a smaller area, be more detailed and are prepared as part of a planning approval process or ongoing maintenance or upgrading program.

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

‘coastal node’ is a distinct and discrete built area that may be located within a coastal foreshore reserve. Excluding permanent residential development, it may vary in size from a grouping of recreational facilities to an area of commercial or tourism facilities or accommodation.

‘coastal planning strategy’ is generally a district or subregion scale plan focusing on the coast designating areas suitable for conservation, recreation and development purposes. It should include a strategic land use and access strategy and determination of an appropriate foreshore reserve.

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

‘coastal protection works’ means any permanent or periodic work undertaken primarily to alter physical coastal processes and/or manage the effects of coastal hazards. The influence of coastal protection works should be evaluated at the sediment cell level.

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

‘consequence’ means the outcome or impact of an event. Consequence is expressed qualitatively or quantitatively – a loss, injury, expressed concern, disadvantage or gain. Consequence can be more than one consequence from one event, range from positive to negative and is generally considered in relation to achievement of objectives.

‘cross-shore’ means perpendicular to the shoreline.

‘development’ has the same meaning as in the Planning and Development Act 2005.

‘environment’ means conditions or influences comprising built, physical and social elements, which surround or interact with the community (including the natural conditions, the natural as modified by human activity and the artificial).

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

‘event’ means any occurrence of a particular set of circumstances that can have an adverse impact(s) on the environment. The event can be certain or uncertain, and be a one-off occurrence or a series of occurrences of a particular set of circumstances.

‘fetch limited’ means a situation where wave energy is limited by the size of the wave generation area.

‘height’ has the same meaning as in the Town Planning Regulations 1967, Appendix B–Model Scheme Text.

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

‘infill development’ refers to sites between existing developments.

‘intolerable’ means risk that is unacceptable in any circumstances or at any level.

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

‘likelihood’ means the probability that something will occur. Likelihood is generally expressed qualitatively or quantitatively.

‘longshore’ means parallel to the shoreline.

‘management authority’ means any authority with decision-making responsibility over areas of water and land within the coastal zone.

‘peak steady water level (PSWL)’ means the highest average elevation of the sea surface caused by the combined effect of storm surge, tide and wave setup resulting from the storm events defined in Schedule One section 5.

‘precautionary principle’ has the meaning in section 5 Policy Measures section 5.11(i).

‘risk’ is specified in terms of an hazardous event or circumstances and the consequence that may flow from it. Risk is measured in terms of a combination of the likelihood of an event occurring and the consequence of that event occurring.

‘risk assessment’ means the overall process or method for evaluating risks associated with a specific coastal hazard and includes risk identification, risk analysis and risk evaluation.

‘risk management’ means the measures taken to reduce, modify, offset or share risks associated with development in areas subject to coastal hazards. These include the coordinated activities to direct and control an organisation with regard to risk; and the culture, processes and structures that are directed towards realising potential opportunities whilst managing adverse effects.

‘salient’ means a bulge in the coastline projecting towards an off-shore structure natural or manmade.

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

‘strategic plan’ may be a coastal strategy or foreshore management plan, structure plan, local planning scheme, local planning strategy or a plan approved by the WAPC.

‘storm surge’ means the increase in water level at the shoreline due to the forcing of winds (wind-setup) and atmospheric pressure.

‘tidal reaches of inland waters’ has the meaning in Schedule One section 3.5.

‘tolerable’ means the willingness to live with a risk to secure benefits, on the understanding that it is being properly controlled.

‘tolerability’ does not mean ‘acceptability’. Tolerating a risk does not mean that it is regarded as negligible, or something we may ignore, but rather as something that needs to be kept under review and reduced further, if and when able to be done so.

‘updrift’ means the direction to which the predominant longshore movement of shoreline material approaches.

‘vulnerability’ means the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. Systems that are highly exposed, sensitive and less able to adapt are vulnerable.

‘wave run-up’ means the rush of water up a shoreline or structure on the breaking of a wave.

‘wave overtopping’ means water carried over the top of a structure or landform due to wave run-up or surge action exceeding the crest.

