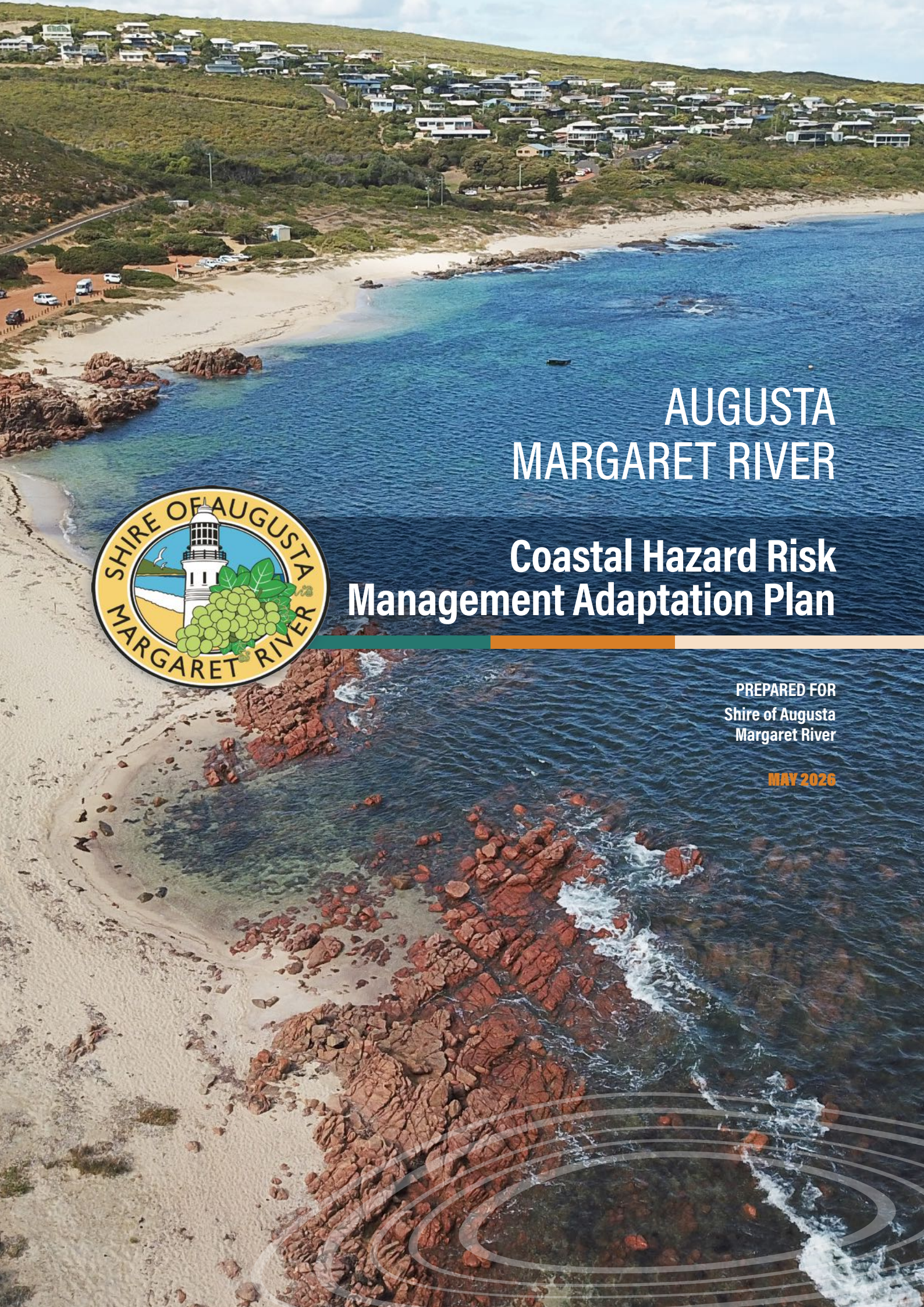


AUGUSTA MARGARET RIVER

Coastal Hazard Risk Management Adaptation Plan

PREPARED FOR
Shire of Augusta Margaret River

MAY 2026

Document prepared in partnership with Shore Coastal and Search Research Services:

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executive summary

Purpose of this CHRMAP

The Shire of Augusta Margaret River prepared its first Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) in 2015. Since then, new coastal monitoring data, revised planning allowance methods, updated State planning policy and a decade of additional coastal change observations have made a comprehensive review necessary. This document is that review. It supersedes the 2015 CHRMAP for the four coastal localities it covers, and is prepared in accordance with State Planning Policy 2.6 — State Coastal Planning Policy (SPP 2.6) and the associated CHRMAP Guidelines issued by the Western Australian Planning Commission (WAPC) in 2019.

The purpose of the CHRMAP is to assess coastal hazard exposure across the Shire's primary coastal localities, evaluate the vulnerability of identified assets, consider adaptation options through a structured multi-criteria and economic assessment process, and recommend a practical implementation and monitoring framework that the Shire can carry forward over the coming decades. It is not a commitment to specific works. Rather, it provides the strategic context and evidence base from which informed decisions can be made over time, as coastal conditions change and triggers are reached.

Study Area and Coastal Hazard Context

The CHRMAP covers four coastal localities, comprising Gracetown, Prevelly, Gnarabup, and Augusta, where consolidation of public and private assets creates meaningful exposure to coastal hazard. A diverse range of coastal types is present across these locations, including sandy beaches, hard rock coast, and weakly lithified sedimentary limestone cliffs, each with different erosion characteristics and levels of uncertainty over the 100-year planning horizon.

Planning allowances for coastal erosion have been reviewed and updated using methods set out in Schedule 1 of SPP 2.6, drawing on rectified aerial photography to 2022 and the geotechnical cliff stability assessment completed by Golder Associates in 2017. Inundation hazard has been assessed using a 1-in-500-year storm event level of 2.9 metres AHD combined with a 0.9 metre sea level rise allowance over the 100-year planning period, producing a combined planning level of 4.0 metres AHD across the study area.

The Blackwood River estuary, Hardy Inlet and Molloy Island are not assessed in this review. Dedicated estuary-specific data from a recent State Government coastal inundation assessment is now available as a primary input for that work, and a separate inland waters hazard assessment is recommended as a priority for the next phase of CHRMAP preparation.



Key Risks and Vulnerable Assets

Across all three study locations, vulnerability to erosion is higher than vulnerability to inundation. Current risk levels are generally low to medium, but are expected to increase as sea levels rise and coastal processes intensify over the planning period.

At Gracetown, public foreshore assets including the boat ramp, Bayview Drive and the Huzzas access stairs are identified as having elevated vulnerability at the 100-year planning horizon. Impacts in the short to medium term are limited, and the primary management focus is monitoring and dune maintenance.

At Gnarabup, the White Elephant Café and adjacent beach access infrastructure are assessed as Very High vulnerability within the 20-year planning period, reflecting recent and ongoing erosion of the dune system in this area. The coastal path and several foreshore carparks are also at elevated risk by 100 years. Prevelly is generally lower risk in the short term, with the Rivermouth carpark the most exposed asset at the 100-year horizon.

Augusta presents the most complex risk profile. Albany Terrace, the adjacent foreshore facilities and the Flinders Bay Caravan Park are assessed as Very High vulnerability within the 20-year planning horizon. Residential land and further commercial uses are identified as Very High vulnerability at 100 years. The dynamic behaviour of the Blackwood River entrance, which has been migrating eastward since at least the 1950s, adds a further dimension of uncertainty to the northern section of Augusta's coastline.

A community survey conducted as part of the engagement process confirmed that environmental protection, access to the marine environment, and the intrinsic value of the coast for future generations are the community's highest priorities. Protection of Aboriginal and cultural heritage values, including Wooditj Dunes and the Blackwood River, was also identified as a significant concern.

Adaptation Planning Approach

Adaptation options have been assessed using a multi-criteria assessment (MCA) framework across six categories including effectiveness, environmental impact, social impact, aesthetic impact, cost, and future adaptability, and with site-specific weightings applied at each location. Preferred options identified through the MCA were then subject to an economic cost-benefit analysis, which confirmed that the benefits of protecting coastal access and infrastructure outweigh the costs at all three study locations. A Benefit Distribution Analysis identifies the distribution of net benefits among resident and visitor groups, informing future decisions on funding apportionment.

The SPP 2.6 adaptation hierarchy of **Avoid**, **Accommodate**, **Retreat**, and **Protect** guides the recommended responses. The CHRMAP does not recommend a uniform approach; instead, it identifies different preferred pathways for different assets and locations depending on risk profile, asset type, and the realistic options available.

The multi-criteria assessment did not recommend managed retreat as a preferred option for any study location in the short to medium term. Accordingly, no Managed Retreat Policy is required of the Shire at this stage.



Summary of Preferred Adaptation Responses

At Gracetown, the preferred approach is to avoid new development in exposed areas, continue dune care and management through the Coastal Management Plan, and integrate the ongoing maintenance and eventual replacement of beach access infrastructure into the Shire's asset management program. Monitoring is the primary near-term action.

At Prevelly and Gnarabup, the focus is on avoiding development in vulnerable areas, continuing beach nourishment near the Gnarabup boat ramp and café, maintaining dune management, and monitoring. The existing rock protection structure in front of the White Elephant Café is considered appropriate to retain in its current limited form.

At Augusta, the Shire's preferred approach is to pursue physical protection of Albany Terrace (which may result in relocation of the foreshore path). Most likely in the form of a rock revetment or equivalent coastal protection structure. This would provide a buffer to adjacent foreshore and residential land and reduce the urgency of planning intervention in the short to medium term. A Special Control Area (SCA) over land within the coastal hazard zone at Augusta is also proposed, conditional on the outcome of the protection decision. The SCA does not compel retreat or prevent development, but ensures that development applications within the hazard zone are assessed with full awareness of coastal hazard risk and that appropriate conditions and title notifications can be applied. All planning responses are conditional on the outcomes of community consultation and the Shire's subsequent deliberations.

Implementation Priorities and Next Steps

Short-term actions (to approximately 2031) include initiating a scheme amendment to introduce the SCA, preparing a supporting Local Planning Policy, reviewing and implementing the coastal monitoring program, preparing a Shire-wide Coastal Management Strategy, incorporating CHRMAP findings into the asset management program, and updating the Emergency Management Plan. Inspections of beach access stairs and limestone cliffs are also identified as immediate priorities.

Medium and long-term actions are structured around adaptive pathways rather than fixed commitments. As monitoring data accumulates and trigger conditions are reached, the Shire will progressively consider replacement and relocation of foreshore assets, the timing and design of structural protection at Augusta, and a comprehensive CHRMAP review at the ten-year mark.

Funding options include CoastWA grants administered by the Department of Transport and Department of Planning, Lands and Heritage, the Federal Disaster Ready Fund, specified area rates applied to beneficiaries within the hazard zone, developer contributions, and visitor-related mechanisms. A more detailed funding strategy will be developed as part of the Coastal Management Strategy.

Monitoring, Review and Staged Decision-Making

The CHRMAP emphasises that coastal management decisions should be made adaptively, guided by monitoring data and trigger conditions rather than predetermined timelines. Four trigger types are defined: proximity triggers (when erosion is approaching a threshold relative to an asset), replacement triggers (when an asset reaches end of life), damage triggers (when irreparable damage occurs within a hazard zone), and access triggers (when a public road or accessway can no longer provide safe legal access).

A beach monitoring program covering 31 sites across the four study locations has been scoped. This program should be reviewed, updated and implemented as a priority, with annual beach profiles and regular photo monitoring providing the data needed to track coastal change and identify when triggers are being approached.

This CHRMAP should be reviewed at least every ten years, or earlier if significant storm events occur, land use planning changes, sea level rise projections are substantially updated, or triggers are reached. The Shire is also recommended to initiate a separate estuarine hazard assessment for the Blackwood River and Molloy Island, drawing on the State Government's 2024 statewide coastal inundation data, as a priority for the next CHRMAP preparation phase.

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Establishing the Context

1.1 Introduction

Background to this Review

The Shire of Augusta Margaret River (the Shire) prepared its first Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) in 2015. That document assessed coastal hazard exposure across the Shire's four primary coastal localities — Gracetown, Prevelly/Gnarabup, and Augusta — and established initial management and adaptation recommendations. Since then, new coastal monitoring data, updated planning processes including revised DTMI coastal process allowances, and changes to the State's planning framework (including the gazettal of State Planning Policy 2.6 and subsequent DPLH CHRMAP Guidelines) have made a comprehensive review necessary. This document represents that review, and supersedes the 2015 CHRMAP for the coastal localities covered.

This CHRMAP focuses on the sandy beach and limestone cliff coastlines associated with the four study locations where consolidated public and private assets are exposed to coastal hazard. It does not extend to the Shire's estuarine and inland waterway environments, including the lower Blackwood River, Hardy Inlet, and Molloy Island areas. Those environments present distinct and complex coastal processes that require separate assessment. The Department of Transport and the Department of Planning, Lands and Heritage have advised that updated hydrological modelling and estuary-specific data is now becoming available at a state level, and it is recommended that a separate inland waters hazard assessment be undertaken once that data is accessible, with outcomes incorporated into the next scheduled review of this CHRMAP.

Purpose

Coastal communities within the Western Australian coastal zone rely upon their interface with the ocean for their livelihood. Settlement on and near the coast in these communities is central to many social and economic activities. There is a significant investment in the form of structures and improvements to benefit the community, in addition to the ecological service provided by natural areas in the landscape.

Managing the coastline involves many players and there is no single responsibility for all the decisions. It is important to draw together all decision makers into an informed and deliberative planning process. The Western Australian Planning Commission (WAPC) has devised a model to do this consistently.

The vulnerability ('risk exposure') of such assets to coastal hazards such as erosion and inundation is expected to increase in the future[1]. In response to this, the WAPC has adopted State Planning Policy 2.6 – Coastal Planning (SPP2.6), whose stated purpose is:

to provide guidance for decision-making within the coastal zone including managing development and land use change; establishment of foreshore reserves; and to protect, conserve and enhance coastal values. This policy recognises and responds to regional diversity in coastal types; requires that coastal hazard risk management and adaptation is appropriately planned for; and encourages innovative approaches to managing coastal hazard risk, and provides public ownership of coastal foreshore reserves.

[1] DPLH Coastal hazard risk management and adaptation planning guidelines, 2019

The policy requires coastal hazard risk management and adaptation planning be undertaken by local government. In this case the Shire of Augusta Margaret River (the Shire) is responsible for areas at risk of being affected by changing coastal hazards for the agreed planning timeframe. The planning study will identify for the study area where existing or proposed development or landholders are most likely to be exposed to changed coastal processes, also analyse and explain the implications of that coastal risk.

The Shire of Augusta Margaret River was the first local government in Western Australia to prepare a **Coastal Hazard Risk Management Adaptation Plan** (CHRMAP). The document was prepared and adopted in 2015, before detailed guidance on the form and content of CHRMAP had been prepared by the WAPC. The approach to the CHRMAP followed a risk identification **>** analysis **>** evaluation process and culminated in an adaptation and implementation plan for the Shire.

Since the preparation of the 2015 the WAPC has released further guidelines and direction on the purpose and content of a CHRMAP, and as such the Shire has commissioned a review of the 2015 document to bring the policy requirements up to contemporary standards and incorporate the results of ongoing coastal monitoring and data collection to inform ongoing local planning and management.

The CHRMAP will set the framework for the assessment of coastal risk over time, and by identifying coastal hazards, analyse the vulnerability for specific assets. It will then provide a basis for the community with the Shire to identify and prioritise management and adaptation responses as part of an implementation plan. The CHRMAP process will provide strategic guidance for coordinated, integrated and sustainable land use planning and management decision-making by the Shire on behalf of the community. It will also guide necessary changes to the Shire Local Planning Strategy, Local Planning Scheme and other relevant strategies and local planning policies.



The CHRMAP process delivers a long-term plan to assist the community to identify those most important assets along the coast, and to then consider how these will be protected and managed for immediate and future risk. The local planning framework is a dynamic legal mechanism for making decisions and this must be informed with current and reliable information such as CHRMAP.

This outcome directs how the Shire will address coastal hazard risks over time with agreed priority.

It adopts a '**risk management**' approach to:

- Consider the risks arising from coastal hazards.
- Identify risk management responses, and
- Prioritise and implement the risk management responses.

It considers '**who**' is responsible for managing the risk:

- **Private parties** are responsible for managing risks to their private assets and incomes and to do so they need to:
  - be aware of the risks and understand their responsibility to manage them,
  - take steps to understand the magnitude and nature of the specific risks to their assets and activities, and
  - develop and implement strategies and actions to manage the risks.
- **Governments**, on behalf of the community, are primarily responsible for the oversight of planning and managing risk to those public goods and public assets which they own and manage. Governments also seek to:
  - develop local policies and regulations consistent with State risk management approaches,
  - facilitate by building resilience and adaptive capacity within the local community, providing timely information about relevant known coastal hazards including erosion and inundation, and
  - building workable partnership with the community to identify and manage risks.

The risk management process, adapted to the CHRMAP process, is outlined in the diagram over.



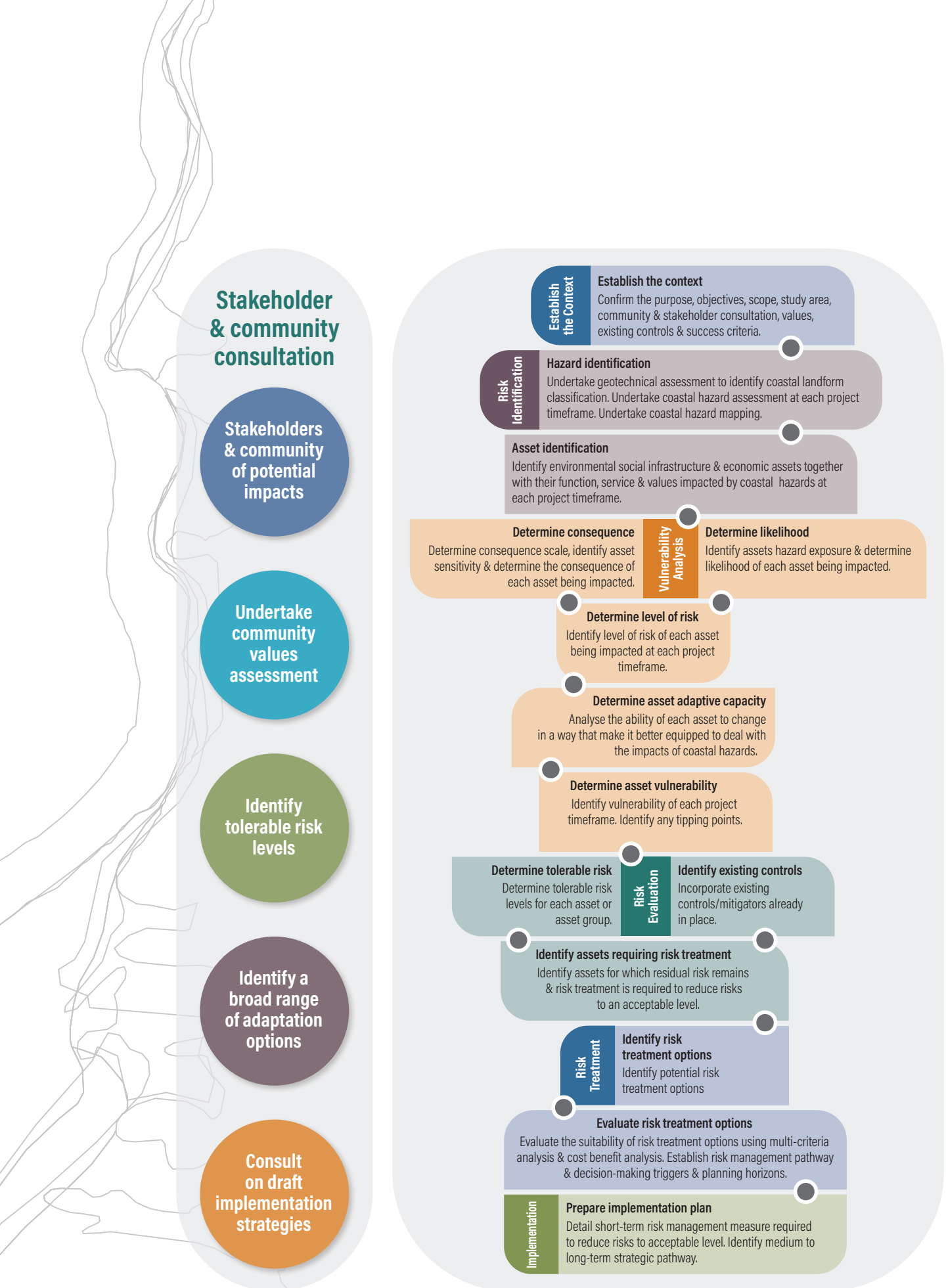


Figure 1.1: Risk management process flowchart adapted to coastal planning[2]

[2] Source: DPLH Coastal hazard risk management and adaptation planning guidelines, 2019

The preparation of the CHRMAP follows a 7-step process:

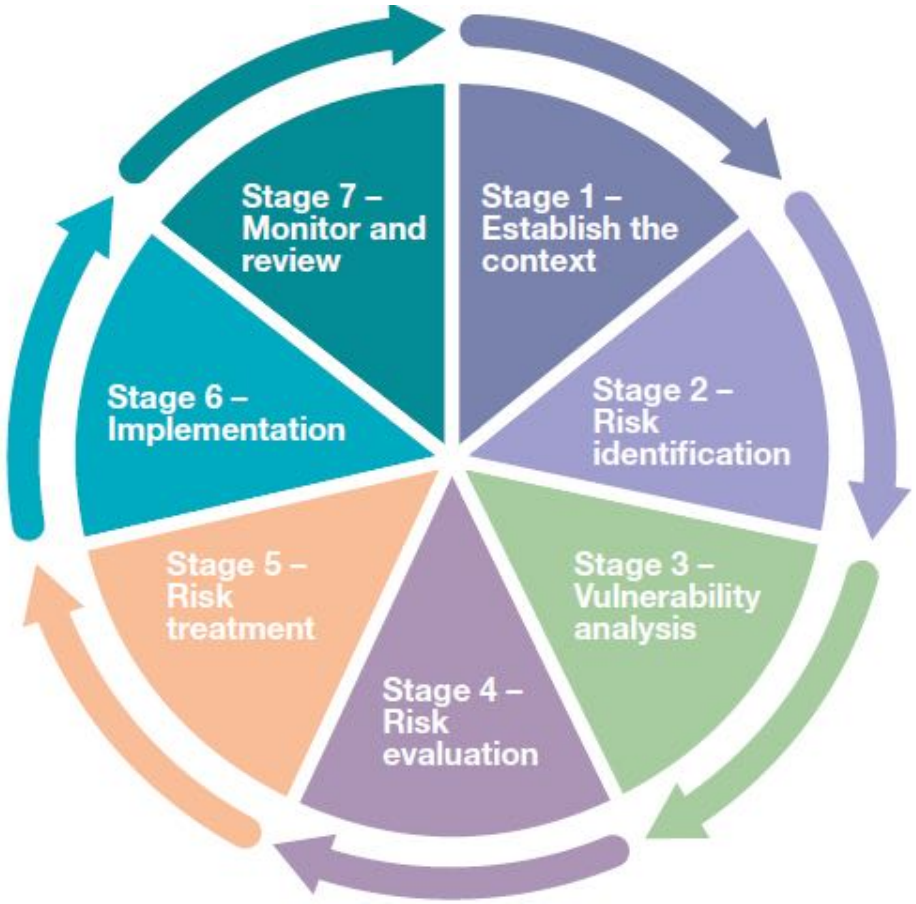


Figure 1.2 – CHRMAP preparation stages

CHRMAP Objectives

The objectives of the CHRMAP are to:

- improve the understanding of coastal features, processes, and hazards in the study area;
- identify significant vulnerability trigger points to set respective timeframes for coastal sub-compartments; to articulate and apply immediate or medium-term risk management measures;
- identify assets (natural and man-made) within the coastal zone and review the services and functions they provide;
- review vulnerability of the identified assets;
- review the value of the vulnerable assets to adverse impacts from coastal hazards;
- determine the consequence and likelihood of coastal hazards on the assets, and assign a corresponding level of risk;
- identify possible (effective) risk management measures (or 'actions') and explain how these can be incorporated into short and longer-term decision-making; and
- engage stakeholders and the community to be involved in planning and decision-making.

1.2 Study Area

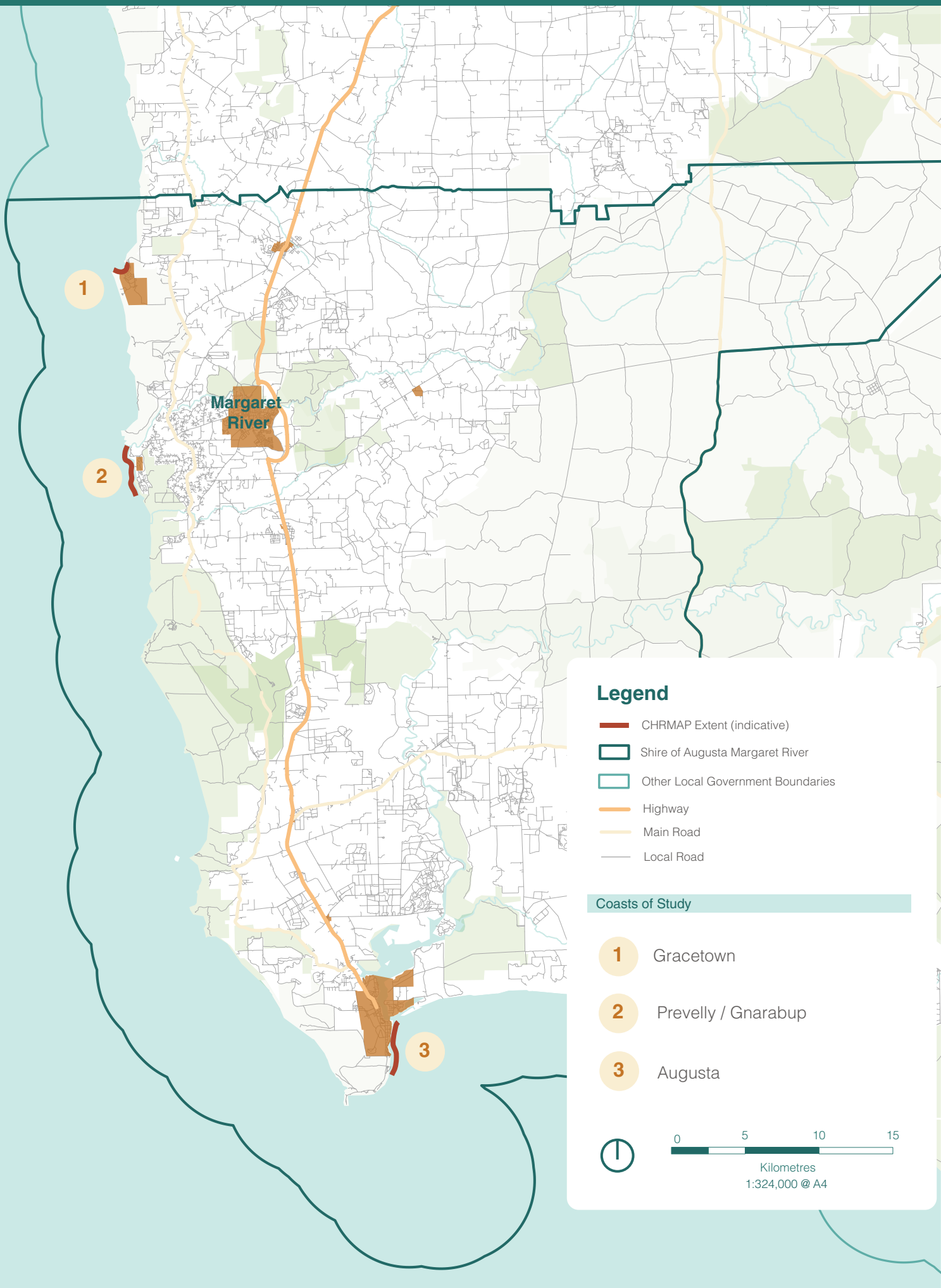
Overview

The study area for this CHRMAP builds on the assets and sites identified in the predecessor 2015 CHRMAP. The focus is the coastline within the Local Government Area of the Shire of Augusta Margaret River, recognising that the management and regulation of coastal land use within the region involves multiple authorities with distinct roles and responsibilities across different sections of the shoreline.

Particular attention is given to the localities of Augusta, Prevelly, Gnarabup and Gracetown, reflecting the history of community interest in the coastline at these locations and the active role the Shire plays in administering land uses within them through its local planning framework. Where relevant, the CHRMAP also provides general commentary on coastal management, adaptation and risk for the balance of the coastline within the Shire's jurisdiction.



FIGURE 1.3 – CHRMAP EXTENT



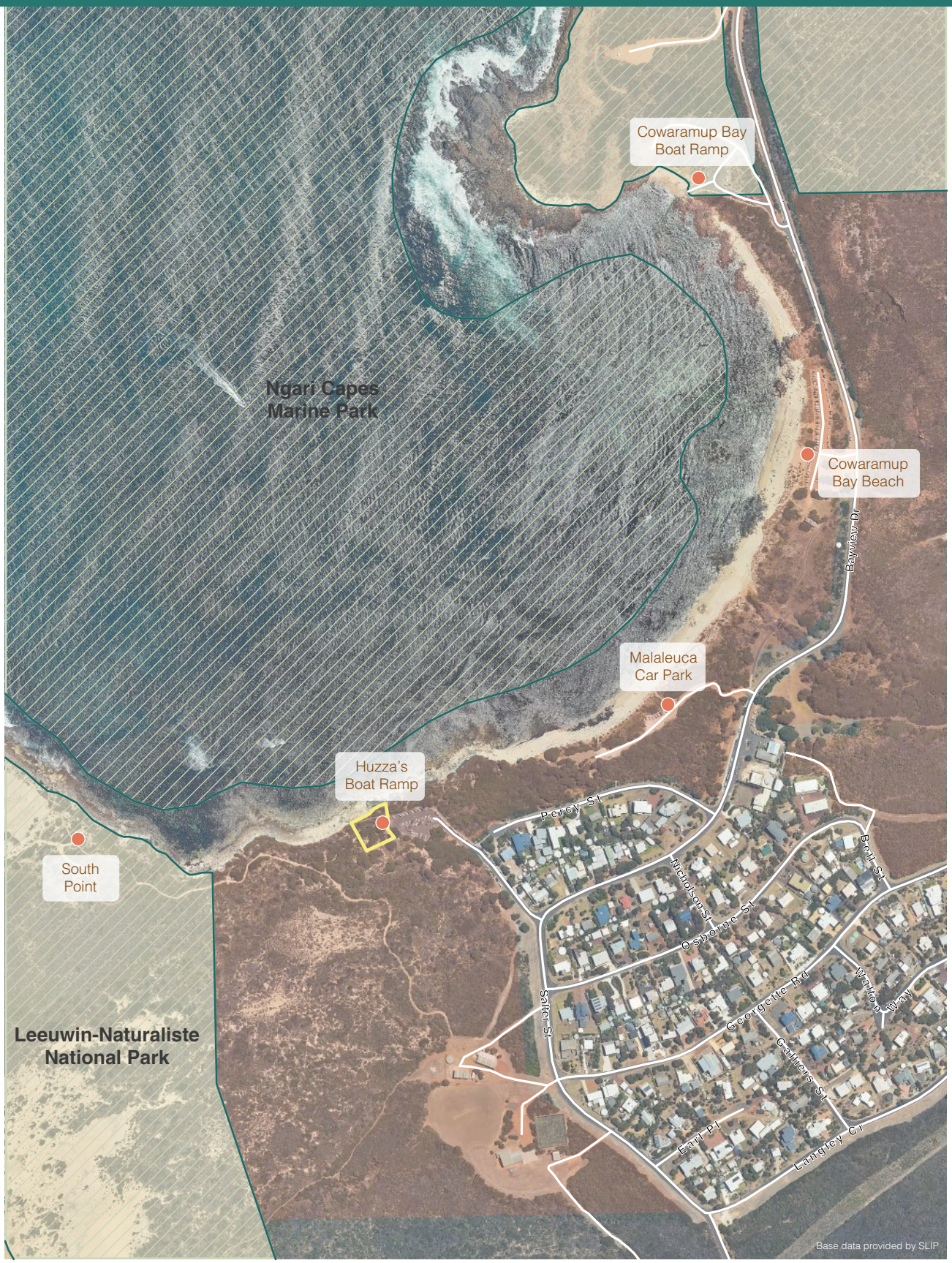
Gracetown

Gracetown has a diverse land use pattern influenced by its coastal setting. The Shire's Local Planning Strategy highlights a mix of residential, recreational and agricultural land uses in the area. Residential development is concentrated near the coast, taking advantage of the scenic outlook and to access the beach and surroundings. This proximity also exposes the community land to potential coastal hazards such as erosion and storm surges. The presence of steep cliffs and sensitive coastal ecosystems creates constraints on development, calling for careful preservation and management efforts to protect the natural environment while catering to sustainable growth.

The key coastal hazards affecting Gracetown include erosion, sea-level rise, and storm surges as the primary coastal hazards affecting Gracetown. These pressures are amplified by the region's dynamic coastal processes and increasing development along the shoreline. To mitigate risks, the CHRMAP emphasises the implementation of adaptive management strategies, such as setback requirements, coastal buffers, and land-use zoning that consider future sea-level rise projections.



FIGURE 1.4 - GRACETOWN FEATURES



Prevelly / Gnarabup

Prevelly and Gnarabup comprise distinct land use patterns, constraints, and coastal pressures. The Augusta-Margaret River Local Planning Strategy outlines the current land use in these areas, highlighting a mix of residential and coastal tourism-related activities.

Prevelly features a concentration of modest residential development nestled along the coastline, making it susceptible to potential coastal pressures such as erosion and storm surges. Gnarabup is known for its tourism appeal, with commercial accommodation and recreational facilities catering to visitors seeking to explore the region's picturesque beaches and coastal attractions. Despite their unique features, both areas share the challenge of balancing development and conservation efforts to safeguard their coastal environments and present amenity of coastal appeal.



FIGURE 1.5 - PREVELLY FEATURES



FIGURE 1.6 - GNARABUP FEATURES



Augusta

At the southern extremity of the Shire of Augusta-Margaret River, Augusta plays a significant role as a key coastal town, port and administrative centre. As outlined in the Augusta-Margaret River Local Planning Strategy, Augusta serves as a hub for essential services, commerce, and community facilities for both residents and visitors. It has marine facilities for vessels and is a hub for eco-tourism business. The town's strategic location at the mouth of the Hardy Inlet and along the Blackwood River estuary contributes to its importance as a gateway to the surrounding natural attractions and tourism destinations within the Shire.

Augusta's historical significance and cultural heritage add to its appeal, making it a notable destination for heritage tourism and enriching the overall appeal of the Shire as a diverse and vibrant region.

The coastal areas of Augusta are a unique blend of mixed land use, constraints, and coastal pressures that shape their current landscape. The Augusta-Margaret River Local Planning Strategy intends for a mix of residential, recreational, and agricultural land uses in the region. Residential development is concentrated along the coastline, taking advantage of the scenic vistas and proximity to beaches, while agricultural activities are located further inland, contributing significantly to the local economy.



FIGURE 1.7 - AUGUSTA (NORTH) FEATURES



FIGURE 1.8 - AUGUSTA (SOUTH) FEATURES

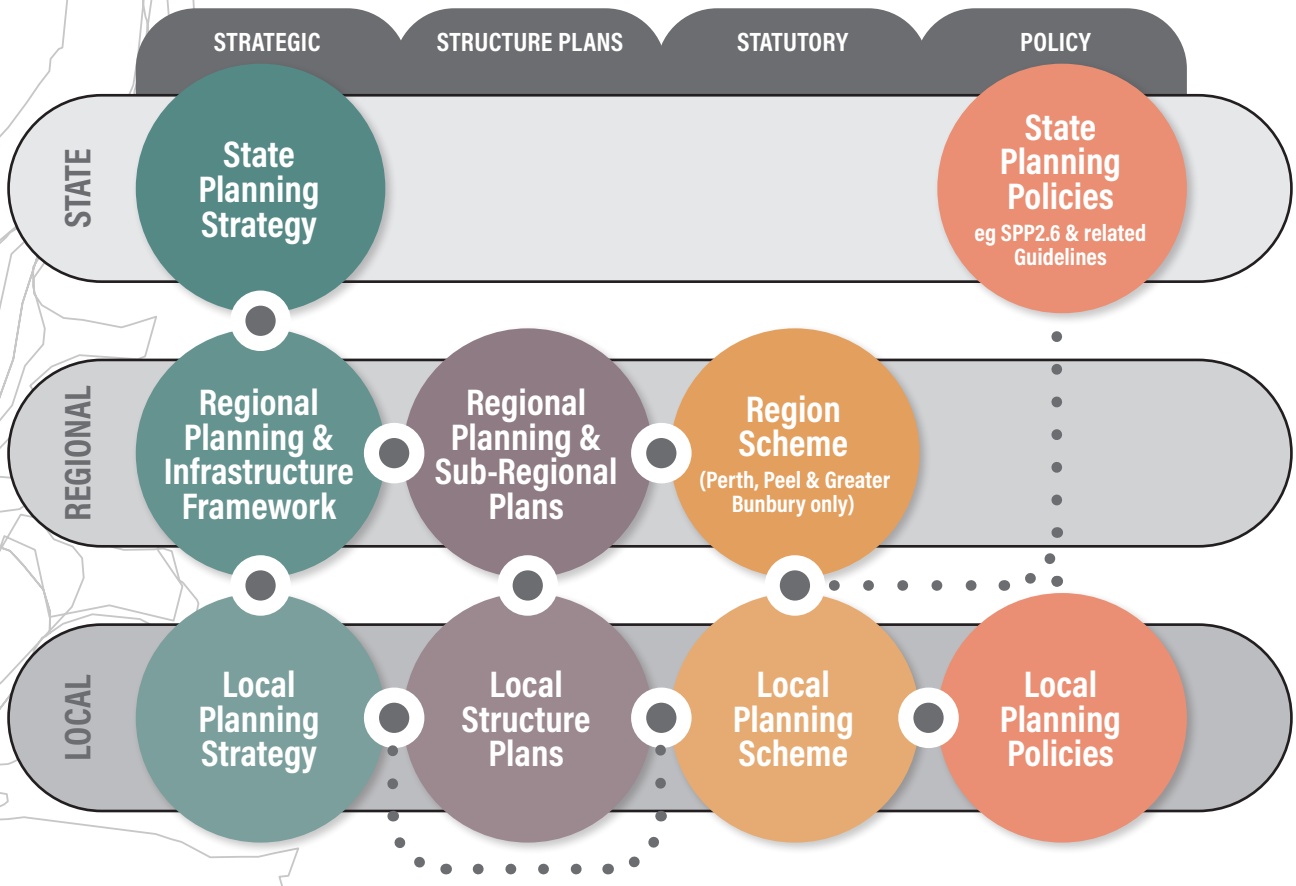


1.3 Existing Planning Controls

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 1.9 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 1.10.

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 1.9 - Planning framework overview



1.4 State Planning Policies and Strategies

The following state documents have been reviewed. Information relevant to the CHRMAP has been included below:

- State Planning Strategy 2050
- WA Coastal Zone Strategy 2017
- State Planning Policy 2.6 – State Coastal Planning Policy (and Guidelines)
- State Planning Policy 2.9 – Water resources
- Coastal Hazard Risk Management and Adaptation Planning Guidelines 2019
- State Planning Policy 3.4 – Natural Hazards and Disasters

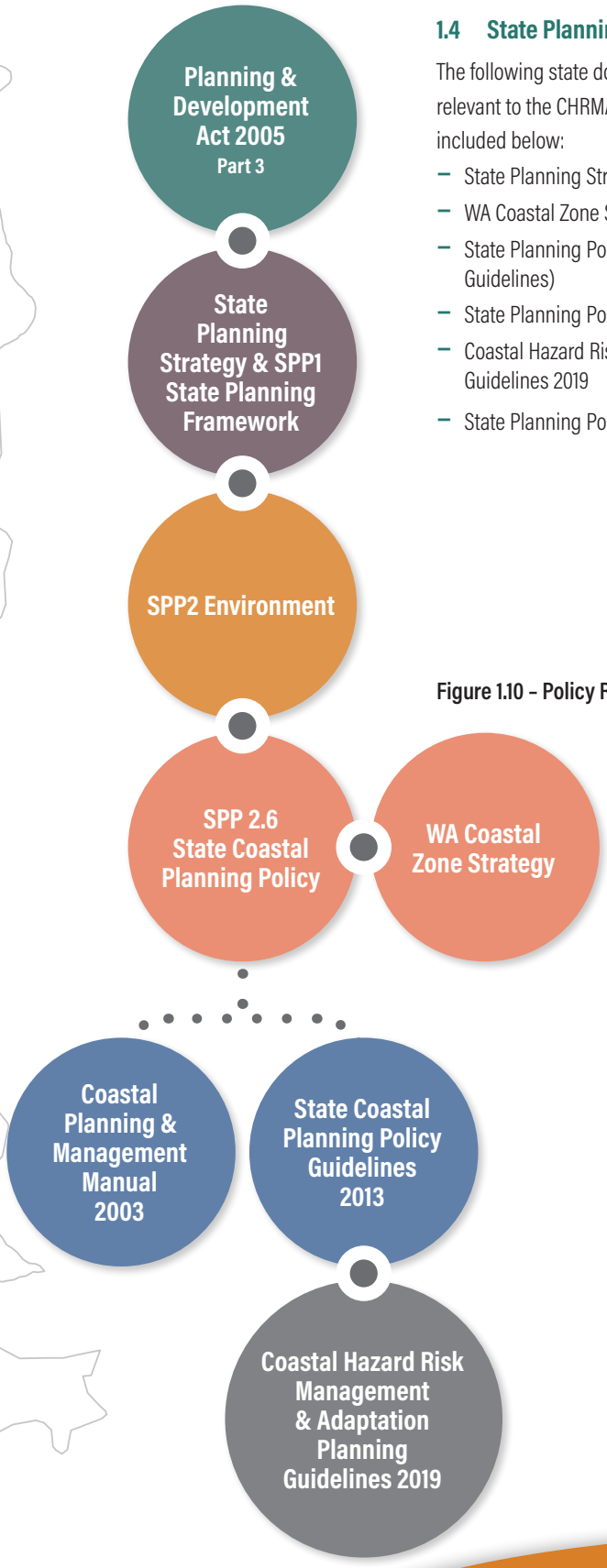


Figure 1.10 – Policy Relationships

1.5 Community Engagement

Engagement Objectives

Engagement with the community and stakeholders informed the preparation of the CHRMAP with social priorities and non-technical considerations. The Stakeholder and Community Engagement Plan (SCEP) objectives include:

- the collection and collation of community and stakeholders' social, environment, infrastructure and economic values and aspirations for the coastal area; this information informed the remainder of the process, in particular the vulnerability analysis and multi-criteria assessment of adaptation options;
- an understanding of the level of tolerance and acceptability of specific risks within the community for specific assets, or groups of assets;
- advising the community and stakeholders about the inclusion of a Benefit Distribution Analysis to assist with apportioning the costs (capital and recurrent) of chosen risk management measures, based on the beneficiary pays principle; and
- distribution of the draft CHRMAP to seek feedback on the proposed adaptation options, pathways and implementation plan.

The CHRMAP project incorporated several consultation methods to engage stakeholders, such as community surveys, interactions with user groups, a dedicated steering group, opportunities for public feedback on draft CHRMAP documents, and council review and approval.

Levels of engagement

Five levels of engagement are recommended on the IAP2 website – Inform, Consult, Involve, Collaborate and Empower. This standard is accepted and used as a guide in many projects and has been adopted as an overarching guide to consultation in this project.

The suggested project response to the IAP2 Participation Spectrum is outlined in Table 1.1.

Table 1.1 - Engagement levels

ENGAGEMENT LEVEL	SUGGESTED PROJECT RESPONSE
INFORM	Distribution of correspondence to key stakeholders and adjacent landowners. Notice published on the Shire website. Shire social media channels used to promote community survey and upcoming activities.
CONSULT	Online community survey distributed and completed (results summarised in this document). Targeted discussions with key agencies including the Department of Transport and Department of Planning, Lands and Heritage. Draft CHRMAP to be advertised for public comment prior to Council adoption (pending).
INVOLVE	Community workshop held at commencement of the project to introduce the CHRMAP process and gather initial community input. Individual community information sessions held with Augusta residents (April 2026).
COLLABORATE	Steering Group established, comprising Shire officers and key internal stakeholders. Regular Steering Group meetings held throughout the project to review technical outputs and guide adaptation recommendations. Targeted agency feedback sought from DTMI and DPLH. Council briefing (pending, prior to public advertising).
EMPOWER	Steering Group provided input to key strategic decisions including adaptation options and planning responses. Community input through the public advertising period will inform Council's final deliberations. Council, as the elected representative body, will formally adopt the CHRMAP, giving effect to community and stakeholder outcomes.

Consultation outcomes

A community survey was conducted as part of the CHRMAP engagement process and distributed to residents, landowners, and regular users of the Shire's coastline across all four study locations. Responses confirmed a strong and consistent connection between the community and the coastal environment, with recreational activities — including swimming, surfing, walking and camping — valued highly alongside the conservation, biodiversity and tourism values that the coastline supports. Respondents demonstrated a high degree of awareness of coastal change and the potential impacts of climate change, and expressed clear expectations that the Shire take an active role in managing coastal hazards over the long term.

Community input directly informed the identification and prioritisation of assets assessed in this CHRMAP. Survey responses validated the importance of physical infrastructure (boat ramps, jetties, roads and recreational facilities), environmental assets (dune systems, coastal vegetation and shorebird habitat), and cultural heritage, including Wooditj Dunes and the Blackwood River. Protection of environmental values and continued access to the marine environment were ranked as top priorities by respondents. Views on funding mechanisms, including rates levies or special area contributions, were mixed, with a majority supporting shared responsibility between government, landowners and the community as the preferred model for managing coastal adaptation over time. These preferences have been taken into account in the weighting of adaptation options through the multi-criteria assessment and cost-benefit analysis.

Prior to the public advertising of this CHRMAP, individual information sessions were held with Augusta residents who wished to meet (April 2026). These sessions were designed to provide residents with the context needed to engage meaningfully when the document is released for public comment — including an explanation of what the hazard lines represent, how the planning horizons work, and what the proposed adaptation options mean for their properties and the broader Augusta coastline.



Risk Identification

2.1 Site inspection

A site inspection of Gracetown, Prevelly/Gnarabup and Augusta was initially undertaken with the project team, the Shire of Augusta Margaret River and the Project Steering Group on 22 May 2023.

Detailed site inspections were undertaken by Shore Coastal over the 2023 winter to inform the review of planning allowances for coastal processes on highly variable mixed sandy/rock coasts. These planning allowances are typically based on sandy coastlines and simplified models on the coastal response to sea level rise. The full Hazard Assessment document is provided at Appendix A.

2.2 2015 Preliminary Risk Identification

The 2015 CHRMAP identified a range of assets that could potentially have been exposed to coastal processes at several key sites around the Shire (refer to Table 2.1).

These assets provided the initial focus of the CHRMAP and will again be reviewed as appropriate during this project.

Table 2.1 - Coastal Assets potentially exposed to coastal processes (2015)

PROJECT SITE	POTENTIAL EXPOSURE TO COASTAL PROCESSES[3]
Gracetown	– Single access road is within 200m setback and a few sections are below 5.0mAHD. – Public infrastructure at Gracetown swimming beach and Melaleuca Beach reasonable low lying with narrow dune with evidence of recent erosion. – Public infrastructure at Southpoint has narrow setbacks to high erodible cliffs. – Foundations of Huzzas access stairs piles exposed. – Private property seaward of Bayview Road and shop within 200m setback.
Prevelly	– Public infrastructure at River Mouth has narrow setbacks to an eroding foreshore influenced by the migration of the river mouth and river flow. – High value development of Surfers Point adjacent to high erodible cliffs. – Limestone coastal path has narrow dune setbacks and evidence of recent erosion. – Small number of private properties along Mitchel Drive within 200m setback.
Gnarabup	– Public infrastructure at Gnarabup has narrow dune setbacks and recent evidence of erosion. – Limestone coastal path has narrow dune setbacks and evidence of recent erosion. – Foundations of timber beach access stairs north of Cafe exposed. – Significant drop off from lower timber stair to beach at many timber beach access stairs along Gnarabup Beach. – White Elephant café has narrow dune setbacks and recent evidence of erosion. Timber deck recently adapted (wall removed, depth of timber piles extended). – Significant drop off from lower timber stair to dune at new composite beach access stairs at Grunters and Gas Bay. – Coastal carparks at Gnarabup and Gas Bay within 200m setback. – Cadastral boundaries for some development seaward of Wallcliffe Road within 200m setback.

[3] Coastal assets either below the 5m AHD contour or within 200m of the coast were identified and documented using aerial imagery, Shire cadastral data and site inspections. The 5mAHD contour was the lowest available contour above a nominal 100yrRP water level, plus an allowance for sea level rise, at all project sites. The 200m represents an allowance for coastal processes for the 100 year planning timeframe a sandy coastline with an erosion trend of 0.5 metres per year. (Source: Shore Coastal, 2015 CHRMAP).

PROJECT SITE	POTENTIAL EXPOSURE TO COASTAL PROCESSES[3]
Augusta North (Blackwood River)	– Public access path along foreshore has narrow setbacks and low lying. – Public infrastructure associated with recreational boating and has some resilience to coastal processes – Large number of private properties within nominal 200m setback. It is noted however application of a 200m setback for inland waters likely to be conservative. – Large number of private properties below 5.0mAHD between Hillview Road and the Cut, including the Turner Caravan Park – Significant recent coastal changes at Blackwood River Mouth (the Cut)
Augusta South (Flinders Bay)	– Public access path along foreshore has narrow setbacks. – Large number of private properties seaward of Turner St and at Flinders – Bay settlement within nominal 200m setback. – Modest number of private properties adjacent to Deere St below 5.0mAHD. – Flinders Bay Caravan Park and a small number of private properties in – Flinders Bay below 5.0mAHD – Significant recent coastal changes at Blackwood River Mouth (the Cut)

Source: Shore Coastal, 2015 CHRMAP

2.3 Review of coastal process allowances

Coastal process allowance mapping

A review of the planning allowances for coastal processes has been undertaken using the procedures outlined in Schedule 1 of State Planning Policy 2.6 – State Coastal Planning Policy (SPP 2.6). The resulting hazard mapping provides an interpretation of the areas that may potentially be exposed to coastal erosion and inundation over the relevant planning timeframes. It is important to note that the lines shown on the hazard maps do not represent the predicted location of the shoreline at those future dates. Rather, they represent the calculated landward extent of the planning allowance for coastal processes, incorporating relevant erosion, recession and other hazard allowances required under SPP 2.6. The area seaward of each line should therefore be understood as land potentially affected by coastal processes within the corresponding planning timeframe, rather than as an indication that the shoreline itself is expected to migrate to that line.

The application of SPP2.6 for determining coastal processes allowances varies depending on the coastal type. The project scope is diverse and includes hard rock coast, weakly lithified sedimentary rock coast, sandy coasts, and dynamic estuary outlets/river mouths.

Sandy Coasts

The procedures outlined in Schedule 1 of SPP2.6. for coastal planning allowances sandy coasts requires consideration of four elements. This following has been assumed for the review of coastal planning allowances for this study:

- **S1 Erosion:** Allowance for Current Risk of Storm Erosion: Modelled storm erosion from 2015 using SBEACH has been reviewed and considered reasonable for planning allowances as only limited coastal monitoring has been undertaken by the Shire to allow validation of updated numerical models (XBEACH), and S1 is a relatively minor component of the planning allowances.
- **S2 Erosion:** Allowance for Historic Shoreline Movement Trends: Analysis of vegetation line movement from 2000 and 2013 aerial imagery (2015 CHRMAP) have been updated using 2013 to 2022 imagery to assess current shoreline movement behaviour.
- **S3 Erosion:** Allowance for Erosion Caused by Future Sea Level Rise: Procedure as outlined in SPP2.6 (100 x Sea Level Rise (m))0.9.
- **Factor of Safety:** 0.2m/year allowance for uncertainty in coastal assessments.

The sum of the four elements has been offset horizontally from the Horizontal Shoreline Datum (HSD), which has been updated based on the 2022 vegetation line (which typically represents the active limit of storm activity). An example of the application is shown in the figure below.



Figure 2.1 - Representation of Planning Allowance for Coastal Processes on a Sandy Coast

Note: HSD – Horizontal Setback Datum, S1 – Allowance for Current Risk of Storm Erosion, S2 – Allowance for Historic Shoreline Movement Trends, S3 – Allowance for Erosion Caused by Future Sea Level Rise, FOS – Factor of Safety (Allowance for Uncertainty)

Hard Rock Coast

The State Coastal Planning Policy defines rocky coasts as those which comprise a continuous rocky substrate which extends to an elevation above the active limit of the shoreline, which "in most instances this elevation should be at least one metre above the HSD". The North Point rocky headland is an example of a "hard rock" type of rocky coast.

The underlying erosion rate on these coasts is typically zero, and The State Coastal Planning Policy outlines the future risk of erosion should be based on a geotechnical assessment of the shoreline stability. Where geotechnical studies are not available, areas seaward and lower than the 4.0mAHD contour have been nominally identified as subject to coastal processes for the 10-100 year planning timeframe.

Weakly Lithified Sedimentary Rocky Coast

Weakly Lithified sedimentary coast typically comprises poorly cemented or semi-lithified, discontinuous, relatively soft, or highly weathered, weak rock. The headland at Surfers Point in Prevelly is an example of a "weakly lithified sedimentary coast".

Where available, the 2017 limestone cliff stability assessment has been used to outline the allowances on the rocky coasts within the study area. Planning allowances based on sandy coasts for limestone cliffs are conservative. However, there is a high degree of uncertainty in the response of weakly lithified sedimentary rock to sea level rise during the 100-year planning period.

Whilst the 100yr planning allowance has been defined for Weakly Lithified Sedimentary Rocky Coast in Golder 2017, the scope did not include assessment of 10yr and 20yr allowances and thus in these areas only the 100-year allowance is identified on the plan.

Where hard rock is clearly visible during site inspections within the study area, the planning allowances have been adjusted locally (e.g. granite outcrops and cliffs east of the road at Gracetown, coastal rock at Trigg St, Augusta).

2.4 Limitations

The review of the coastal process allowances for the next 10, 20 and 100 years provides an indication of the potential area of influence of coastal processes within the Shire for different timeframes. However, Planning allowances for coastal processes are based on methods outlined in schedule 1 of the WA State Coastal Planning policy (SPP2.6), and Allowances are not a prediction of the shoreline position at the end of the respective planning periods.

Other key limitations are outlined below:

- These plans do not have the precision required to define the erosion risk to individual properties or landholdings.
- The assessment of sea level rise impacts on the shoreline is limited to a simplistic application of the Bruun rule for sandy coasts as per SPP2.6. However, coastal rock has been considered in the 100yr planning allowances where it is likely to reduce the future extent of shoreline retreat.
- Allowances for sedimentary rock coasts (weakly lithified sedimentary cliffs) are based on geotechnical investigations by Golder (2017), where appropriate.
- There is a high degree of uncertainty in the response of weakly lithified sedimentary rock to sea level rise during the 100-year planning period

2.5 Gracetown

Gracetown is a northwest facing embayment exposed to high energy waves. The shoreline position is controlled by a granite headland to the north (North Point) and a lower elongated granite headland, overlaid by sand dunes and weakly lithified sedimentary rock to the south (South Point). Within the bay there are numerous reefs that cause wave refraction and wave breaking, and along the shoreline there are rocky outcrops that provide a secondary control on shoreline position. A small creek drains to the beach along this section of coast. The coastal type includes sandy beaches backed by low dunes from the boat ramp to Melaleucas, weakly lithified sedimentary rock cliffs fronted by boulder beaches, limestone rock fall or narrow, thin perched sandy beaches. Development is associated with the Gracetown townsite and various beach and boating access nodes.

The storm erosion allowance (S1) for Gracetown is based on the 2015 CHRMAP SBEACH modelling. This has been applied to sandy coasts only. The historic shoreline change (S2) for each sector was assessed using the coastline movements from the 2015 CHRMAP (2000 – 2012), as well as the more recently available rectified aerial photography up to 2022. The long-term underlying erosion rate of the Gracetown sandy coasts (from Swimmers Beach to North Melaleuca is generally 0m/yr., however a 0.2m/yr. long term erosion rate at South Melaleuca Beach was observed.



Figure 2.2 - Site photos at Melaleucas (South) following erosion in 2020 (left), and Gracetown Swimming Beach during a high-water level event (right)

The hard rock coast at North Point, and Weakly Lithified Sedimentary coasts towards South Point have underlying erosion rates of zero, and the future risk of erosion for the Weakly Lithified Sedimentary coast along South Point has been based on a geotechnical assessment of the shoreline stability (Golder 2017).

There are several large rocky features that are clearly visible landward of the sandy coasts from South Melaleucas to North Point. These rocky features are hard rock that typically extend well above the 5mAHD contour. Coastal rock has been considered in the 100yr planning allowances where it is likely to reduce the future extent of shoreline retreat.

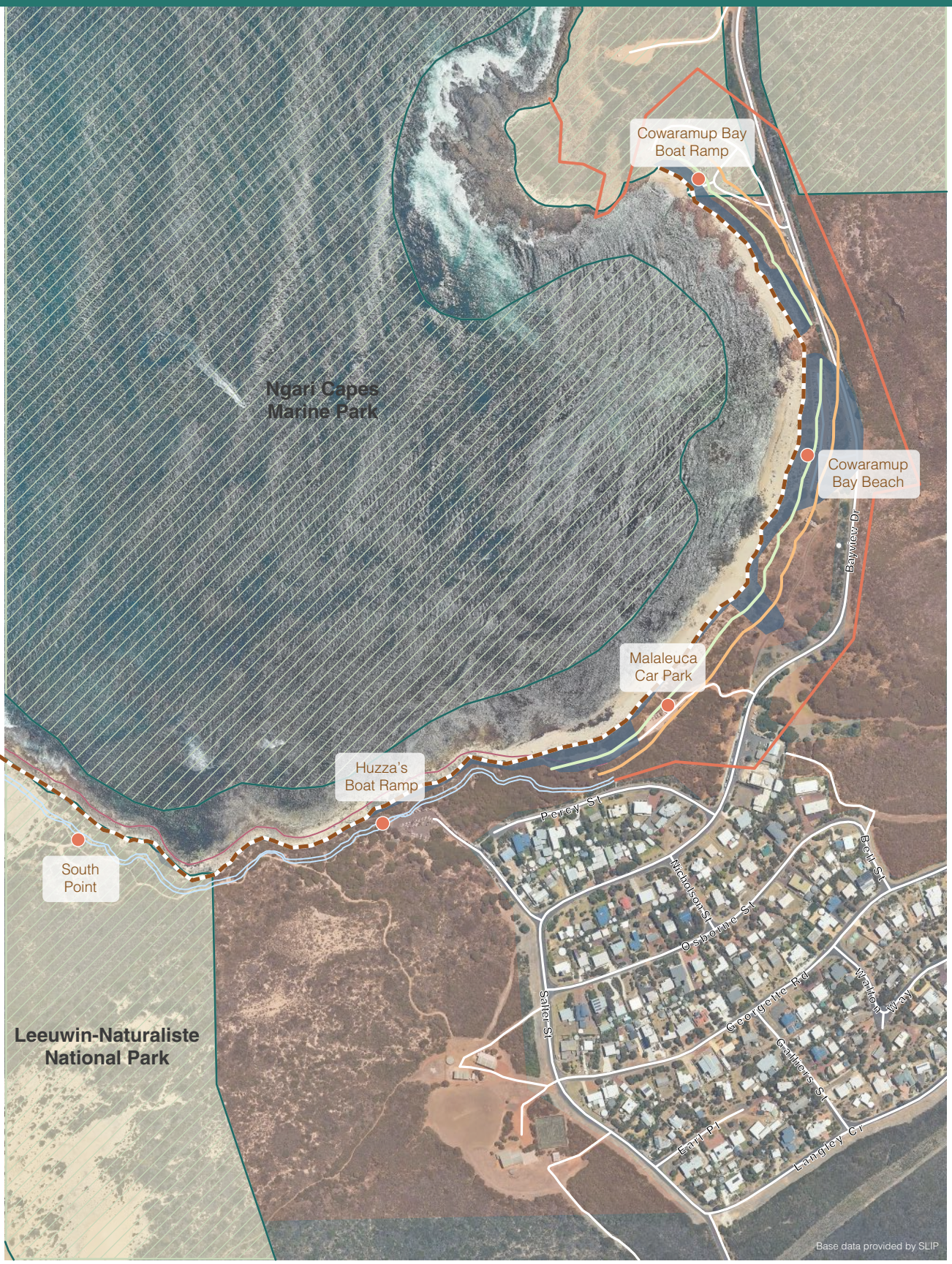


Figure 2.3 - Site photos at Gracetown showing exposed rock landward of the access road, where the 100yr Allowance has been adjusted locally to be seaward of these features.

Table 2.2 – Planning allowances for coastal processes – Gracetown

COASTAL NODE	NORTH POINT HEADLAND	COWARAMUP BAY SWIMMING BEACH	MELALEUCA BEACH	SOUTH POINT CAR PARK	SOUTH POINT
Coastal Type	Hard Rock Coast	Sandy Coast	Sandy Coast	Weakly Lithified Sedimentary Rock Coast	Weakly Lithified Sedimentary Rock Coast
10yr Planning Allowance (m)	0	20	20	0	0
20yr Planning Allowance (m)	0	40	40	0	0
100yr Planning Allowance (m)	0 (approx. 4mAHD contour)	130	150	Variable (Golder 2017)	Variable (Golder 2017)

FIGURE 2.4 – HAZARD LINES AND INUNDATION AREAS - GRACETOWN



2.6 Prevelly

Prevelly is a generally west facing coastline with inshore lagoons and offshore reefs exposed to high energy waves. Shoreline position is controlled by weakly lithified sedimentary headlands. Coastal types include the Margaret River mouth, weakly lithified sedimentary rock coast (Surfers Point) and sandy coast (Riflebutts Beach). Thin, perched beaches overlaying rock are evident at Surfers Point whilst the beach at Riflebutts is relatively steep, high and narrow. Development is associated with the Prevelly townsite and coastal nodes at Surfers Point and the Rivermouth.

The storm erosion allowance (S1) for Prevelly is based on the 2015 CHRMAP SBEACH modelling. This has been applied to sandy coasts only. The historic shoreline change (S2) for each sector was assessed using the coastline movements from the 2015 CHRMAP and the more recently available rectified aerial photography up to 2022.

A small section of sandy coast near the Rivermouth shows variable behaviour and is subject to erosion and accretion depending on a northern or southern opening of the river and seasonal changes. However, no longer-term erosion trend was evident. Landward of the 20- year coastal process allowance (behind the Rivermouth carpark), the coast is backed by steep hills that extend to over 35m above mean sea level.

West of the Rivermouth carpark, the coast becomes a weakly lithified sedimentary coast, and the Golder 2017 geotechnical assessment has been used to delineate 100yr allowances. Riflebutts Beach typically demonstrates seasonal changes in beach shape and erosion during winter, but the longer-term coastline movements since 2000 is a net change of 0m.



Figure 2.5 - Erosion under beach access stair near Surfers Point (left), and coastal rockfall signage and fencing at the base of the Riflebutts cliffs (right).

Table 2.3 – Planning allowances for coastal processes – Prevelly

COASTAL NODE	RIVERMOUTH BEACH	RIVERMOUTH ROAD	SURFERS POINT	RIFLEBUTTS BEACH	PREVELLY (DOG BEACH)
Coastal Type	Sandy Coast	Weakly Lithified Sedimentary Rock Coast	Weakly Lithified Sedimentary Rock Coast	Sandy Coast	Sandy Coast
10yr Planning Allowance (m)	20	0	0	20	20
20yr Planning Allowance (m)	40	0	0	40	40
100yr Planning Allowance (m)	NA	Variable (Golder 2017)	Variable (Golder 2017)	120	150



FIGURE 2.6 – HAZARD LINES AND INUNDATION AREAS - PREVELLY



2.7 Gnarabup

Gnarabup is a generally west facing coastline with inshore lagoons and offshore reefs exposed to high energy waves. Shoreline position is controlled by weakly lithified sedimentary headlands. Coastal types include hard rock coast (Gas Point), weakly lithified sedimentary rock coast and sandy coast. The hard rock at Gas Point is overlayed with sand dunes. Steep high sandy beaches with coarse sediments are backed by high dunes with intermittent limestone outcrops and cliffs from Gas Point to Gnarabup Point.

The Gnarabup stretch of coastline contains the Shire of Augusta Margaret Rivers' only beachside cafe, one of the Shire's most popular swimming beaches, and the Gnarabup jetty and boat ramp. There is a popular sheltered swimming beach north of the White Elephant café that has undergone recent coastal management actions including sand nourishment and a local diversion of a coastal path that was eroded during storms in recent years.

The storm erosion allowance (S1) for Gnarabup is based on the 2015 CHRMAP SBEACH modelling. This has been applied to sandy coasts only. The beach at Gnarabup has experienced erosion in recent years (2017 – 2022) with the loss of mature dune vegetation, impacting coastal infrastructure such as stairs, fencing, café decking and threatening sections of the coastal walkway. There is an underlying long term erosion rate of historic shoreline change (S2) at Gnarabup (White Elephant) and Gnarabup (Back Beach).

The Gnarabup Headland and Grunters Headland are identified as weakly lithified sedimentary coast, and the Golder 2017 geotechnical assessment has been used to delineate 100yr allowances for the Gnarabup Headland and the Grunters headland. Between these two headlands (landward of Back Beach) a limestone ridge is visible approximately 40m landward of the vegetation line, extending to ~20m above mean sea level. However, as there is no geotechnical information on the continuity or composition of the ridge, the area has been treated as a sandy coast. Geotechnical investigations may reduce local planning allowances in this area. More detailed geological evaluation has been undertaken in association with the development proposal for this land. This proposal has yet to be determined and so the acceptance or otherwise of that work has not been determined through that process.



Figure 2.7 - Sand Nourishment at Gnarabup Beach in 2022 (left), and a local path diversion following storm erosion in 2018 (right)

Table 2.4 – Planning allowances for coastal processes – Gnarabup

COASTAL NODE	GNARABUP (WHITE ELEPHANT)	GNARABUP HEADLAND	GNARABUP (BACK BEACH)	SEWERS
Coastal Type	Sandy Coast	Weakly Lithified Sedimentary Rock Coast	Weakly Lithified Sedimentary Rock Coast	Sandy Coast
10yr Planning Allowance (m)	20	0	20	20
20yr Planning Allowance (m)	40	0	40	40
100yr Planning Allowance (m)	150	Variable (Golder 2017)	150	150



FIGURE 2.8 – HAZARD LINES AND INUNDATION AREAS - GNARABUP



2.8 Augusta

The Augusta South project site includes the Flinders Bay shoreline of the Augusta townsite and the Flinders Bay settlement. This is an east facing embayment sheltered from high energy Indian Ocean waves but with significant exposure to the southeast. Coastal types include hard rock coast and sandy coast. Public infrastructure and a coastal road are located along modest dunes with narrow setbacks. There are several thin perched sandy beaches controlled by granite outcrops in the Flinders Bay area. Augusta Boat Harbour, along the rocky coastline south of Flinders Bay, marks the southern extent of this project site.

The storm erosion allowance (S1) for Augusta is based on the 2015 CHRMAP SBEACH modelling. This has been applied to sandy coasts only.

The historic shoreline change (S2) was assessed using available rectified aerial photography. For the sandy coast adjacent to the Blackwood Rivermouth, caution of interpretation of the coastline movements is required due to the large-scale changes observed at the river entrance. Rates of change of more than 20m per year have been observed as the river entrance morphology evolves. The inlet channel is highly dynamic, with sediment behaviour influenced by marine processes (waves and tides), inlet processes (tidal currents, spit development, delta formation) and occasional flooding. For this section of sandy coast "Albany Terrace – Blackwood River Cut", the median erosion rate of ~2.5m/yr has been applied for the 10-year Coastal Process Allowance. However, for the longer term (100yr) allowance, the longer-term coastline movements average of 0m/yr has been applied. This aims to capture the risk due to the potential for rapid short-term shoreline changes but apply a considered allowance for the longer changes that are less volatile. It should be noted that the current entrance was artificially cut in 2010.

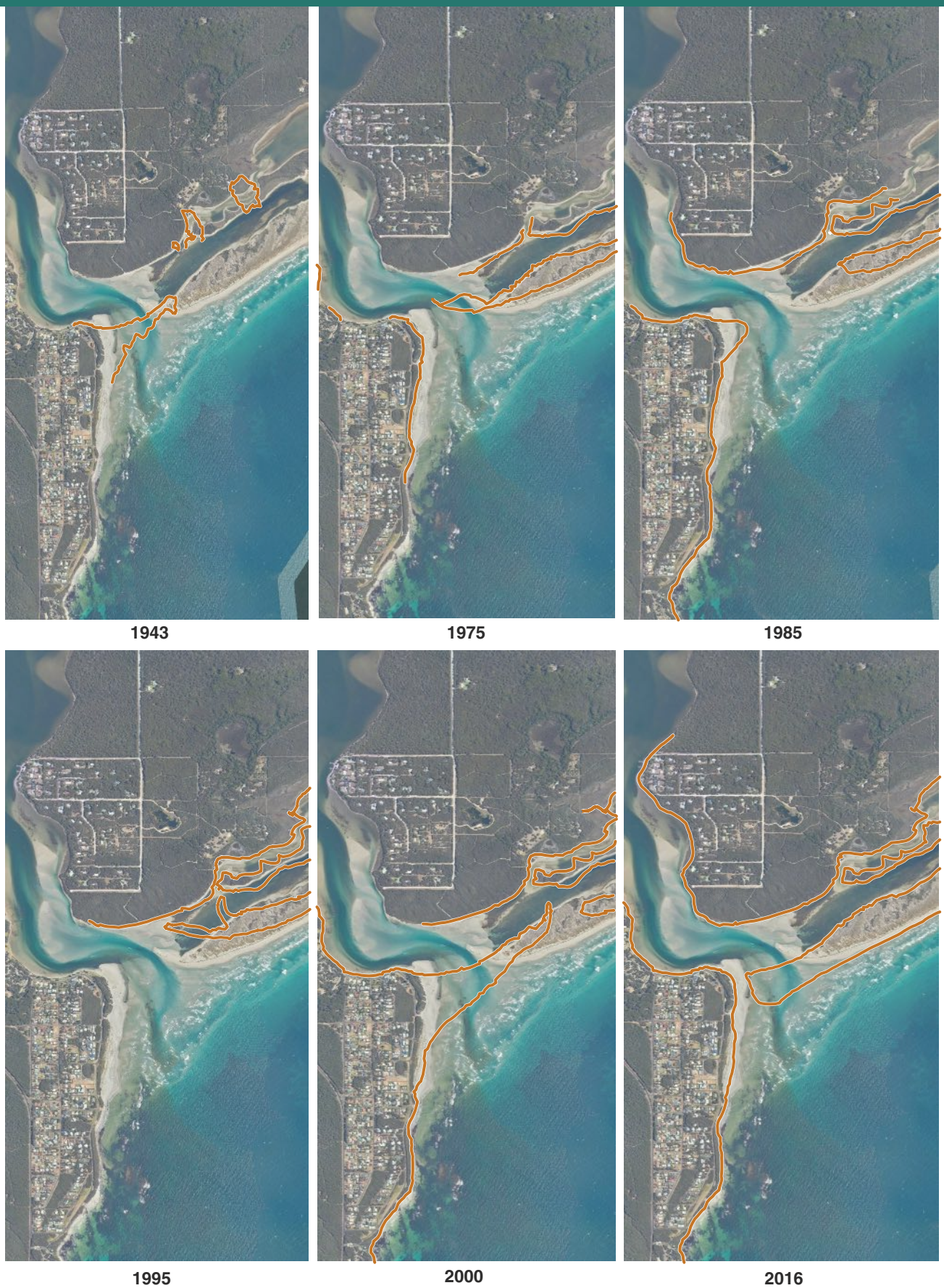
The Blackwood River mouth is dynamic and is currently in a phase of eastward migration. This process has been occurring since at least the 1950s and aerial photography over that period shows a consistent pattern of change. Figure 2.9 illustrates the shift in the river mouth position between 2010 and 2022, while Figure 2.10 shows longer-term vegetation movement since the 1950s, providing a broader picture of how the entrance has evolved over time. It is likely that the river will continue to move in a north easterly direction over the next few decades, resulting in accretion of the coastline and more of a buffer to residential properties.



Augusta 2010 Augusta 2017 Augusta 2022

Figure 2.9 - Aerial imagery showing Blackwood River mouth Dynamics in 2010 (prior to new alignment), and changes from 2017 to 2022.

FIGURE 2.10 - VEGETATION MOVEMENT LINES - BLACKWOOD RIVER MOUTH



The section of coast "Albany Terrace – Sandy/Rocky Coast" consists of visible hard rock along the shoreline, and has been stable in the long term. However, the rock is relatively low; the GBGMAPS (2022) investigations identify the level of the top of rock as typically between 0 and 2mAHD while the 2017 MNG Lidar typically demonstrates the crest of the hard visible rock is at ~2mAHD. Based on SPP2.6 this is too low to consider this section of coast as "hard rock" for the 100yr planning period, particularly with lower areas evidence of dune erosion behind the rock. The coastal process allowances are based on a long-term coastline movements trend of 0m/year, but have allowances for acute storm erosion (s1), sea level rise (s3) and a factor of safety.



Figure 2.11 - Visible rock along Albany Terrace

Table 2.5 – Planning allowances for coastal processes – Augusta

COASTAL NODES	ALBANY TERRACE – BLACKWOOD RIVER CUT	ALBANY TERRACE – ROCKY COAST	ALBANY TERRACE – SANDY COAST	FLINDERS BAY CARAVAN PARK	FLINDERS BAY
Coastal Type	Sandy Coast	Sandy Coast/ Rocky Coast	Sandy Coast	Sandy Coast	Sandy Coast/ Rocky Coast
10yr Planning Allowance (m)	40	10	10	10	10
20yr Planning Allowance (m)	NA	30	30	30	30
100yr Planning Allowance (m)	120	120	120	120	120

FIGURE 2.12 – HAZARD LINES AND INUNDATION AREAS – AUGUSTA NORTH



FIGURE 2.13 – HAZARD LINES AND INUNDATION AREAS – AUGUSTA SOUTH



2.9 Coastal Inundation (S4 Allowances)

Under SPP 2.6, the planning allowance for coastal inundation is calculated by combining two components: the inundation level associated with a large storm event, and an allowance for predicted sea level rise over the planning period. Together, these define the extent of land that could be affected by inundation now and into the future.

For the study area between Gracetown and Augusta, the storm inundation level is based on a significant but rare coastal storm — one with a 0.2 percent chance (or a 1 in 500 year likelihood) of occurring in any given year. This produces a water level of 2.9 metres above the Australian Height Datum (AHD), which is the standard reference point for measuring coastal elevations. Adding a 0.9 metre allowance for sea level rise over the 100-year planning period gives a combined inundation planning level of 4.0 metres AHD.

Put simply, land below this level could be subject to inundation at some point within the planning horizon. This 4.0 metre contour has been mapped across the coastal study areas using survey data captured by LiDAR aerial survey in 2017, providing a clear picture of which land and assets fall within the potential inundation zone.



Vulnerability Assessment and Risk Evaluation

A Vulnerability Assessment and Risk Evaluation Chapter Report was prepared which constitutes the second stage of the risk identification process. All identified at-risk assets within the management units were assigned vulnerability ratings, according to the various scales. The vulnerability results are presented in full in the Vulnerability Analysis Chapter Report. A summary is presented below.

3.1 Asset Identification

There are a range of coastal assets through the Shire that will be impacted by coastal erosion and/or inundation in future planning periods. These are broadly described in the following categories:

- Social - examples include community use of coast, recreation along the coast
- Economic – examples include facilities, services, jobs, industry, private property including infrastructure
- Environmental – examples include environmental values, coastal flora and fauna, ecosystem, dunes
- Heritage – significant sites and places of historical or cultural importance.

For the purposes of this study, coastal assets were identified in the following ways:

- Review of the previous CHRMAP
- Asset information was provided in excel formats for use in this study by the Shire
- Data available via data.wa.gov.au
- The coastal values survey(s) and other engagement activities to identify additional assets of importance and value to the community
- Site visits to investigate locations and discussion with community members with local knowledge
- Identification of further assets from aerial photography (e.g., developed areas of foreshore reserve).

3.2 Asset class

A range of coastal assets through the Shire that may be impacted by coastal processes in future planning periods broadly span the following categories:

- Roads
- Residential
- Commercial
- Public & Community
- Developed Foreshore Reserve
- Undeveloped Foreshore Reserve
- Environmental/ecosystem services
- Aboriginal Heritage.

3.3 Identified Coastal Assets

A coastal asset register has been established from existing data; the first site visit and via analysis of aerial photography. Reports from the Australian Exposure Information Platform (AEIP) provide an early indication of existing institution, infrastructure, and business assets, along with built form quantities and values.
The location/extent of assets is shown on Figure 3.1 – Gracetown Hazard Lines, Inundation Areas and Assets.

FIGURE 3.1 – GRACETOWN HAZARD LINES, INUNDATION AREAS AND ASSETS



FIGURE 3.2 – PREVELLY HAZARD LINES, INUNDATION AREAS AND ASSETS

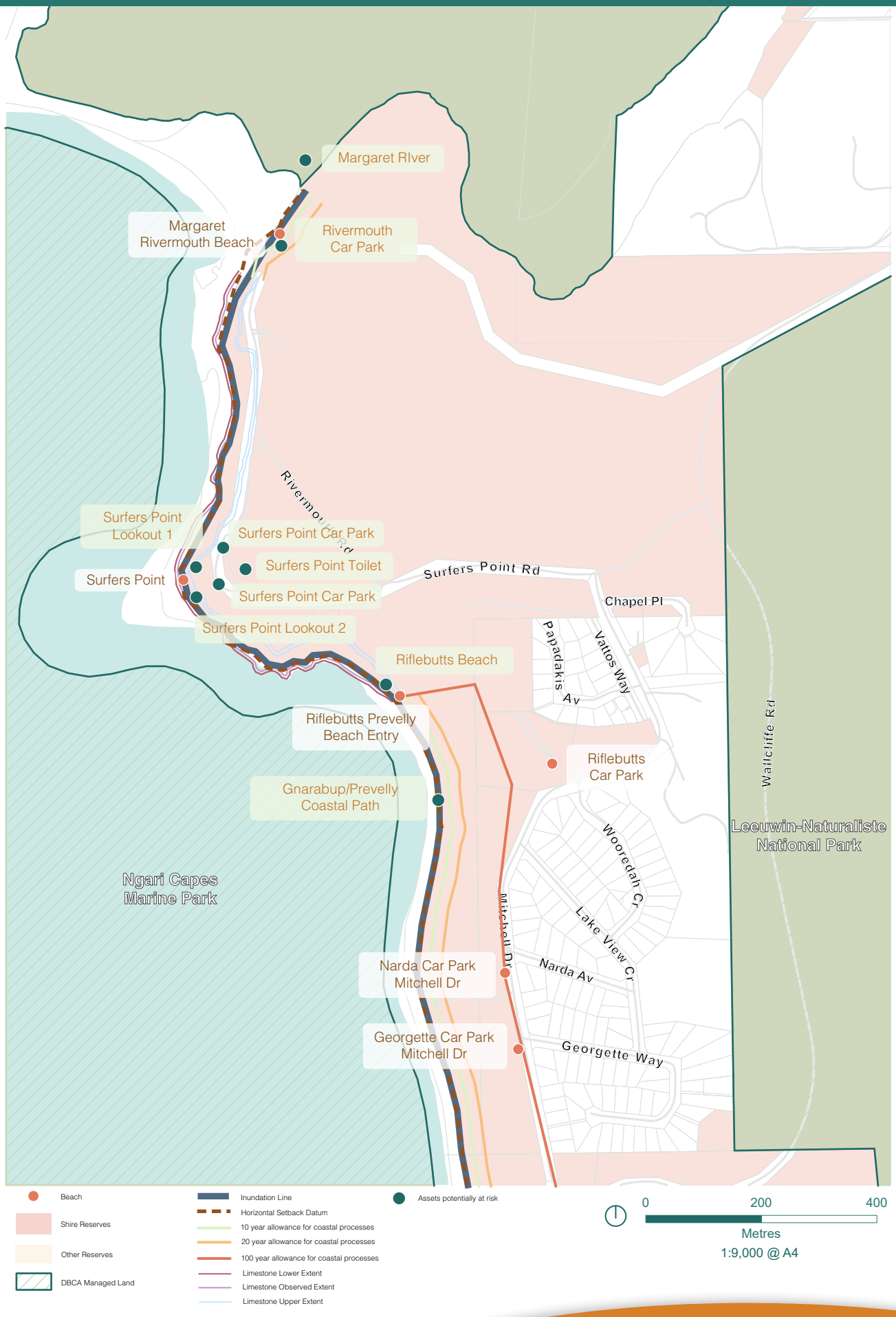
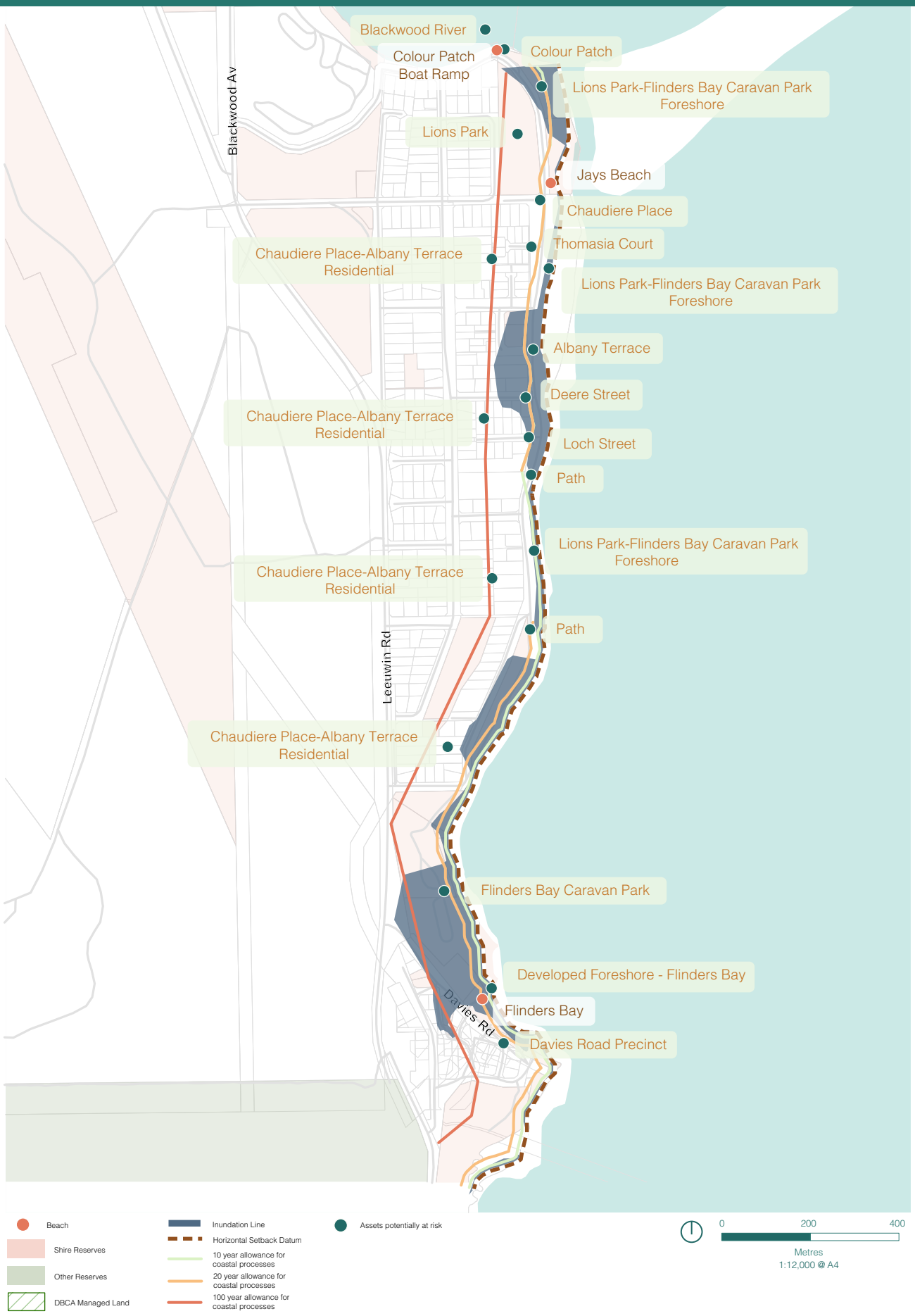


FIGURE 3.3 – GNARABUP HAZARD LINES, INUNDATION AREAS AND ASSETS



FIGURE 3.4 – AUGUSTA HAZARD LINES, INUNDATION AREAS AND ASSETS



3.4 Risk Assessment Framework

Approach to the risk assessment

A vulnerability assessment determines how coastal assets may be affected by change and events over the planning period. The factors influencing asset vulnerability include exposure, sensitivity, and adaptability. Exposure refers to the likelihood of an asset being affected by coastal change or hazards. Sensitivity relates to the potential damage or loss an asset might suffer, while adaptability reflects the asset's capacity to adjust, withstand, or cope with such hazards. This is displayed diagrammatically in Figure 3.5, with the input components displayed in blue.

In considering vulnerability in this report, inundation and erosion hazards considered separately. Assets are grouped according to class for ease of interpretation and to facilitate potential economic impacts of asset vulnerability.

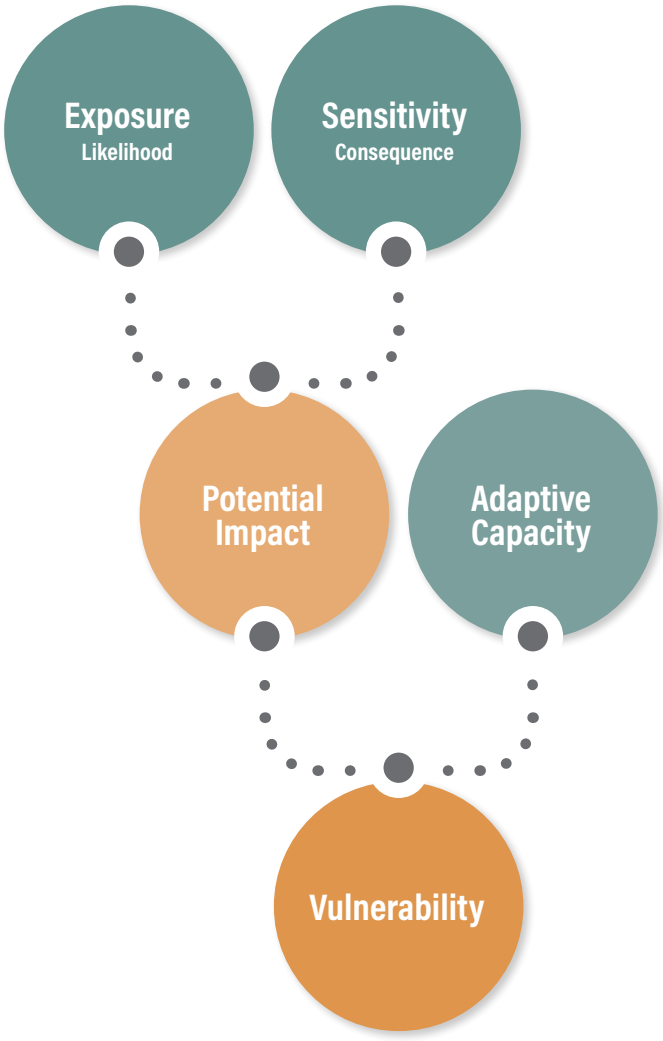


Figure 3.5 – Vulnerability assessment components (reproduced from WAPC 2019)

Identifying the likelihood of an asset being affected

The exposure or likelihood of coastal assets to hazards directly corresponds to the probability of those hazards impacting an asset. In other words, it reflects the chance of erosion and/or storm surge inundation affecting both existing and future assets, along with their associated values (WAPC, 2019). The likelihood scale adopted for this study is presented in Table 3.1. Ratings have been allocated to asset categories for each hazard at each timeframe based on the interpretation of the hazard assessment results. The methods used are explained in detail in Vulnerability Analysis Chapter Report.

Table 3.1 – Exposure / Likelihood

LIKELIHOOD RATING	DESCRIPTION	EXPOSURE TO COASTAL PROCESSES
Almost Certain	Expected to occur in most circumstances	High
Likely	Impact to asset shoreline for a given planning timeframe is likely	Medium
Possible	Impact to asset shoreline for a given planning timeframe is possible	Medium
Unlikely	Impact to asset shoreline for a given planning timeframe is unlikely	Low
Rare	May occur in exceptional circumstances	Low

What is the consequence of an asset being affected?

Within the context of this CHRMAP, consequence relates to the ability of an asset to respond to a coastal hazard without intervention. The response to the hazard could be a gradual response or a stepped change in response to discrete events (WAPC 2019).

The consequence ranking presented in Table 3.2 outlines the physical impact that an event can have on an asset. For the purposes of this CHRMAP, a simplified approach has been taken to classify consequence into High, Medium or Low.

Table 3.2 – Consequence Rating

LIKELIHOOD RATING	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 the 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 $20,00 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. No convenient alternative exists.
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 assets. Limited chance of recovery. No alternate habitats exist. Regional habitats exist	Severe (medium-term) decline or disruption to asset, services and function, <50n% 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 pf recovery. No alternate habitat(s) exist	Long term or permanent loss of asset, services and function >75% of community affected. No alternative exists.

Potential impact – how to define risk?

The indicative level of risk or the potential impact in relation to coastal hazards is calculated by the product of exposure and sensitivity (Table 3.3). It provides a classification of the potential impacts of coastal hazards on the identified assets within the Shire and are to be determined and considered for each of the planning timeframes identified within the CHRMAP.

The evaluated level of risk in relation to hazards is influenced by the asset's tolerability (ie consequence). Definitions are provided in Table 3.4 below.

Table 3.3 – Risk Level (Potential Impact) Matrix as Product of Sensitivity (Consequence) and Exposure (Likelihood)

SENSITIVITY/ CONSEQUENCE	EXPOSURE / LIKELIHOOD				
	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 3.4 – 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 of 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 the risk to acceptable levels.

Adaptive capacity

The adaptive capacity of a coastal asset refers to its ability to adjust and respond effectively to the identified hazards of erosion and inundation. An asset with high adaptive capacity can readily adjust or possesses inherent flexibility to respond to dynamic conditions. For instance, while built coastal structures and properties near the coast are constrained by their fixed nature, the mobile nature of beach and dune systems may exhibit greater adaptability, often coping with change and minimising additional impacts.

The scale of adaptive capacity is provided in Table 3.5 below.

Table 3.5 – Adaptive capacity scale

ADAPTIVE CAPACITY	DESCRIPTION
No adaption required	Potential impact has insignificant effect on asset. Controls are re-established naturally or with ease before more damage would likely occur.
Very High	Good adaptive capacity. Functionally 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.

In Table 3.6 below the assigned adaptive capacity for each asset category are presented in relation to both erosion and inundation combined. Ratings in relation to adaptive capacity is determined by the asset itself, groups of assets and then the opinions of the community and stakeholders.

Table 3.6 – Assigned adaptive capacity

ASSET CATEGORY	ADAPTIVE CAPACITY: EROSION	ADAPTIVE CAPACITY: INUNDATION
Roads	Low	Moderate
Residential	Low	Moderate
Commercial	Low	Moderate
Developed Foreshore Reserve	High	High
Undeveloped Foreshore Reserve	Low	High
Environmental	Low	Moderate
Aboriginal Heritage	Low	Moderate

Vulnerability scale

The vulnerability of an asset is determined by evaluating both the potential impact of coastal hazards (risk level) and the adaptive capacity of the identified asset. According to the CHRMAP Guidelines issued by the WAPC (2019), the study considers four vulnerability levels, which should be assessed for each of the specified timeframes within the CHRMAP. Figure 3.6 below illustrates the process of assessing vulnerability as part of the CHRMAP.



Figure 3.6 – Vulnerability assessment process

Table 3.7 below is an example of the vulnerability matrix contained within the guidelines and has been used in the assessment against assets as part of the production of this CHRMAP.

Table 3.7 - Vulnerability Matrix

	ADAPTIVE CAPACITY			
RISK LEVEL	**Low**	**Moderate**	**High**	**Very High**
Extreme	Very High	Very High	High	Medium
High	Very High	High	Medium	Medium
Medium	High	Medium	Medium	Low
Low	Medium	Medium	Low	Low

3.5 Vulnerability Analysis

As illustrated at Figure 3.5 above, vulnerability is a product of risk and adaptive capacity. To calculate vulnerability, each component of the formula has been considered, the results are presented in this section, along with brief analysis of key assets that are at risk.

Vulnerability to erosion

Vulnerability assessment outcomes

The outcomes of the vulnerability analysis across key assets, for coastal erosion, is provided in Table 3.8 below.

Table 3.8 - Erosion Vulnerability Ratings.

		VULNERABILITY			
ASSET TYPE	DESCRIPTION	CURRENT	10YR	20YR	100YR
GRACETOWN					
Developed Foreshore	Cowaramup Bay Boat Ramp and car park	Medium	Medium	Medium	High
Developed Foreshore	Swimming Beach	Medium	Medium	Medium	Medium
Developed Foreshore	Melaleuca Car Park	Medium	Medium	Medium	Medium
Developed Foreshore	South Point Car Park (Huzzas car park)	Medium	Medium	Medium	High
Developed Foreshore	Toilets Located at Melaleuca Beach car park	Medium	Medium	Medium	Medium
Developed Foreshore	Toilets Located at South Point car park	Medium	Medium	Medium	Medium
Developed Foreshore	Stairs/ramp at Huzza's	Medium	Medium	High	High
Environment ecosystem	National Park	Medium	Medium	Medium	Medium
Undeveloped foreshore	Remaining undeveloped foreshore areas in Gracetown	Medium	Medium	Medium	Medium
Road	Bayview Drive	Medium	Medium	Medium	Very High
Commercial	Gracie's General Store	Medium	Medium	Medium	Medium
PREVELLY/GNARABUP					
Developed Foreshore	Rivermouth Carpark	Medium	Medium	Medium	High
Developed Foreshore	Margaret River Surfers Point car parks	Medium	Medium	Medium	Medium
Developed Foreshore	Margaret River Surfers Point Toilet	Medium	Medium	Medium	Medium
Developed Foreshore	Margaret River Surfers Point Lookout 1	Medium	Medium	Medium	Medium
Developed Foreshore	Margaret River Surfers Point Lookout 2	Medium	Medium	Medium	Medium

		VULNERABILITY			
ASSET TYPE	**DESCRIPTION**	**CURRENT**	**10YR**	**20YR**	**100YR**
Undeveloped Foreshore	Shire-managed reserve between Surfers Point and Gnarabup Boat Ramp	Medium	Medium	High	High
Developed Foreshore	Gnarabup Coastal Path	Medium	Medium	High	High
Developed Foreshore	Gnarabup Boat Ramp	Medium	Medium	Medium	Medium
Commercial	White Elephant Café	Medium	Medium	Very High	Very High
Developed Foreshore	Gnarabup Boat Ramp Toilets	Medium	Medium	Medium	High
Developed Foreshore	Beach Access at Gnarabup Boat Ramp	Medium	Medium	High	High
Undeveloped Foreshore	Foreshore area between Long Reef Car Park and Gas Bay	Medium	Medium	Medium	High
Developed Foreshore	Long Reef Car Park	Medium	Medium	Medium	High
Developed Foreshore	Grunters Beach Car Park	Medium	Medium	Medium	High
Developed Foreshore	Gas Bay Car Park	Medium	Medium	Medium	High
Aboriginal Heritage	Margaret River	Medium	Medium	Medium	Medium
AUGUSTA					
Developed Foreshore	Colour Patch	Medium	Medium	#N/A	High
Environment ecosystem	Lions Park	Medium	Medium	#N/A	Medium
Residential	Located between Chaudiere Place and Albany Terrace (adjacent to caravan park)	Medium	Medium	Medium	Very High
Road	Albany Terrace; Trigg Street; Loch Street, Deere Street; Knight Place; Thomasia Court; Chaudiere Place	Medium*	Medium	Very High	Very High
Undeveloped Foreshore	Located between Lions Park and Department Flinders Bay Caravan Park	Medium	Medium	High	High
Aboriginal Heritage	Blackwood River	Medium	Medium	Medium	Medium
Developed Foreshore	Flinders Bay Park/Jetty	Medium	Medium	High	High
Commercial	Flinders Bay Caravan Park	Medium	Medium	Very High	Very High

*This vulnerability is based on the current opening of the river mouth. The river entrance is likely to trend north-east next decades, creating a greater buffer and setback between the road/residential areas and the shoreline, and lines will be reviewed following on-going coastal monitoring.

The outcomes of the vulnerability analysis across key assets, for coastal inundation, is provided in Table 3.9 below.

Table 3.9 - Inundation Vulnerability Ratings

ASSET TYPE	DESCRIPTION	VULNERABILITY
GRACETOWN		
Developed Foreshore	Cowaramup Bay Boat Ramp and car park	Low
Developed Foreshore	Melaleuca Car Park	Medium
Developed Foreshore	South Point Car Park (Huzzas car park)	Low
Developed Foreshore	Toilets Located at Melaleuca Beach car park	Low
Developed Foreshore	Toilets Located at South Point car park	Low
Developed Foreshore	Stairs/ramp at Huzza's	Low
Environment ecosystem	National Park	Medium
Undeveloped foreshore	Remaining undeveloped foreshore areas in Gracetown	Medium
Road	Bayview Drive	Medium
Commercial	Gracie's General Store	Medium
PREVELLY/GNARABUP		
Developed Foreshore	Rivermouth Carpark	Low
Developed Foreshore	Margaret River Surfers Point car parks	Low
Developed Foreshore	Margaret River Surfers Point Toilet	Low
Developed Foreshore	Margaret River Surfers Point Lookout 1	Low
Developed Foreshore	Margaret River Surfers Point Lookout 2	Low
Undeveloped Foreshore	Shire-managed reserve between Surfers Point and Gnarabup Boat Ramp	Low
Developed Foreshore	Gnarabup Boat Ramp	Low
Commercial	White Elephant Café	Medium
Developed Foreshore	Gnarabup Boat Ramp Toilets	Low
Developed Foreshore	Beach Access at Gnarabup Boat Ramp	Low
Undeveloped Foreshore	Foreshore area between Long Reef Car Park and Gas Bay	Low
Developed Foreshore	Long Reef Car Park	Low
Developed Foreshore	Grunters Beach Car Park	Low
Developed Foreshore	Gas Bay Car Park	Low
Aboriginal Heritage	Cliffs at Wallcliffe; Wooditj Dunes	Medium
Aboriginal Heritage	Margaret River	Medium

ASSET TYPE	DESCRIPTION	VULNERABILITY
AUGUSTA		
Developed Foreshore	Colour Patch	Medium
Environment ecosystem	Lions Park	Medium
Residential	Located between Chaudiere Place and Albany Terrace (adjacent to caravan park)	Medium
Road	Albany Terrace; Trigg Street; Loch Street, Deere Street; Knight Place; Thomasia Court; Chaudiere Place	Low
Undeveloped Foreshore	Located between Lions Park and Department Flinders Bay Caravan Park	Medium
Aboriginal Heritage	Blackwood River	Medium
Developed Foreshore	Flinders Bay Park/Jetty	Medium
Commercial	Flinders Bay Caravan Park	High
Commercial	Schoolroder's Accommodation	Medium

3.6 Priorities for Risk Treatment

Identifying priorities for risk treatment is an important and somewhat subjective consideration of the vulnerability of key assets, coupled with the coastal values of the community that were gathered during the early stages of the project. Key assets at risk were identified in section 3.5, and the community survey conducted as part of the engagement process provided a clear picture of what the coastline means to local residents and users, and what they most want to protect.

The survey results revealed that environmental protection was the community's highest protection priority, with respondents ranking it first ahead of all other considerations. Closely following was the importance of maintaining access to the marine environment, reflecting how central the coast is to daily life and recreation in the Shire. When asked what they valued most about the coastline, respondents rated the intrinsic value of the coast for future generations as the most important consideration, followed closely by the coast's flora, fauna, and ecological character. These results were reinforced by respondents' views on what would be most difficult to lose: access to the beach, loss of flora and fauna, and loss of coastal character and landscape were ranked as the three most significant concerns.

In terms of coastal activities, swimming, walking trails and camping, and passive recreation were ranked as the most important uses of the coastline, indicating that informal, nature-based enjoyment of the coast is central to community identity. The physical features respondents considered most at risk were dunes and beaches, followed by vegetation and dune areas, and then fauna including shorebirds and marine mammals. This is consistent with the community's strong emphasis on environmental values.

Protection of Aboriginal and other cultural heritage sites was also identified as a priority, ranked third among protection preferences, ahead of maintaining sandy beaches and coastal recreation facilities. Protection of private land and commercial businesses were ranked lowest, suggesting the community places shared environmental and cultural values above private or economic interests when trade-offs are required.

Taken together, the engagement findings point to a community that views the coastline primarily through the lens of environmental stewardship, ecological character, and access for recreation and future generations. These values have underpinned the risk treatment priorities and adaptation pathway developed in this CHRMAP.

A risk management framework (likelihood, consequence, risk priorities) approach as previously applied in CHRMAP, is combined with consultation outcomes and discussion with the Shire to agree priorities which align with their organisational risk management frameworks.

In the process, the degree of tolerance and acceptability of coastal risk for key assets by the community has been determined using identified community values identified in Section 1.5 of this report, along with a review of existing planning controls.

This approach now forms a framework for future adaptation options to be considered in subsequent chapters. By incorporating existing controls and community values, the relative vulnerability is used to assess mitigation and adaptation priorities across different planning time frames. Prioritisation becomes critical to define trade-offs, including the physical transfer of erosion pressure or financial costs. This holistic approach ensures well-informed planning decision-making in coastal and risk management.

Gracetown, Prevelly/Gnarabup and Augusta all have assets that may be at risk over time, and as such all sites will require a level of risk mitigation. In summary, all three sites have higher level of vulnerability to erosion compared to inundation.

Table 3.10 – Priorities for risk treatment

ASSET TYPE	DESCRIPTION	VULNERABILITY	PLANNING PERIOD
GRACETOWN			
Developed foreshore	Cowaramup Bay Boat Ramp and car park	High	100-yr
Undeveloped foreshore	South Point Car Park (Huzzas car park)	High	100-yr
Road	Bayview Drive	High	100-yr
Developed foreshore	Stairs/ramp at Huzza's	High	20-yr
PREVELLY/GNARABUP			
Developed Foreshore	Rivermouth Carpark	High	100-yr
Commercial	White Elephant Café	Very High	20-yr
Undeveloped Foreshore	Shire-managed reserve between Surfers Point and Gnarabup Boat Ramp	High	20-yr
Developed Foreshore	Gnarabup Coastal Path	High	20-yr
Developed Foreshore	Beach Access at Gnarabup Boat Ramp	High	20-yr
Undeveloped Foreshore	Foreshore area between Long Reef Car Park and Gas Bay	High	100-yr
Developed Foreshore	Long Reef Car Park	High	100-yr
Developed Foreshore	Grunters Beach Car Park	High	100-yr
Developed Foreshore	Gas Bay Car Park	High	100-yr
AUGUSTA			
Developed Foreshore	Colour Patch	High	100-yr
Residential	Located between Chaudiere Place and Albany Terrace (adjacent to caravan park)	Very High	100-yr
Road	Albany Terrace and some adjoining roads.	Very High	20-yr
Undeveloped Foreshore	Located between Lions Park and Department Flinders Bay Caravan Park	High	20-yr
Developed Foreshore	Flinders Bay Park/Jetty	High	20-yr
Commercial	Flinders Bay Caravan Park	Very High	20-yr

Risk Treatment

4.1 Risk treatment approach

Overview

The risk treatment and adaptation stage within the CHRMAP framework focuses on addressing residual risks to coastal assets. Its primary objective is to identify appropriate risk treatment responses that can effectively mitigate coastal hazard risks for the shoreline areas and coastal assets in the Shire of Augusta Margaret River (the Shire) over various timeframes. Additionally, these responses should allow for flexibility in future decision-making.

Key considerations include:

- **Current Risk Assessment:** Presently, the level of coastal hazard risk for coastal assets in the Shire is generally low. However, this risk is anticipated to escalate due to projected sea level rise in the coming years.
- **Sea Level Rise Scenarios:** The CHRMAP has examined various sea level rise scenarios consistent with SPP2.6. These scenarios assess how coastal assets may be affected by hazards in the future, considering events ranging from annual occurrences to extreme events (within the limits outlined in Section 2.9).
- **Uncertainty Acknowledgment:** Recognising the uncertainty associated with long-term predictions related to sea level rise and climate change, the risk treatment process incorporates this uncertainty into its considerations.
- **Risk Treatment Pathways:** The CHRMAP outlines risk treatment pathways that enable the management of coastal assets in the present while adjusting to changing risk profiles in the future. These pathways are designed to adapt over time, aligning with increasing risk levels due to sea level rise and climate change. Trigger points, rather than fixed time frames, guide adjustments.
- **Examples of Triggers:** Instances where a shift to a new level of risk management may be necessary include measured or actual changes in sea level or shoreline erosion near structures (e.g., houses).
- **Community Responsibility:** The ability of shorelines and riverine areas in the Shire to adapt and respond to changing conditions rests with the Shire and the community.

In summary, the CHRMAP emphasises critical shoreline management areas for short-term focus and identifies trigger points for potential adjustments in risk treatment strategies to address higher levels of risk to coastal assets in future planning years.

Decision-making context

Although the Shire is a manager of coastal areas and assets, it is not the role nor remit of the Shire to protect or compensate for the loss of freehold property from damage caused by coastal processes. The CHRMAP process delivers a plan to assist the community to identify those most important assets along the coast, and to then consider and produce a plan as to how these will be protected and managed for immediate and future risk.

The CHRMAP adopts a '**risk management**' approach to:

- Consider the risks arising from coastal hazards.
- Identify risk management responses, and
- Prioritise and implement the risk management responses.

It considers '**who**' is responsible for managing the risk:

- **Private parties** are responsible for managing risks to their private assets and incomes and to do so they need to:
  - be aware of the risks and understand their responsibility to manage them,
  - take steps to understand the magnitude and nature of the specific risks to their assets and activities, and
  - develop and implement strategies and actions to manage the risks.
- **Governments**, on behalf of the community, are primarily responsible for the oversight of planning and managing risk to those public goods and public assets which they own and manage. Governments also seek to:
  - develop local policies and regulations consistent with State risk management approaches,
  - facilitate by building resilience and adaptive capacity within the local community, providing timely information about relevant known coastal hazards including erosion and inundation, and
  - building workable partnership with the community to identify and manage risks.

Adaptation hierarchy

SPP2.6 (Western Australian Planning Commission, 2013) establishes a structured hierarchy of adaptation pathways designed to inform decision-making in coastal areas. These pathways serve as the framework for the Shire to evaluate adaptation strategies aimed at minimising risks associated with coastal hazards. The hierarchy of treatment options includes '**Avoid**,' '**Planned / Managed Retreat**,' '**Accommodate**,' and '**Protect**.' It is important to note that neither State nor Local Government are legally bound to safeguard private assets from coastal hazards. It is also noted that the CHRMAP process strongly discourages the long-term adoption of the 'Protect' pathway for adaptation.

The following table outlines the objectives of each of the treatment options.

Table 4.1 - Risk treatment options

RISK TREATMENT OPTION	OBJECTIVES
Avoid	Prevent new assets from being established in areas susceptible to coastal hazards. The preferred option where feasible, particularly for undeveloped land. More difficult to apply where existing development is already in place.
Retreat	Move or remove assets threatened by erosion or sea level rise, allowing the coast to evolve naturally. Implemented through the planning system for private land or through asset management for public land. Existing assets are removed at end of life, upon significant storm damage, or when a defined trigger is reached.
Accommodate	Apply design and management measures that make risk manageable, allowing continued land use until risk becomes unacceptable. Includes structural responses (minimum floor levels, relocatable structures) and non-structural responses (planning framework changes, title notifications, development conditions). Can facilitate transition to retreat or protection over time.
Protect	Shield assets from erosion, recession and storm surge through hard structures (seawalls, groynes, breakwaters) or soft measures (beach nourishment, dune revegetation). Protection strategies must account for off-site impacts and align with SPP 2.6 requirements, including governance, ownership and maintenance arrangements.

Adapted from: (Western Australian Planning Commission, 2019).

In addition to the four main categories above additional management approaches considered in the CHRMAP are:

- **No Regrets**
  The "no-regrets" category refers to actions (such as ongoing monitoring) that enhance resilience and preparedness against the effects of coastal hazards. These strategies can be put into action while further risk assessments to assets are being conducted or during the evaluation process to identify a preferred risk treatment option.
- **Do Nothing**
  The "do-nothing" risk treatment option implies the acceptance of all risk levels and the decision not to take any further action. This strategy serves as a benchmark for comparing all other risk treatment options. It assumes a stance of non-intervention, accepting the risks as they are.

Adaptation toolkit

The full range of adaptation options considered in this CHRMAP, including descriptions, possible actions and suitability considerations for the study area, is provided at Appendix B. The options address both short-term and long-term coastal hazard adaptation, extending beyond climate change impacts alone. While risks and adaptation strategies are evaluated independently, the triggers for implementing any given option can be adjusted to reflect specific circumstances. If erosion or inundation risks escalate sooner than anticipated, an earlier adaptation response can be initiated accordingly.

4.2 Multi-Criteria Assessment

MCA categories

A multi-criteria analysis (MCA) provides a qualitative framework to rank risk treatment options and has been completed to consider adaptation options for identified assets at Gracetown, Prevelly, Gnarabup and Augusta. The MCA is based on 6 broad categories as outlined in Table 4.2 below.

Table 4.2 - MCA criteria

CRITERIA	MCA CONSIDERATIONS
Effectiveness	Ability for the option to mitigate the coastal hazard risk.
Environmental Impact	Impact on existing native vegetation / dunes / coastal processes (including both construction and ongoing maintenance).
Social Impact	Impacts on amenity. Potential impacts on Aboriginal and European heritage sites and values are considered in this criterion. Public acceptability.
Landscape	Impacts on landscape. Consideration of aesthetics associated within nearby areas.
Cost	Upfront capital costs. Ongoing maintenance costs. Economic impacts – such as loss of businesses, income, value.
Future adaptability	Whether the option is easily adaptable in future, such as for updated sea level rise levels. If the option limits the feasibility of selecting other options in future.

Adapted from (Western Australian Planning Commission, 2019).

Assessment framework

Each adaptation option was evaluated against a range of criteria as part of the Multi-Criteria Assessment (MCA) process. The full MCA framework, including all criteria definitions and scoring methodology, is provided at Appendix C. Tables 4.3 to 4.6 below summarise the assessment outcomes for each location, with criteria listed across the top row and ratings scored on a scale of -2 to 2.

The ratings have provided a priority for adaptation options to be subject to Cost Benefit Analysis, leading to a clear direction for adaptation will be identified and incorporated into the Implementation Plan. It is acknowledged that that more than one adaptation option may be required across varying timeframes.

It is important to note that the ratings/scores are subjective and have been informed by the project team's knowledge of local conditions, stakeholder knowledge, community engagement outcomes and feedback, and Shire input. To provide further nuance regarding the relative importance of each criterion, site-specific weightings have also been assigned to the MCA criteria using the same inputs.

Table 4.3 - MCA Outcomes - Gracetown

OPTION	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE	COMMENT
WEIGHTING	25.00%	10.00%	10.00%	10.00%	25.00%	20.00%	100%	
MR2 Remove/ Relocate	2	1	2	1	1	1	1.35	Infrastructure be moved landward over time. The majority of infrastructure will be impacted in a 10-20yr timeframe.
AC1 Design assets to withstand impacts	1	1	2	1	1	2	1.3	Design requirements need to be addressed within the Shire's existing Asset Management Plans.
NR1 Monitoring	1	1	1	1	1	1	1	Monitoring will provide ongoing data that will enable easy identification of triggers in future.
NR2 Protection structure audit	1	1	1	1	1	1	1	There are no existing structures to audit within Gracetown.
PR1 Dune care / management	2	1	2	2	-1	-1	0.55	Dune management has been addressed within the existing Cowaramup Bay Coastal Management Plan. This document may need review within 10 years.
AV Avoid development	2	1	-2	0	2	-2	0.5	The majority of land affected is land managed by the Shire or other government authority. Social impact has been marked negative as avoidance of infrastructure may limit public use/enjoyment of the foreshore area. This needs to be balanced with the current Shire plans to upgrade the foreshore in this locality.
MR1 Leave assets unprotected	-1	0	-1	0	2	1	0.35	Assets may be impacted in a 10-20+ year timeframe. Leaving unprotected in the shorter term would likely be appropriate, and decisions on location/ relocation could be made as part of the Shire's normal asset management approach.
PR5 Beach (sand) nourishment	1	1	1	1	-1	-1	0.1	Nourishment may be an appropriate short to mid-term option.

OPTION	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE	COMMENT
WEIGHTING	25.00%	10.00%	10.00%	10.00%	25.00%	20.00%	100%	
MR3 Planning controls	na	na	na	na	na	na	**na**	Land is largely reserved land in the Local Planning Scheme and there are no planning provisions that will provide further guidance.
MR4 Voluntary acquisition	na	na	na	na	na	na	**na**	The majority of the land is within Shire-managed or DBCA-managed reserves.
AC2 Planning controls for accommodation	na	na	na	na	na	na	**na**	Land is largely reserved land in the Local Planning Scheme and there are no planning provisions that will provide further guidance.
NR3 Notification on title	na	na	na	na	na	na	**na**	Not applicable given all risks are on public land.
NR4 Emergency evacuation plans	na	na	na	na	na	na	**na**	An emergency evacuation plan is not likely to be required (unless in the very long term), from a CHRMAP perspective.
PR3 Seawall	1	0	0	0	-2	0	**-0.25**	A buried seawall may be an appropriate option in the long-term (subject to further monitoring and review over a 20-year period).
DN Do nothing	-2	-1	-1	-1	0	-1	**-1**	Impacts will likely occur over time.
PR4 Nearshore reef/ Breakwater/ Artificial Reef	-1	-1	0	0	-2	-1	**-1.05**	There is an existing reef in this locality.
PR2 Groyne	-2	-1	0	-1	-2	-1	**-1.4**	A groyne is unlikely to provide adequate protection in this locality.

Table 4.4 - MCA Outcomes – Prevelly

OPTION	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE	COMMENT
WEIGHTING	25%	10%	10%	10%	25%	20%	100%	
AV1 Avoid development	2	2	0	0	1	1	**1.15**	The majority of land affected is land managed by the Shire or other government authority, with the majority of the area undeveloped.
NR1 Monitoring	1	0	1	0	2	1	**1.05**	Monitoring will provide ongoing data that will enable easy identification of triggers in future.
NR2 Protection structure audit	1	1	1	1	1	1	**1**	There are no existing protection structures in place.
PR5 Beach (sand) nourishment	2	1	1	1	-1	1	**0.75**	Nourishment may be an appropriate short to mid-term option.
MR1 Leave assets unprotected	-1	-1	0	0	1	1	**0.1**	Coastal dunes (south of Surfers Point) will continue to erode.
AC1 Design assets to withstand impacts	1	1	1	1	-1	-1	**0.1**	There is some evidence of this occurring in this area already, with development at Surfers Point and White Elephant café being designed with regard to anticipated coastal processes.
PR1 Dune care/ management	1	2	1	2	-2	-1	**0.05**	Dune management south of Surfers Point could be possible however costs may be prohibitive across larger areas. Dune management has been addressed within the Prevelly Gnarabup Foreshore Management Plan. This document may need review within 10 years.
MR3 Planning controls	na	na	na	na	na	na	**na**	Land is largely reserved land in the Local Planning Scheme and there are no planning provisions that will provide further guidance.
MR4 Voluntary acquisition	na	na	na	na	na	na	**na**	The majority of the land is within Shire-managed reserves.
AC2 Planning controls for accommodation	na	na	na	na	na	na	**na**	Land is largely reserved land in the Local Planning Scheme and there are no planning provisions that will provide further guidance.
NR3 Notification on title	na	na	na	na	na	na	**na**	Not applicable given all risks are on public land.

OPTION	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE	COMMENT
MR2 Remove/ Relocate	1	1	0	0	-2	0	**-0.15**	Only some assets could be removed/ relocated. As majority of the foreshore area is undeveloped, environment/ ecosystem services still impacted.
NR4 Emergency evacuation plans	-2	0	0	0	0	0	**-0.5**	An emergency evacuation plan is not likely to be required (unless in the very long term), from a CHRMAP perspective.
PR3 Seawall	1	-2	0	-1	-2	0	**-0.55**	A partially buried sea wall may be effective however cost it likely to be prohibitive.
PR4 Nearshore reef/ Breakwater/ Artificial Reef	1	-1	0	0	-2	-1	**-0.55**	Further studies would be required to understand the implications of an artificial reef. Cost may be prohibitive.
PR2 Groyne	-1	-2	0	-1	-1	-1	**-1**	A groyne is unlikely to provide adequate protection in this locality, or may lead to foreshore management issues in other locations.
DN Do nothing	-2	-2	-2	0	-1	-1	**-1.35**	Impacts will likely occur over time.

Table 4.5 - MCA - Gnarabup

OPTION	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE	COMMENT
25.00%	25%	10%	15%	15%	25%	10%	100%	
AV Avoid development	2	2	0	0	1	1	**1.05**	Most of the land affected is land managed by the Shire or other government authority. There is some existing development in this area, such as White Elephant café, which has been constructed cognisant of coastal processes.
NR1 Monitoring	1	0	1	0	2	1	**1**	Monitoring will provide ongoing data that will enable easy identification of triggers in future.
NR2 Protection structure audit	1	1	1	1	1	1	**1**	There are some existing protection structures associated with the White Elephant café.
PR5 Beach (sand) nourishment	2	1	1	1	-1	1	**0.75**	Currently undertaken at southern end of the beach near Gnarabup Boat Ramp.
PR1 Dune care/ management	1	2	1	2	-2	-1	**0.3**	Dune management has been addressed within the Prevelly Gnarabup Foreshore Management Plan. This document may need review within 10 years.
AC1 Design assets to withstand impacts	1	0	1	0	-1	-1	**0.05**	Relates largely to café area and associated development - asset can possibly be protected or strengthened.
MR3 Planning controls	na	na	na	na	na	na	**na**	Land is largely reserved land in the Local Planning Scheme and there are no planning provisions that will provide further guidance.
MR4 Voluntary acquisition	na	na	na	na	na	na	**na**	Most of the land is within Shire-managed or DBCA-managed reserves.
AC2 Planning controls for accommodation	na	na	na	na	na	na	**na**	Land is largely reserved land in the Local Planning Scheme and there are no planning provisions that will provide further guidance.
NR3 Notification on title	na	na	na	na	na	na	**na**	Not applicable given all risks are on public land.

OPTION	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE	COMMENT
MR2 Remove/ Relocate	1	1	0	0	-2	0	**-0.15**	Only some assets could be removed/ relocated - most likely those impacted in the longer-term. Environment/ ecosystem services still impacted. Difficult to relocate café due to topography. The Shire is currently undertaking planning/trail design work to move a portion of existing walk trails further inland.
PR4 Nearshore reef/ Breakwater/ Artificial Reef	1	-1	0	0	-2	-1	**-0.45**	Further studies would be required to understand the implications of an artificial reef. Cost may be prohibitive.
NR4 Emergency evacuation plans	-2	0	0	0	0	0	**-0.5**	An emergency evacuation plan is not likely to be required (unless in the very long term), from a CHRMAP perspective.
MR1 Leave assets unprotected	-2	-1	-1	0	1	-2	**-0.7**	White Elephant café, boat ramp, sandy dunes are likely to be impacted in the medium to longer term.
PR2 Groyne	-1	-2	-2	-1	-1	-1	**-1.25**	A groyne is unlikely to provide adequate protection in this locality.
PR3 Seawall	1	-2	-2	-2	-2	-2	**-1.25**	A partially buried sea wall may be effective however cost it likely to be prohibitive.
DN Do nothing	-2	-2	-2	0	-1	-1	**-1.35**	Impacts will likely occur over time.

Table 4.6 - MCA - Augusta

OPTION	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE	COMMENT
15.00%	15%	20%	25%	20%	10%	10%	100%	
AC1 Design assets to withstand impacts	1	1	2	0	1	1	**1.05**	Appropriate floor levels for development could assist in accommodating development within potentially impacted areas.
NR2 Protection structure audit	1	1	1	1	1	1	**1**	There are no existing structures to audit within Augusta.
AV Avoid development	2	2	0	0	1	1	**0.9**	This is an appropriate option where possible, however there is considerable existing private and public development within this section.
PR1 Dune care/ management	1	1	1	1	1	0	**0.9**	Dune management may assist in the short-medium term in protecting inland development.
MR3 Planning controls	1	0	2	0	1	1	**0.85**	There are areas of zoned land within the area, and use of planning controls to manage a retreat option could be considered.
AC2 Planning controls for accommodation	1	0	2	0	1	1	**0.85**	There are areas of zoned land within the area, and use of planning controls to manage a retreat option could be considered.
NR1 Monitoring	1	0	1	0	2	1	**0.7**	Monitoring will provide ongoing data that will enable easy identification of triggers in future.
PR3 Seawall	2	0	1	0	-1	2	**0.65**	Buried seawall adjacent to coastal road in the medium-longer term will strengthen dunes and could provide protection to inland development, however would be subject to further review and study in future years.
NR4 Emergency evacuation plans	1	0	1	0	-1	1	**0.4**	An emergency evacuation plan is not likely to be required (unless in the very long term), from a CHRMAP perspective.
PR5 Beach (sand) nourishment	1	1	0	1	-2	-1	**0.25**	This may be a viable option is certain locations in the short-medium term.

OPTION	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE	COMMENT
NR3 Notification on title	1	0	0	0	0	1	**0.25**	A notification on title can provide prospective landowners with notice that their property may be subject to future coastal processes. A notification can only be applied at a time when there is a dealing on the title or by mutual agreement.
MR2 Remove/ Relocate	2	2	-2	-1	-2	0	**-0.2**	May be difficult in this locality due to the existing nature of the development and limited options for relocation.
PR4 Nearshore reef/ Breakwater/ Artificial Reef	1	-1	0	0	-2	-1	**-0.35**	A reef/breakwater is not suitable to this section of coast for adaptation purposes. It is noted there is a Department of Transport-managed harbour further south.
MR4 Voluntary acquisition	2	0	-2	-1	-2	1	**-0.5**	This is likely to be an expensive option.
PR2 Groyne	-1	-2	0	-1	-1	-1	**-0.95**	A groyne/s is unlikely to provide adequate protection in this locality.
MR1 Leave assets unprotected	-2	0	-2	-2	0	-2	**-1.4**	Leaving assets unprotected could place them at risk in the medium to longer term.
DN Do nothing	-2	-2	-2	0	-1	-1	**-1.4**	Impacts will likely occur over time.

Preferred options

MCA Outcomes

The MCA approach has identified the following high-level adaptation options as having 'positive' score, forming the basis for more in-depth analysis of preferred implementation options.

Gracetown

1. **Remove/relocate:** Gradually relocate or remove public infrastructure further inland over a medium to long-term period.
2. **Dune care/management:** Implement dune care and management as outlined in the current Coastal Management Plan, aiming to fortify the dunes and enhance their resilience.
3. **Avoid development:** Avoid development in vulnerable areas whenever possible, balancing the needs of public infrastructure and considering the expected lifespan of these facilities, acknowledging that some regions may not face significant impact until the medium to long term.

Prevelly

1. **Avoid development:** Where possible, refrain from placing development in affected areas. This approach should be nuanced, considering public infrastructure needs and the expected lifespan of the relevant facilities. It is important to note that some regions may not face significant impact until the medium to long term.
2. **Monitoring:** Conduct ongoing monitoring, especially of sandy beaches and dunes, to better understand the effects of coastal processes. This data will help identify appropriate triggers for action in the medium to long term.
3. **Beach nourishment:** Implement beach nourishment as needed over the medium to long term.

Gnarabup

1. **Avoid Development:** It is advisable to refrain from initiating development in vulnerable areas as much as possible. This approach should be balanced with the need for public infrastructure and the expected longevity of such infrastructure. It's important to note that some regions may not experience potential impacts until the medium or long term.
2. **Beach Nourishment:** The process should be maintained near the Gnarabup boat ramp and White Elephant café as necessary.
3. **Undertake Dune Care and Management:** Actions should be taken in line with the existing Coastal Management Plan. The primary goal would be to fortify the dune system to enhance its resilience.

Augusta

1. **Design to Standards:** All new developments should be executed to meet suitable standards, considering probable effects.
2. **Avoid Development:** As much as feasible, development should be avoided in impacted areas. This approach should be delicately balanced with the necessities of public infrastructure and the projected lifespan of the said infrastructure. It is worth noting that potential impacts may not be evident until the medium or long term in some locations.
3. **Planning Controls:** These should be put into effect for both managed retreat (where feasible) and accommodation. This action is connected to Point 1 (design to standards).
4. **Protect:** Dune Care and Management, and future development of a seawall.

4.3 Potential responses

Planning responses

The planning responses to coastal risk are outlined in Table 4.7 below:

Table 4.7 – Planning Responses

RESPONSE	ADVANTAGES	DISADVANTAGES	LOCAL CONTEXT APPLICABILITY
Local Planning Policy (LPP)	Addresses coastal hazard and risk issues at both district (broad) and location-specific levels. Allows mapping of coastal hazards with flexibility for updates. Can swiftly accommodate changes based on new coastal studies. Provides flexibility to vary "deemed-to-comply" development requirements.	LPPs are "due regard" documents and lack the full legal force of provisions in a local planning scheme. Not as binding as scheme provisions.	LPPs can be tailored for specific areas, covering aspects like required floor levels and development contributions. Likely to be a preferred option.
Special Control Area (SCA)	SCAs can address specific issues (e.g., storm surge, coastal processes) across multiple zones or reserves. Can require development approval for otherwise exempted development. Preferred for identifying where and what type of development needs approval based on coastal risk.	Scheme amendments may be necessary whenever coastal issue mapping is updated. However, referencing a separate LPP within the SCA can mitigate this.	SCAs can be prepared for zoned land areas, containing specific provisions or referring to accompanying LPPs.

Adapted from (Western Australian Planning Commission, 2019) and (Baird, 2023).

Planned or managed retreat policy

The multi-criteria assessment did not recommend Planned or Managed Retreat as a preferred adaptation option for any of the study locations in the short to medium term, and accordingly no Managed Retreat Policy is required of the Shire at this stage.

Foreshore management plan

Foreshore management plans can provide a practical framework for implementing the recommendations outlined in the CHRMAP. Specifically, these plans focus on individual foreshore reserves across the Shire and could consider:

1. **Strategic Implementation:** By aligning with CHRMAP recommendations, foreshore management plans guide practical actions to enhance resilience, protect natural assets, and promote sustainable use of coastal areas.
2. **Site Specific actions:** Foreshore management plans propose site-specific strategies. These may include beach nourishment, dune restoration, or living shoreline approaches.
3. **Community Engagement:** These plans become a vital communication tool. They provide detailed frameworks for community spaces and facilities, fostering engagement and collaboration among residents, local authorities, and stakeholders.
4. **Education/Awareness:** Plans raise awareness about coastal hazards and the need for adaptation. Educated communities are better equipped to respond effectively.
5. **Monitoring and review:** A Foreshore Management Plan can provide a monitoring protocol for a particular site, to provide information on coastal changes and assist in the identification of future triggers to take further action.

It is noted that the Shire has existing Foreshore Management Plans for Gracetown and Prevelly/Gnarabup. The existing plans deal with dune management and environmental protection and could be expanded to include additional consideration of infrastructure provision (via Shire's existing asset management system), sand renourishment and other appropriate adaptation mechanisms.

Emergency response plan

In accordance with the Emergency Management Act 2005, the Shire is responsible for assisting the community in preparing, preventing, responding and recovering from various emergencies. The Shire's Local Emergency Management Committee (LEMC) has prepared a Local Emergency Management Arrangement (LEMA) and Local Recovery Plan (LRP) which includes useful information in relation to emergency preparation and response, including flooding.

From a purely CHRMAP perspective, an Emergency Response Plan is not currently required.

Economic framework

The CHRMAP is supported by an economic evaluation of adaptation options. This evaluation has two key components:

- Cost Benefits Analysis (CBA) (Risk Treatment)
- BDA (part of Implementation Plan)

The multi-criteria analysis contained in this report, coupled with the supporting cost benefit analysis, is used to assist the evaluation of adaptation options and future pathways recommendations in this report.

4.4 Cost Benefit Analysis

A high-level economic assessment was undertaken as part of this CHRMAP to establish the economic warrant for coastal adaptation investment across the three main study locations. Using a benefit transfer approach consistent with the 2015 CHRMAP, the assessment compared the use and non-use values of coastal amenity at each location against the replacement cost of at-risk Shire assets, confirming that the benefits of protecting coastal access and infrastructure outweigh the costs at Gracetown, Prevelly-Gnarabup and Augusta South. A Benefit Distribution Analysis was also undertaken, identifying the distribution of net benefits among resident and visitor stakeholders at each location and informing the Shire's approach to funding and prioritisation of adaptation works. The results of both analyses are summarised below and the full report is provided at D. It is noted that a more detailed economic comparison of specific adaptation options will be undertaken as part of the business case development for individual adaptation works, particularly where capital investment decisions are required.



A summary of the CBA is provided below:

It should be noted that not all of the economic benefits arising from the use and non-use of coastal sites are captured in the basic asset values of the infrastructure that facilitate access to these sites. The perceived value of benefits arising from the use (access, recreation, environmental health, heritage) and non-use (existence, bequest, option) values are dependent upon multiple factors including location (urban or non-urban), development (highly developed or undeveloped), population (residents and visitors), time of year (seasonal) and types of beach use (active/passive).

The previous AMRSC CHRMAP used the benefit transfer approach to estimating the value of beach access in the study areas. These values were derived from multiple studies of comparable coastal areas in Australia that employed a range of methods to estimate economic values. In the absence of any primary research data for the economic value of beaches in the three study sites for this CBA, these values have been CPI adjusted for use in this report.

In the previous AMRSC CHRMAP (2015), beach areas were valued at $200 per square metre, based on actual primary data from comparable study sites. Adjusting for the sum of trimmed mean CPI increases 2016 to 2023 of 20 percent provides a 2023 value per square metre of $240. By comparison, a 2016-17 study of seven urban and regional coastal areas in NSW (Pascoe et al, 2017) indicated that sandy beaches had an average value of $219 per square metre, equivalent to $254 in 2023 (CPI adjusted).

The cost of coastal assets within the low-, medium- and high-risk zones in the three study sites is based on the replacement values of the assets provided by the Shire Assets Management staff. Asset values also included costings for the relevant projects in the Gracetown Infrastructure Plan approved by the Shire Council in May 2024.

Summary of Costs-Benefits Values and Ratios

Net benefits = Total Benefit (Area of sandy beach * $240) minus Total Cost (Replacement Value of Assets at risk)

Cost Benefit Ratio = Total Benefit/Total Cost.

Table 4.8 – CBA Summary Table

STUDY SITE	NET BENEFIT ($)	COST BENEFIT RATIO
Gracetown	219,236	1.17
Prevelly-Gnarabup	4,198,098	2.13
Augusta South	5,117,248	1.74

The decision rule for projects, (in this case adaptation projects) using the Cost Benefit Ratio requires a value greater than one. Any adaptation project with ratio value less than one should not proceed as the total replacement value of the assets will exceed the estimated use and non-use benefits that the coastal sites yields. The ratio is also useful for comparing and prioritising adaptation options across study sites, with higher values indicating greater socio-economic benefits arising from adaptation options. It can also be used to inform funding and budgeting amounts when preparing grant applications for infrastructure projects and public works associated with adaptation options.

Adaptation Recommendations

5.1 Adaptation overview

Context

A range of coastal adaptation options have been identified, addressing potential risks and necessary adaptations across the entire Shire, as well as more specific needs for individual localities. This section outlines the adaptation recommendations that are applicable Shire-wide, focusing on the Shire's planning framework, which includes statutory, strategic, and policy considerations, along with overarching governance aspects. These recommendations aim to establish a consistent framework for the implementation of Avoid, Accommodate, Retreat and Protect adaptation strategies.

To ensure a comprehensive approach to managing coastal risks, adaptation measures will be integrated into the Shire's broader planning and management efforts. By focusing on a unified strategy, the Shire can mitigate risks and enhance the resilience of coastal infrastructure and communities.

The Shire will implement several measures to manage and adapt its coastal areas. These are outlined in more detail below.

5.2 Overarching recommendations

This section outlines the key recommendations for implementing the Coastal Hazard Risk Management and Adaptation Plan (CHRMAP). These broad recommendations provide the framework for more detailed adaptation actions at specific sites, along with providing guidance on an implementation plan.

Local Planning Strategy

CHRMAP outcomes should be addressed as a minor amendment to the Shire's Local Planning Strategy, with areas at risk not being identified for further intensification of development. Reference should be made to the requirements of SPP2.6 as they pertain to proposed development subject to coastal hazard risk, including the requirements for adequate coastal foreshore reserves.

Local Planning Scheme – Special Control Area

The coastal hazard assessment for Augusta identifies land at risk of erosion and inundation across two broad categories: public assets along Albany Terrace and the foreshore, which are exposed to risk in the short to medium term, and private residential land behind and adjacent to the road, which may be at risk over the longer 100-year planning period. How these risks are managed over time will depend in part on whether the Shire proceeds with physical protection of Albany Terrace, principally a rock revetment or equivalent coastal protection structure, which would provide a buffer to the residential land behind it and reduce the need for planning intervention in the short to medium term.

Where protection is not in place, or where hazard eventually overtakes the protection, a planning response is required to ensure that development within the hazard zone does not increase community exposure to risk over time and that future landowners are informed of the hazard. The introduction of a Special Control Area (SCA) provides that planning framework. It does not compel managed retreat or prevent development outright, but ensures that development applications within the hazard zone are assessed with full regard to the coastal hazard context, that appropriate conditions can be applied, and that title notifications are placed on affected land.

The SCA recommendation is therefore conditional. If the Shire proceeds with the protection option for Albany Terrace, the urgency of planning intervention is reduced and the SCA may not be required in the short term. If protection is deferred or not pursued, the SCA should be implemented as a priority. This question, whether to protect, apply planning controls, or both, is one of the key matters to be tested through community consultation, and the Shire's position will be confirmed following that process. In either case, the SCA provisions set out below are presented for consideration as the appropriate planning response if and when intervention is required.

To implement the SCA, the Shire should initiate an amendment to Local Planning Scheme No. 2 to:

a) Insert sub-clause 6.4.5 under Part 6 – Special Control Areas as follows:

6.4.5 Coastal Hazard Special Control Area (SCA5)

6.4.5.1 Objective

The Shire of Augusta-Margaret River has prepared and adopted a Coastal Hazard Risk Management and Adaptation Plan that identifies land potentially at risk of coastal erosion or inundation. This Special Control Area provides guidance for land use and development within these areas. The objectives of SCA5 are –

a. To identify land within Augusta-Margaret River at risk of erosion and inundation by coastal processes by 2125.
b. To ensure public health and safety and reduce risk associated with coastal erosion and inundation.
c. To protect new development from the impacts of coastal erosion and inundation.
d. To avoid inappropriate land use and development of land at risk of coastal erosion and inundation.
e. To ensure land in the coastal zone is continuously available for coastal foreshore management, public access, recreation and conservation purposes.
f. To ensure land use and development does not accelerate coastal erosion or inundation risk; or have a detrimental impact on the functions of public reserves.
g. To ensure coastal process considerations are taken into account in preparing strategic planning proposals and in assessing subdivision and development applications.

6.4.5.2 Additional Provisions

a. Notwithstanding any other provision of the Scheme, all proposed development within SCA5 requires the development approval of the local government, unless the development is specified in the local government's Coastal Hazard Local Planning Policy as a type that does not require development approval.
b. In considering any application for development approval, or its advice in relation to a proposed structure plan, or application for subdivision of land within SCA5, the local government is to have particular regard to:
    i. The Shire of Augusta-Margaret River Coastal Hazard Risk Management and Adaptation Plan;
    ii. State Planning Policy 2.6 – State Coastal Planning Policy;
    iii. The Shire of Augusta-Margaret River Coastal Hazard Local Planning Policy;
    iv. The likely effect on public safety and the risk associated with coastal inundation and erosion;
    v. The existing and likely future effect of coastal erosion or inundation on the land;
    vi. The vulnerability of any roads providing access to the land and any public utility infrastructure servicing the land;
    vii. The continued suitability of servicing the land with an onsite effluent disposal system, where reticulated sewer is not available;
    viii. The impact that any proposed earthworks, retaining walls or other protective measures will have on the amenity of the locality and water flows;

a. The adequacy of the coastal foreshore reserve to provide for continued coastal foreshore management, public access, recreation, conservation and landscape amenity;

c. An application for development approval for development proposed within SCA5 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 conditions so as to:

   i. constrain the location of development;

   ii. control the form of construction, including foundations and associated works;

   iii. determine the form, location and construction of access;

   iv. require a minimum floor level for development;

   v. limit the term of the approval;

   vi. require the approved development to be removed and the land restored to a condition as near as practicable to its condition immediately before development started to the satisfaction of the local government upon a trigger event occurring; and

   vii. 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:

      i. that the lot is located in an area likely to be subject to coastal erosion and/or inundation over the next 100 years;

      ii. of any limited term of a development approval; and

      iii. of any requirement to remove approved development and restore the land as near as practicable to its condition immediately before the development started to the satisfaction of the local government upon a trigger event occurring.

e. Where an application for subdivision of land within SCA5 is referred to the local government, it may recommend that the Commission applies conditions requiring:

   i. the finished surface level of the land, or the level of public roads providing access to the land, are raised sufficient to reduce the risk of coastal inundation;

   ii. building envelope/s, where applicable, provide a specified area of land that is located above the coastal inundation level;

   iii. 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 erosion and/or inundation over the next 100 years.

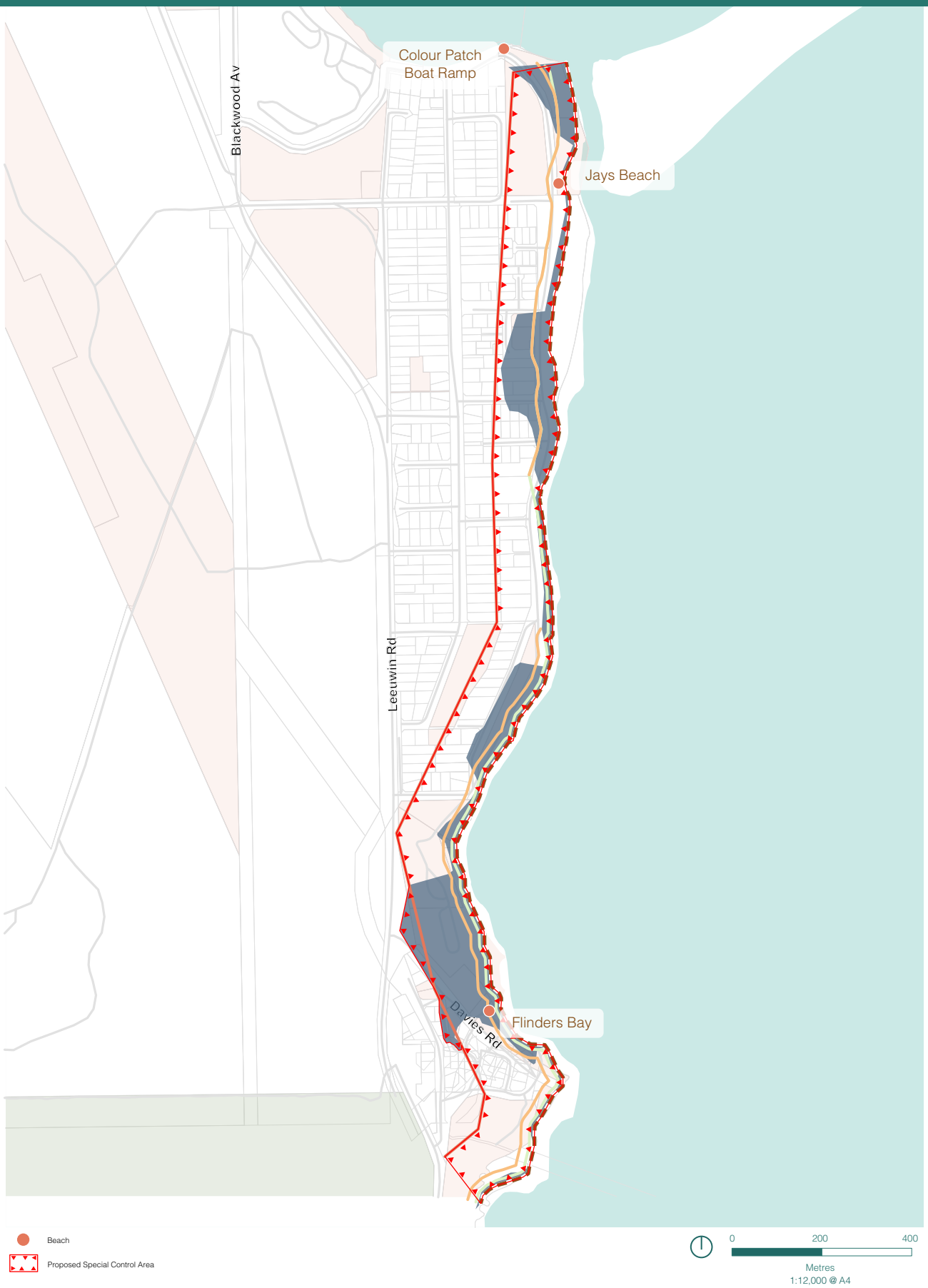
f. Notwithstanding the provisions of above, development approval is not required within SCA5 for the following development if such development is otherwise exempt from requiring development approval under the Scheme:

   i. temporary or non-permanent structures not used for human habitation.

   ii. extensions to an existing single, grouped or multiple dwelling where the net floor area of the proposed extensions is no more than 50m2; and

   iii. a change of use where no new structures are proposed.

FIGURE 5.1 - SPECIAL CONTROL AREA EXTENT



Local Planning Policy

To provide context for the Special Control Area, it is recommended that the Shire of Augusta-Margaret River prepare a supporting Local Planning Policy. The Local Planning Policy should address several key matters to ensure comprehensive management and guidance for development within the area:

Requirements for Development Applications in areas affected by the SCA: The policy should outline specific criteria that development applications must meet to be considered within the Special Control Area. This could include detailed assessments of potential environmental impacts and adherence to coastal management guidelines. The policy should also stipulate necessary documentation and evidence that applicants must provide to demonstrate compliance with these requirements:

1. **Guidelines for Exempted Development:** The policy should clearly define which types of development are exempt from requiring formal development approval. This includes specifying temporary or non-permanent structures not used for human habitation and extensions to existing dwellings where the net floor area increase does not exceed 50m^2. Additionally, it should address change of use applications where no new structures are proposed, ensuring that these exemptions do not compromise coastal hazard mitigation measures.
2. **Guidance for the Shire on Strategic Planning Proposals:** The policy should provide a framework for assessing strategic planning proposals, such as rezoning and significant land-use changes within the SCA. This framework should ensure that such proposals align with broader coastal management objectives, taking into account long-term sustainability and resilience against coastal hazards like erosion and inundation.
3. **Subdivision Referrals:** When the local government provides a response to subdivision applications within the SCA referred by the Commission, the policy should recommend conditions that mitigate coastal risks. These may include raising the finished surface level of the land or access roads to reduce inundation risk, designating building envelopes above the anticipated inundation level, and placing notifications on titles to inform future landowners of the coastal hazards.
4. **Development Applications:** For development applications within the SCA, the policy should establish criteria for approval that prioritises minimising coastal risk. This includes ensuring that building designs, materials, and placements are resilient to coastal hazards and that developments do not exacerbate erosion or inundation risks to neighbouring properties or the wider community.
5. **Risk Management Pathways:** The policy should incorporate effective risk management pathways to address the coastal hazards identified in the Coastal Hazard Risk Management and Adaptation Planning (CHRMAP). These pathways should outline a structured decision-making process, emphasising adaptive responses that evolve over time. By avoiding premature commitments to specific risk treatment options, the policy ensures flexibility and appropriateness in addressing changing circumstances.

Notifications on title

Notifications on title are an important mechanism for informing current and future landowners, prospective purchasers and developers about significant matters affecting the use and enjoyment of land, including potential exposure to coastal erosion, inundation and other coastal hazards. By placing a notification on the certificate of title, the relevant coastal hazard is disclosed during property transactions and can be taken into account when decisions are made about purchasing, developing or managing the land. Notifications therefore support informed decision-making and encourage the implementation of appropriate risk management and adaptation measures.

Notifications on title may be implemented through subdivision and development approval processes. In the case of subdivision, the Western Australian Planning Commission may require a notification to be placed on the title as a condition of subdivision approval. Where development is proposed on land potentially affected by coastal hazards, the Shire may also impose a condition of development approval requiring the landowner to register a notification under section 70A of the Transfer of Land Act 1893. Although registration requires the registered proprietor to execute the relevant documentation, compliance with the notification requirement may be made a condition of the approval and is therefore not dependent on the landowner independently volunteering to place the notification on the title.

Section 70A may also provide a mechanism for registering a notification where no subdivision or development application is being determined. In those circumstances, however, registration would ordinarily require the cooperation and written consent of the registered proprietor. Opportunities to place notifications on existing titles may therefore be more limited unless they arise through subdivision, development approval or another process through which the notification can be validly required.

Coastal Management Strategy

The preparation of a Coastal Management Strategy across the entire Shire will significantly enhance the implementation of the Coastal Hazard Risk Management and Adaptation Planning (CHRMAP). By building on existing Foreshore Management Plans, the Coastal Management Plan can provide a comprehensive and cohesive framework that integrates various coastal management activities. This integration will facilitate a more effective approach to managing coastal hazards and promoting long-term sustainability.

A coordinated Shire-wide Coastal Management Plan will also streamline dune management and sand renourishment efforts. It will allow for the identification of suitable sand sources on a Shire-wide basis, ensuring that resources are utilised efficiently and effectively. Moreover, the plan will ensure that dune maintenance and sand renourishment activities are conducted in a strategic manner, aligning with broader coastal management objectives and mitigating the impacts of erosion and inundation.

By adopting a unified approach, the Shire can achieve greater consistency in coastal management practices, reducing the risk of fragmented or ad-hoc efforts that may be less effective. This strategic planning will support the resilience of coastal areas and contribute to the overall success of the CHRMAP, ensuring that the Shire is well-prepared to address current and future coastal hazards.

Infrastructure Asset Planning

The Shire's Asset Management program will be crucial in implementing the Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) objectives. Given that many coastal areas at risk are managed by the Shire, it is essential to integrate CHRMAP goals into the Shire's short- to medium-term asset management strategies. This integration will ensure that appropriate measures are taken in a timely manner to address potential coastal hazards.

By aligning asset management with CHRMAP outcomes, the Shire can better plan, prioritise, and undertake necessary actions to manage coastal risks. This approach will help maintain the integrity and resilience of coastal infrastructure and support sustainable development practices. Incorporating CHRMAP objectives into the asset management program will facilitate a more coordinated and efficient response to coastal hazards, ultimately contributing to the long-term sustainability of the Shire's coastal areas.

Emergency Management Plan

The outcomes of the Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) should be integrated into the Shire's existing Emergency Management Plan to address potential inundation risks, impacts to infrastructure, and severe erosion events.

Reflecting CHRMAP outcomes in the Emergency Management Plan will allow for a more coordinated and strategic approach to managing coastal emergencies. This includes identifying vulnerable areas, prioritising risk mitigation efforts, and establishing clear protocols for emergency response thus providing a better response to managing the impacts of coastal hazards, minimise damage, and ensuring a swift recovery process. This proactive stance will support the long-term resilience and sustainability of the Shire's coastal areas.

Dissemination of information

Dissemination of information should be achieved through a structured communication strategy, ensuring all stakeholders are informed of the CHRMAP outcomes and their integration into the Emergency Management Plan. This includes regular updates, public information sessions, and accessible online resources.

5.3 Risk management pathways

Effective risk management pathways are essential for addressing the coastal hazards the CHRMAP, and the adaptation responses. These pathways provide a structured approach to decision-making, incorporating a sequence of decision points over time. This ensures that responses are adaptive and appropriate as circumstances evolve, avoiding premature commitments to specific risk treatment options that may not be suitable in the long term.

By establishing these clear risk management pathways, the Shire can plan, prioritise, and prepare for future actions even if all decisions cannot be made today. This approach emphasises responsiveness to changing conditions while maintaining flexibility in selecting the most suitable risk treatment options from the risk management hierarchy outlined in the CHRMAP.

The pathways approach also highlights the importance of trigger points, which are specific conditions or thresholds that signal the need for action. These trigger points are integral to the dynamic nature of the risk management process, allowing for timely and efficient implementation of risk management measures as coastal hazards and associated risks manifest over time.

This section outlines the pathways and triggers for action for each of the key locations. An example of the approach is outlined in the figure below, and a summary of pathways provided in Section 5.4.

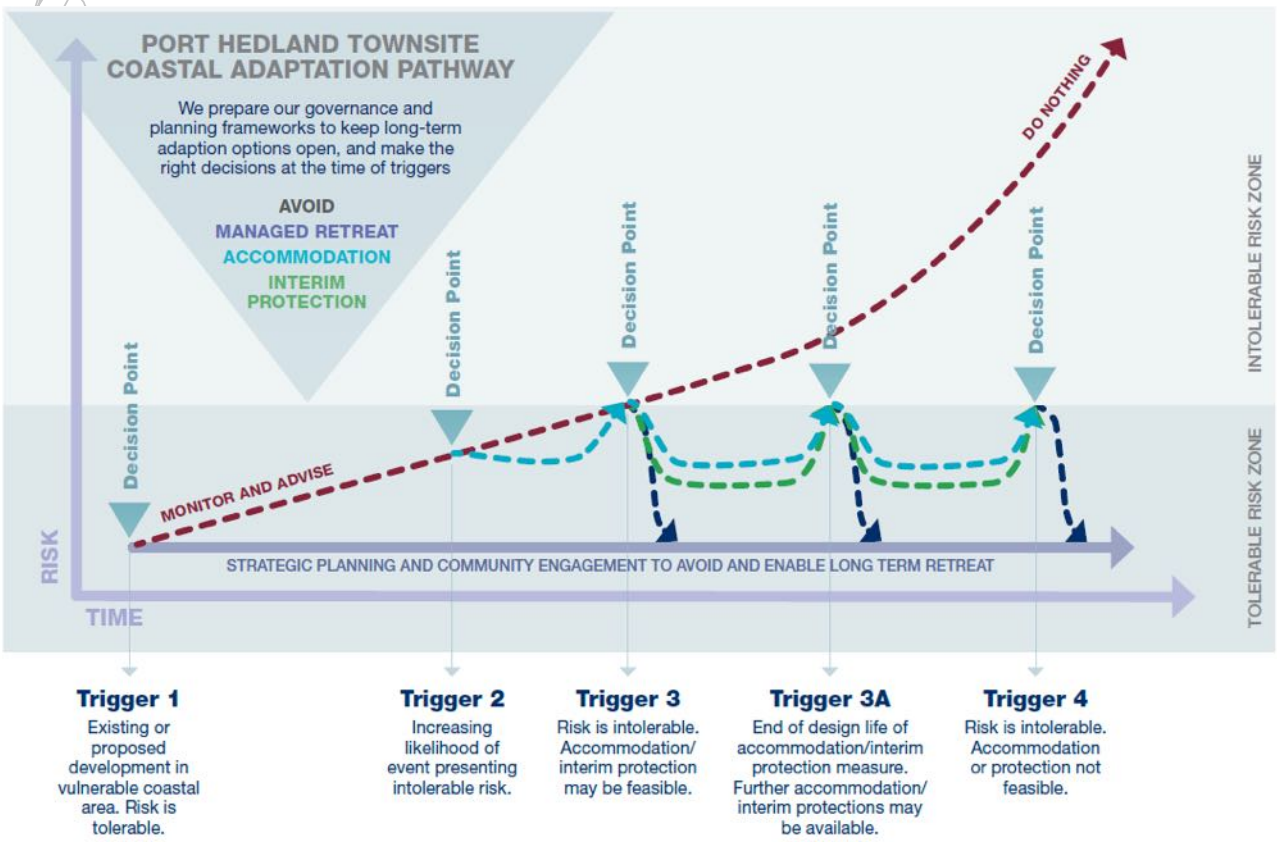


Figure 5.2 – Risk management pathway approach (Western Australian Planning Commission, 2019)

Triggers

There are four trigger points considered by this CHRMAP:

1. **Proximity trigger:** when the most landward portion of an erosion scarp threatens ground stability, or when long-term erosion trends, as evidenced by monitoring, indicate an insufficient erosion buffer for the upcoming winter season.
2. **Replacement trigger:** When an asset being accommodated reaches the end of its useful life and needs replacement.
3. **Damage trigger:** when any property within a designated hazard zone or Special Control Area sustains irreparable damage.
4. **Access trigger:** When a public road or accessway can no longer provide legal access to a property or townsite.

Key assumptions

The timeframes specified in the coastal adaptation pathways in the CHRMAP are adaptable and depend on the current state of the Shire's local planning framework, current understanding of coastal processes, and climate projections over a longer-term planning horizon. Adjustments may be required if there are changes in land planning practices, coastal process knowledge, or climate projections, resulting in an evolving implementation pathway over time.

Suggested adaptation actions have been developed from data collected throughout the various stages of the CHRMAP project, including the Multi-Criteria Analysis (MCA) and Cost Benefit Analysis (CBA). It is worth noting that the preparation of the MCA and CBA involved interpretation and approximations concerning criteria and cost quantifications. Therefore, the proposed options are conceptual and intended for comparative analysis.

Further investigations, such as surveys, policy reviews, environmental impact assessments, development approvals, and endorsements from relevant authorities, as well as engagement with local stakeholders and the community, are necessary before implementing the CHRMAP actions. These options should undergo preliminary and detailed design, costing, and any other required preparatory work. Optimisation and modification of the options should follow these additional investigations.

5.4 Pathways

The coastal monitoring and adaptation measures outlined in this plan provide a basis for longer-term coastal management and adaptation. However, this will require gradual implementation of different adaptation pathways over time. While individual pathways for assets may be site-specific, the general progression of pathways is outlined in Figure 5.3 below.

	PLANNING HORIZON (YEARS)										
Coastal Asset Type	5	10	20	30	40	50	60	70	80	90	100
Undeveloped Foreshore	AVOID										
Developed Foreshore											
Coastal stairs and platforms	ACCOMMODATE				MANAGED RETREAT						
Carparks	MONITORING	PROTECT			MANAGED RETREAT						
Buildings (large structures, toilets, change rooms etc)		PROTECT			MANAGED RETREAT						
Coastal Walkways		MANAGED RETREAT									
Coastal Access Paths		MANAGED RETREAT									
Public Marine Structures (Boat Ramps/Jetties)		ACCOMMODATE							MANAGED RETREAT		
Landscaping, Playgrounds and Shelters		MANAGED RETREAT									
Residential		ACCOMMODATE			PROTECT						

Adapted and updated from 2015 CHRMAP

Figure 5.3 – Adaptation pathways

Site-based adaptation

Specific site-based adaptation options have been considered for each location. These have been based on the work completed previously, including the multi-criteria assessment and cost-benefit analysis. Further ground-truthing has since occurred to refine the adaptation approach.

The following sections outline the options from the adaptation toolkit that are suited to each location over the planning horizon.

6.1 Gracetown adaptation

The coastal infrastructure in Gracetown, including stairs and pathways, currently experiences occasional impacts and are appropriately maintained by the Shire as required. It is essential to incorporate these considerations into the Shire's Asset Management Plan to address these existing conditions. Broader impacts on this locality are not anticipated in the short to medium term.

An important requirement is continuous monitoring (NR1) to identify impacts and trends, thus providing the necessary context for any required medium to long-term actions. It is noted that the Multi-Criteria Analysis (MCA) suggested a **PROTECT** option focusing on Dune Care and Management. This approach should be implemented through the Coastal Management Plan/Foreshore Management Plan actions discussed in the preceding chapter.

The recommended adaptation options for Gracetown are:

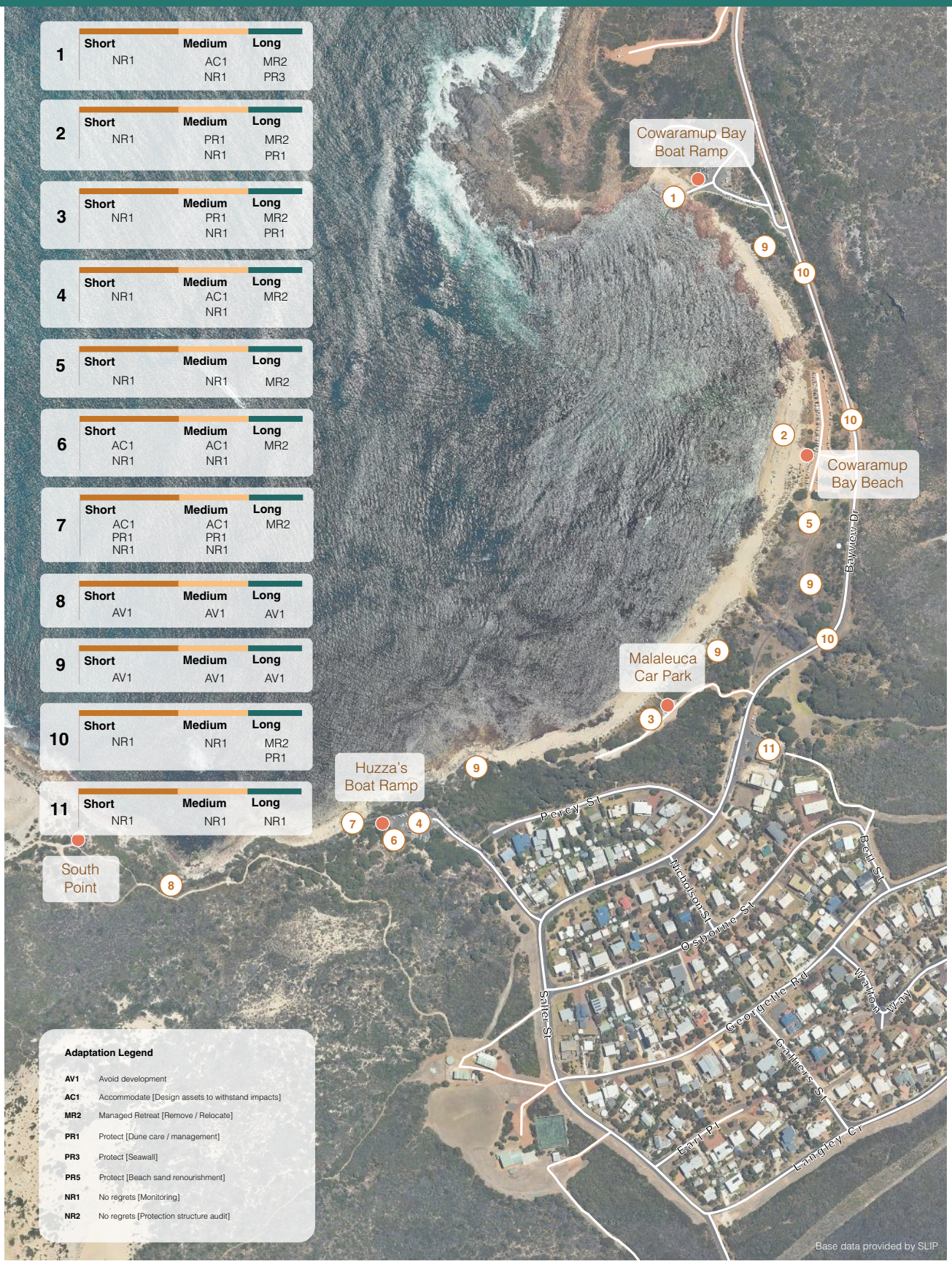
- AV1 Avoid (Avoid Development)
- AC1 Accommodate (design assets to withstand impacts)
- MR2 Managed Retreat (remove or relocate assets)
- PR1 Protect (dune care or management)
- PR3 Protect (Seawall)(in front of asset only)
- NR1 No regrets (monitoring).

These are outlined in more detail below, and illustrated in Map 6.1.

Table 6.1 – Actions for Gracetown

		PLANNING HORIZON (YEARS)			
ASSET TYPE	DESCRIPTION	10 (SHORT)	20 (MEDIUM)	20-100 (LONG)	OVERVIEW
Developed Foreshore	Cowaramup Bay Boat Ramp	NR1	AC1 NR1	MR2 PR3	Ensure that the boat ramp structure can accommodate coastal change in the short to medium term. In the longer term, plan to relocate the boat ramp, or protect the structure in its current position.
Developed Foreshore	Cowaramup Bay Boat Ramp car park	NR1	NR1	MR2	Undertake annual beach and structure monitoring in accordance with monitoring plan.
Developed Foreshore	Cowaramup Bay Swimming Beach car park	NR1	PR1 NR1	PR1 MR2	Undertake annual beach and structure monitoring in accordance with monitoring plan. Review the Gracetown Foreshore Management Plan (as part of a broader Coastal Management Plan) to ensure that CHRMAP outcomes are identified, especially around the 'Protect' option of Dune Care and Maintenance.
Developed Foreshore	Melaleuca Car Park	NR1	PR1 NR1	MR2	
Developed Foreshore	South Point Car Park (Huzzas car park)	NR1	NR1 AC1	MR2	
Developed Foreshore	Toilets Located at Cowaramup Bay Swimming Beach car park	NR1	NR1	MR2	
Developed Foreshore	Toilets Located at Huzza's car park	NR1	NR1	NR1	Undertake annual beach and structure monitoring in accordance with monitoring plan.
Developed Foreshore	Stairs/ramp at Huzza's	NR1 AC1 PR1	NR1 AC1 PR1	MR2	Undertake annual beach and structure monitoring in accordance with monitoring plan. Review the Gracetown Foreshore Management Plan (as part of a broader Coastal Management Strategy) to ensure that CHRMAP outcomes are identified, especially around the 'Protect' option of Dune Care and Maintenance.
Undeveloped foreshore	National Park	AV1	AV1	AV1	Avoid further development
Undeveloped foreshore	Remaining undeveloped foreshore areas in Gracetown	AV1	AV1	AV1	Review the Gracetown Foreshore Management Plan (as part of a broader Coastal Management Strategy) to ensure that CHRMAP outcomes are identified, especially around the 'Protect' option of Dune Care and Maintenance.
Road	Bayview Drive	NR1	NR1	MR2 PR1	Monitor the impact of coastal hazards on Bayview Drive. Plan for future protection or retreat.
Commercial	Gracie's General Store	NR1	NR1	NR1	Monitor in accordance with triggers.

FIGURE 6.1 - SUMMARY OF GRACETOWN ADAPTATION OPTIONS



6.2 Prevelly/Gnarabup adaptation

The sandy beaches, nearshore coastal car parks, and coastal pathways are the primary assets at risk along this section of the coast. The risk becomes more pronounced in the 20–100-year planning allowance timeframe. The future location of the White Elephant Café and adjoining beach access/boat launching area may require consideration over time, necessitating ongoing monitoring to gather additional data.

Most assets in this coastal section are reserved for Parks and Recreation. Similar to Gracetown, managing these assets can be integrated into the Shire's standard asset management processes. A small portion of land within the 100-year planning allowance is zoned for Future Development. Any development proposed on this parcel will be subject to a detailed assessment of local geology and hazard risk through an independent development assessment process.

The recommended adaptation options for Prevelly/Gnarabup are:

Prevelly

- AV1 Avoid (Avoid Development)
- AC1 Accommodate (design assets to withstand impacts)
- MR2 Managed Retreat (remove or relocate assets)
- PR1 Protect (dune care or management)
- NR1 No regrets (monitoring).

Gnarabup

- AV1 Avoid (Avoid Development)
- AC1 Accommodate (design assets to withstand impacts)
- MR2 Managed Retreat (remove or relocate assets)
- PR1 Protect (dune care or management)
- PR3 Protect (seawall)(existing, in front of café only)
- PR5 Protect (Beach (sand) renourishment)
- NR1 No regrets (monitoring)
- NR2 (protection structure audit).

These are outlined in more detail below, and illustrated in Maps 6.2 (Prevelly) and 6.3 (Gnarabup).

Table 6.2 – Actions for Prevelly/Gnarabup

		PLANNING HORIZON (YEARS)			
ASSET TYPE	DESCRIPTION	10 (SHORT)	20 (MEDIUM)	20-100 (LONG)	OVERVIEW
Developed Foreshore	Rivermouth Carpark and beach access	AC1 NR1	AC1 NR1 PR1	MR2 PR1	– Undertake monitoring. Ensure beach access points. **Accommodate** coastal processes by being built and maintained to appropriate standards. Review the Prevelly/Gnarabup Foreshore Management Plan to ensure that CHRMAP outcomes are identified, especially around the **Protect** option of Dune Care and Maintenance
Developed Foreshore	Margaret River Surfers Point car parks	NR1	NR1	NR1	
Developed Foreshore	Margaret River Surfers Point Toilets	NR1	NR1	NR1	
Developed Foreshore	Margaret River Surfers Point Lookout 1	NR1	NR1 AC1	AC1 PR1	
Developed Foreshore	Margaret River Surfers Point Lookout 2	NR1	NR1 AC1	AC1 PR1	
Undeveloped Foreshore	Shire-managed reserve between Surfers Point and Gnarabup Boat Ramp	AV1 NR1	AV1 NR1 PR1	AV1 NR1 PR1	– **Avoid** development. – Review the Prevelly/Gnarabup Foreshore Management Plan to ensure that CHRMAP outcomes are identified, especially around the **Protect** option of Dune Care and Maintenance
Developed Foreshore	Gnarabup coastal path	NR1	AC1 PR1	MR2	
Developed Foreshore	Gnarabup Boat Ramp	AC1 PR5 NR1 NR2	AC1 PR5 NR1 NR2	AC1 PR5 NR1 NR2	– Ensure that the boat-ramp, beach access and café are **accommodated** by ensuring assets are constructed to appreciate standards. – Continue to **Protect** the ramp via the current practice of sand nourishment in the area. – Continue to monitor the coastline, and undertake regular inspections of coastal protection structure in the vicinity.
Commercial	White Elephant Café	AC1 PR5 PR3 NR1 NR2	AC1 PR5 PR3 NR1 NR2	AC1 PR5 PR3 NR1 NR2	
Developed Foreshore	Gnarabup Boat Ramp Toilets	AC1 PR5 NR1 NR2	AC1 PR5 NR1 NR2	AC1 PR5 NR1 NR2	
Developed Foreshore	Beach Access at Gnarabup Boat Ramp	AC1 PR5 NR1	AC1 PR5 NR1	AC1 PR5 NR1 MR2	
Undeveloped Foreshore	Foreshore area between Long Reef Car Park and Gas Bay	AV1	AV1	AV1	– **Avoid** further development.
Developed Foreshore	Long Reef Car Park	NR1	NR1	NR1 MR2	– Monitor the coast. In the longer term, **Managed Retreat** may be required.
Developed Foreshore	Grunters Beach Car Park	NR1	NR1	NR1 MR2	
Developed Foreshore	Gas Bay Car Park	NR1	NR1	NR1 MR2	
Aboriginal Heritage	Margaret River	AV1	AV1	AV1	– **Avoid** development.

FIGURE 6.2 - PREVELLY ADAPTATION OPTIONS

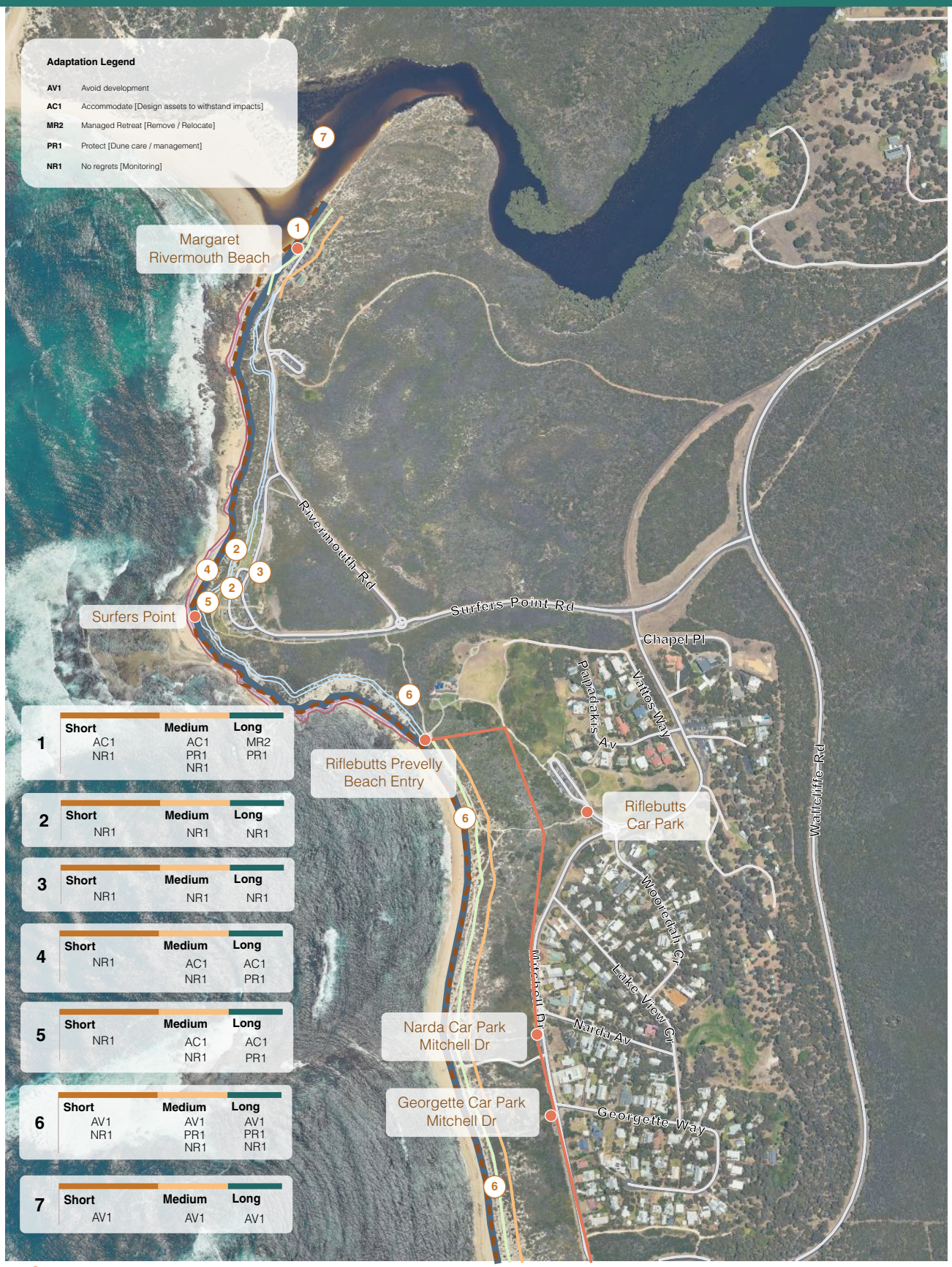


FIGURE 6.3 - GNARABUP ADAPTATION OPTIONS



Beach
8 Shire-managed reserve
9 Between Main Beach and Gnarabup Boat Ramp
10 Gnarabup Boat Ramp
11 White Elephant Cafe
12 Gnarabup Boat Ramp Toilets
13 Beach Access at Gnarabup Boat Ramp
14 Foreshore Area between Long Reef Carpark and Gas Bay
15 Long Reef Carpark
16 Grunters Beach Carpark
17 Gas Bay Carpark

Inundation Line
Horizontal Setback Datum
10 year allowance for coastal processes
20 year allowance for coastal processes
100 year allowance for coastal processes
Limestone Lower Extent
Limestone Observed Extent
Limestone Upper Extent

0 200 400
Metres
1:10,000 @ A4

6.3 Augusta adaptation

The Augusta coastline is home to a diverse range of public and private assets, many of which are potentially at risk due to changing environmental conditions. In the short to medium term (10–20 years), the majority of at-risk assets are public properties which are managed by the Shire. These areas are classified as high to medium exposure zones and require attention to mitigate potential damage. As stated earlier, there is a potential for a greater protection as the river entrance shifts to the north-east as predicted and trending at present.

Looking towards the long term (100 years), the risk extends to private properties, including land zoned for Residential and Caravan Park use. This necessitates a comprehensive adaptation strategy to protect both public and private interests. Proper planning and implementation of coastal adaptation measures will be essential to safeguard the assets and ensure sustainable development along the Augusta coastline.

The recommended adaptation options for Augusta are:

- AV1 Avoid (Avoid Development)
- AC1 Accommodate (design assets to withstand impacts)
- AC2 Accommodate (Planning controls for accommodation)
- MR2 Managed Retreat (remove or relocate assets)
- PR1 Protect (dune care or management)
- PR3 - Seawall
- NR1 No regrets (monitoring)
- NR2 No regrets (protection structure audit)
- NR3 No regrets (Notification on Title)
- NR4 (No regrets (Emergency Management Plan).

These are outlined in more detail below, and illustrated in Maps 6.4 (Augusta North) and 6.5 (Augusta South).

Table 6.3 – Actions for Augusta

		PLANNING HORIZON (YEARS)			
ASSET TYPE	DESCRIPTION	10 (SHORT)	20 (MEDIUM)	20-100 (LONG)	ACTIONS FOR AUGUSTA
Developed Foreshore	Colour Patch [4]	NR1	NR1	AC1 NR1	Monitor Colour Patch Boat Ramp/park area. Plan to **Accommodate** in the longer-term. Note that monitoring of the river mouth location should be undertaken to further understand coastal/riverine dynamics in this area.
Undeveloped foreshore	Lions Park	AV1	AV1 PR12 NR1	AV1 PR1 AC1	**AVOID** development. Prepare a Foreshore Management Plan to ensure that CHRMAP outcomes are identified, especially around the **Protect** option of Dune Care and Maintenance.
Residential	Located between Chaudiere Place and Albany Terrace (adjacent to caravan park)	NR1	NR1 NR3 AC1 AC2	NR1 NR3 AC1 AC2 PR3	Implement **Accommodate** options within the local planning framework by applying a Special Control Area to affected land. In the longer-term, monitor for any encroachment of the foreshore towards the road. Should an erosion scarp threaten ground stability, or erosion trends (as evidenced by monitoring) indicate insufficient erosion buffer, plan to **PROTECT** the road. Protecting the road should assist in protecting the residential areas on the landward side of the road.
Road	Albany Terrace; Trigg Street; Loch Street, Deere Street; Knight Place; Thomasia Court; Chaudiere Place ; Adjacent Paths	NR1	NR1	PR3	Monitor for any encroachment of the foreshore towards the road. Should an erosion scarp threaten ground stability, or erosion trends (as evidenced by monitoring) indicate insufficient erosion buffer, plan to **Protect** the road. Note -this is the Shire's preferred option currently.
Undeveloped Foreshore	Located between Lions Park and Department Flinders Bay Caravan Park	AV1 PR1 NR1	AV1 PR1 NR1	AV1 PR1 NR1	**Avoid** development. Prepare a Foreshore Management Plan to ensure that CHRMAP outcomes are identified, especially around the **Protect** option of Dune Care and Maintenance.
Aboriginal Heritage	Blackwood River	AV1	AV1	AV1	**Avoid** development.
Developed Foreshore	Flinders Bay Park/Jetty; Viewing Platforms; Access Points	PR1 NR1	PR1 AC1	PR1 MR2	**Avoid** development. Prepare a Foreshore Management Plan to ensure that CHRMAP outcomes are identified, especially around the **Protect** option of Dune Care and Maintenance. In the longer term, **Managed retreat** may be required, with assets removed or relocated.

[4] Note, located on Blackwood River foreshore. Coastal/riverine processes will need to be considered further.

		PLANNING HORIZON (YEARS)			
ASSET TYPE	DESCRIPTION	10 (SHORT)	20 (MEDIUM)	20-100 (LONG)	ACTIONS FOR AUGUSTA
Commercial	Flinders Bay Caravan Park	AC1 AC2 NR4	AC1 AC2 NR4 MR2	AC1 AC2 NR4 MR2	Ensure that any development within the caravan park is built to **Accommodate** coastal hazards. The site will be within the proposed Special Control Area, so Council will have the ability to assess and manage this process. Ongoing monitoring of the foreshore in this vicinity will provide guidance on potential impacts/timing, so that appropriate action can be taken. In the longer term, **Managed Retreat** may be required, with assets removed or relocated.
Residential	Davies Road precinct	NR1	NR1 NR3 AC1 AC2	NR1 NR3 AC1 AC2	Implement **Accommodate** options within the local planning framework by applying a Special Control Area to affected land. In the longer-term, monitor for any encroachment of the foreshore towards the road. Should an erosion scarp threaten ground stability, or erosion trends (as evidenced by monitoring) indicate insufficient erosion buffer, plan to **Protect** the road. Protecting the road should assist in protecting the residential areas on the landward side of the road.

FIGURE 6.4 - AUGUSTA (NORTH) ADAPTATION OPTIONS

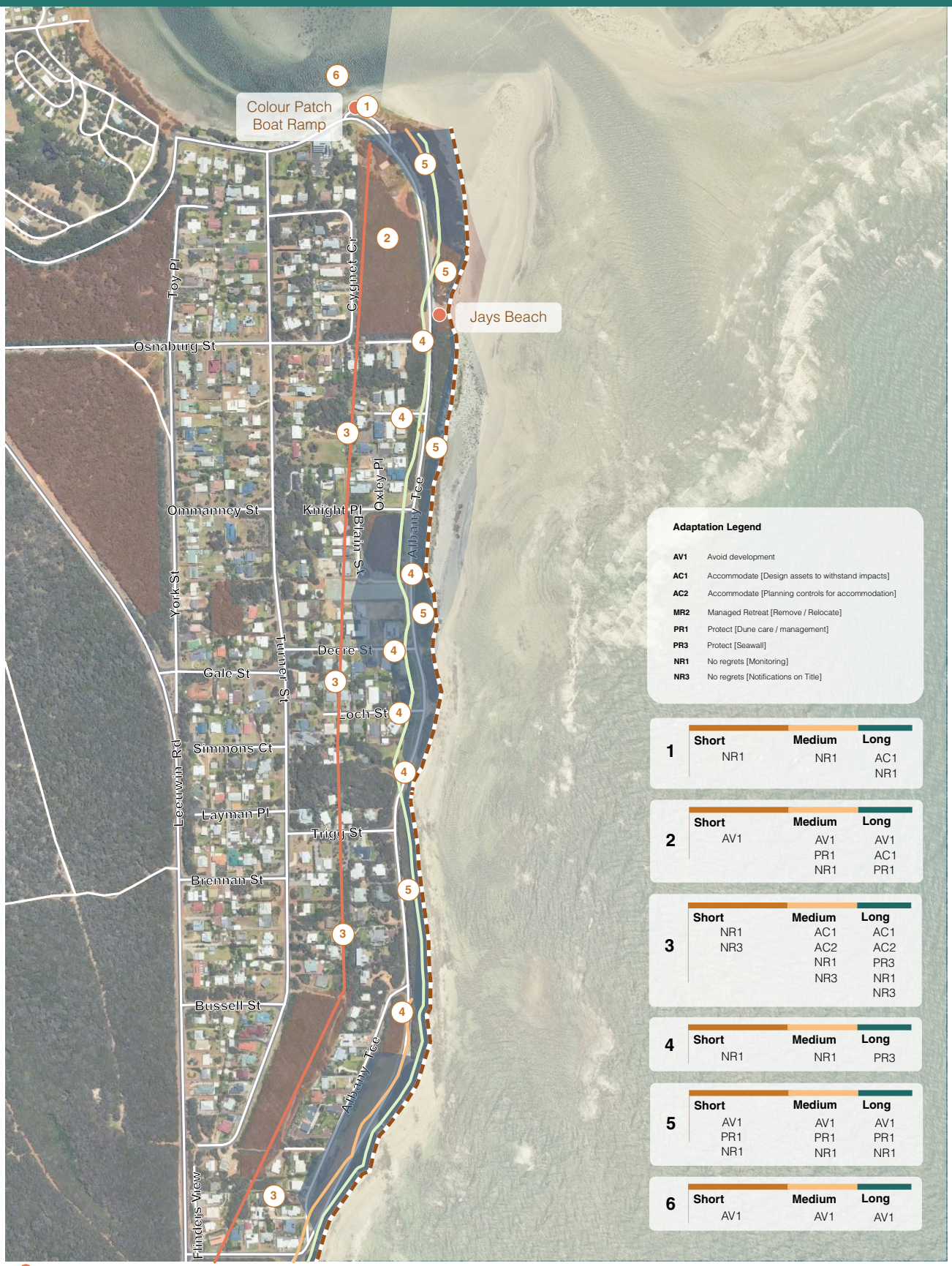


FIGURE 6.5 - AUGUSTA (SOUTH) ADAPTATION OPTIONS



6.4 Budget summary

The table below provides indicative budget and resource allowances for key tasks associated with site-specific implementation options. All figures are in 2025 dollars and should be treated as indicative only; costs will likely increase over time as works are programmed and scopes are refined.

LOCATION	ACTION	BUDGET OR ALLOWANCE
Shire-Wide	Prepare a Coastal Management Strategy	$150 000
Gracetown	Beach Access Stair Monitoring. Allowance for regular structural engineer inspections of beach access stairs, and maintenance and replacement as required.	Existing budget allowances
	Cliff Hazard Assessments. Allowance for regular geotechnical engineer inspections and reporting of limestone cliff stability.	Existing budget allowances
	Dune Care and Maintenance. This is typically undertaken by local community groups including Nature Conservation and the Gracetown and Cowaramup Bay Community Association, with seedlings and plant guards supplied by the Shire. Undertake	Existing budget allowances; Possible Coastwest Grants
	Cowaramup Bay Boat Ramp. Adaptation associated with coastal change and sea level rise is a potential longer term project. The scope would need to consider jetty deck levels, increased wave loads and uplift, a replacement concrete ramp and jetty approaches. Budget is for design scope only.	$30,000 to $60,000
Prevelly	Gnarabup Coastal Path: Three options were provided to the Shire for consideration in 2020 (Refer to Seashore Engineering). These were based on a new limestone path and/or boardwalk setback from the existing path.	$500 to $2000 per linear metre.
	Gnarabup Sand Nourishment: Buffers at the boat ramp continue to be managed with sand nourishment and beach scraping. The Shire currently allows in the order of $20,000 per year for these works to maintain a dune buffer to the carpark at a pinch-point. The balance of imported and relocated sand and wrack will be variable from year-to-year and costs influenced by seasonal weather and beach behaviour.	$30000 per year
	Beach Access Stair Monitoring: Allowance for regular structural engineer inspections of beach access stairs, and maintenance and replacement as required.	Existing budget allowances.
	Cliff Hazard Assessments: Allowance for regular geotechnical engineer inspections and reporting of limestone cliff stability.	Existing budget allowances
	Dune Care and Maintenance. This is typically undertaken by local community groups including Nature Conservation and the Coastal Residents Association, with seedlings and plant guards supplied by the Shire.	Existing budget allowances



LOCATION	ACTION	BUDGET OR ALLOWANCE
Gnarabup	Hydrographic Survey: Previously completed in April 2018 and April 2023 (DTMI Coastal Hotspots). Could be undertaken on a 5-years basis with next survey to be scheduled for 2028	$20,000 to $30,000 - Coordinated by the Shire with the assistance of community groups including the Margaret River Coastal Residents Association and Nature Conservation Margaret River Region
	Wave and Current Modelling: Development of a wave and current numerical model for the nearshore areas to better understand local coastal dynamics and influence on shoreline behaviour	$30,000 to $50,000
Augusta	Blackwood River Entrance Monitoring: Higher resolution monitoring of entrance behaviour. Sites identified for coastal monitoring including beach photography, UAV and beach profile survey in the wider monitoring plan.	$30000 per survey
	Coastal Processes and Adaptation Options for Albany Terrace: Coastal engineering study of Blackwood River entrance behaviour and sandy beaches to the west, adjacent to Albany Tce. Scope should include interim and longer term adaptation options including sand nourishment, dune rehabilitation and structural protection to the road (rock revetment).	$30,000 - $60,000 depending upon scope.
	Albany Terrace Coastal Adaptation - Preliminary Design and Estimating: Develop preliminary design for coastal adaptation seawall along vulnerable sections of Albany Tce and develop a cost estimate. Options include a rock revetment, sand nourishment, dune rehabilitation or localised road realignment	$20,000 to $40,000, assuming no further survey or geotechnical data required

Implementation

7.1 Short-term implementation

Context

Short-term implementation actions cover an approximate 10-year period (with medium and long-term implementation spanning approximately 10-20 years and 20-100 years, respectively). The short-term actions of this CHRMAP include:

- modifications to the Shire's planning framework
- developing and implementing an annual monitoring program
- updating the Emergency Management Plan
- establishing a communications framework
- preparing or updating other technical studies.

These actions are explained below.

Short term implementation summary

Table 7.1 outlines key implementation actions

Table 7.1 – Short term implementation

ACTION NO.	DESCRIPTION	RESPONSIBLE DIRECTORATE [5]	APPROVAL AGENCIES	YEAR	PERFORMANCE MEASURE
S1	Amend LP Scheme to incorporate Special Control Area.	SDI	WAPC/Minister for Planning	2027–2028	Scheme amendment gazetted
S2	Prepare Local Planning Policy	SDI	Council	2027–2028	LPP adopted
S3	Develop a 5-year Coastal Monitoring Program	SDI	Council	2027	Monitoring program prepared prior to EOFY27
S4	Implement monitoring program for years 1-5	SDI	Council	2027–2031	Monitoring data available for 5 years
S5	Prepare Shire Coastal Management Strategy	SDI	Council	2028–2029	Adopted CMS
S6	Review existing Foreshore Management Plans	SDI	Council	2028–2029	Adopted FMP's
S7	Update Emergency Management Plan	SDI	Council	2028–2029	Updated EMP
S8	Incorporate CHRMAP findings into asset management program	SDI	Council	2027–2028	Asset management cognisant of coastal hazards and adaptation.
S9	Program review of CHRMAP and short/ medium term actions (including review of monitoring data)	SDI	Council	2031	Revised short term action for years 5-10.
S10	Investigate options for rates levy for protection works, subject to BDA	CCS	Council	2031	Report into funding options for required protection works in years 5-10.
S11	Inspections of fall distance from lower stair to beach (regular / post storm inspections)	SDI	Council	Annual	Asset monitoring plan prepared.
S12	Structural inspections of timber/composite stairs/retaining walls (annual inspections)	SDI	Council	Annual	Asset monitoring plan prepared.
S13	Geotechnical inspection of limestone cliffs and safety signage audit (five yearly audit)	SDI	Council	2027	Last completed 2019 – recommended for 5-yearly review thus should be completed in Year 1 of current CHRMAP.

[5] Responsibility refers to what internal directorate within the Shire is responsible for coordinating the action. SDI – Sustainable Development and Infrastructure; SEC – Sustainable Economy and Communities; CCS – Corporate and Customer Services.

Blackwood River and Molloy Island

The 2015 CHRMAP included an assessment of the riverine and estuarine environments of the Blackwood River and Molloy Island. These areas have been excluded from the current CHRMAP on the basis that the Department of Transport and Major Infrastructure (DTMI) has recently completed a Statewide Coastal Inundation Assessment for Western Australia, with the Phase 2 report published in 2024. This assessment identifies inundation threats over the next 25 years, determines risk to coastal communities, and examines pathways to manage those threats. Incorporating this dataset into a site-specific hazard assessment for the Blackwood River and Molloy Island will produce a more robust and defensible analysis than would otherwise be possible.

It is recommended that the Shire initiate an update to this CHRMAP to address these locations, drawing on the DTMI statewide assessment as a primary input. Given the low-lying nature of parts of the Molloy Island and lower Blackwood River areas, and the presence of residential and recreational assets in those locations, this work should be treated as a priority for the next phase of CHRMAP preparation. In the interim, the Shire should monitor any further guidance issued by DTMI or the Department of Planning, Lands and Heritage regarding the application of the statewide data to local planning decisions.

7.2 Medium and long-term implementation

Medium-term actions span 10-20 years and long-term actions extend to 100 years, with short-term measures providing a foundation that can manage coastal change across the full 20-year medium-term period.

The long-term strategy guides future planning, supports monitoring and review, and fosters collaboration among coastal land managers, stakeholders and the community. The two primary responses are protection, undertaking works to prevent erosion or inundation to assets, and managed retreat, systematically relocating assets with low adaptive capacity out of the hazard zone over time. Within the Shire, the majority of at-risk assets outside Augusta are Shire-managed, which provides flexibility to implement these responses through operational and asset management mechanisms rather than planning instruments alone.

As monitoring data accumulates, long-term pathways may change substantially, trigger sooner than anticipated, or be deferred.

Medium to long term implementation summary

A summary of medium to long term actions is provided in Table 7.2 below.

Table 7.2 – Medium to long term implementation

ACTION	DESCRIPTION	TRIGGER	TIMEFRAME
ML1	Develop a planning framework to enable managed retreat of foreshore assets, ensuring that as assets approach end of useful life, relocation to a less exposed position is considered ahead of like-for-like replacement in the existing location.	Asset approaching end of useful life in a coastal hazard zone, where in-situ replacement is inconsistent with projected hazard allowances.	Long
ML2	Replace Shire foreshore structures (including stairs, paths and boardwalks) as they reach end of life, with replacement location and design informed by current hazard data. Where feasible, structures should be repositioned further landward, achieving a gradual and practical retreat of assets over time consistent with ML1.	Individual asset reaching end of useful life; replacement location and design to be determined with reference to monitoring data and hazard allowances current at that time.	Long
ML3	Maintain foreshore dune structure to preserve natural coastal protection and buffer capacity. Active management may include sand import, dune rehabilitation and revegetation where monitoring identifies a reduction in dune volume or integrity.	Monitoring data indicating a reduction in dune volume, extent or integrity below acceptable thresholds, or where erosion is encroaching on assets or infrastructure.	Long
ML4	Undertake studies to determine whether a seawall or other structural protection is warranted at appropriate locations in Augusta, including preliminary design and cost estimation.	Monitoring data indicating that erosion trends at Augusta are approaching a threshold at which structural protection may be required, thus informing the timing for when a seawall investigation should be initiated.	Long
ML5	Undertake a comprehensive review of CHRMAP	10 years since adoption	Medium

7.3 Funding options

Beneficiary (user) Pays

'User Pays' principles essentially dictate that the beneficiaries of adaptation Options should pay for them. Mechanisms for fundraising may include:

- Specified Area Rates – as described below and considering the findings of the BDA (not required until the longer-term).
- Mechanisms for visitors to the town, as users 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.

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 Shire consider the establishment of a specified area rate. 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 relevant Adaptation Options and take into account the outcomes of the Benefit Distribution Analysis (BDA) report. The proceeds of the Specified Area Rate can then be held in reserve and expended over time to implement this CHRMAP.

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. 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:

- 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 DTMI 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.

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.

The Australian Government's primary disaster resilience funding mechanism is the Disaster Ready Fund (DRF), which provides up to $200 million annually in Commonwealth funding for disaster resilience and risk reduction projects across Australia, delivered in partnership with state, territory and local governments. The DRF supports a broad range of eligible activities relevant to coastal adaptation, including risk assessments and mapping, business case development, community-focused management programs, investment in monitoring infrastructure, and adaptation and resilience works including both grey infrastructure and nature-based solutions. Round 4 of the DRF is expected to open in early to mid-2026. Further information is available at nema.gov.au.

It should be noted that Federal funding mechanisms typically 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.

Monitoring and Review

8.1 Coastal Monitoring and Implementation

Coastal monitoring will guide short to medium-term implementation by tracking changes to the coastline and observing trigger points. This process also enhances the knowledge base for future CHRMAP revisions and targeted investigations. This section summarises the key monitoring actions and any recommended changes to the existing program.

8.2 Sandy coastline monitoring

Coastal monitoring is typically undertaken on a local or regional scale and can include photo monitoring, survey, UAV imagery and coastal engineering inspections.

A beach monitoring program was developed 7 years ago for the Shire (Shore Coastal, 2018). However, only 1-years monitoring has been implemented by the Shire (Shore Coastal, 2020b).

The scope of a Shire based coastal monitoring program has been established and included:

- Establishment of 31 coastal monitoring sites.
- Beach photo monitoring in winter and summer and inspections by a coastal engineer of the 31 sites including:
  - Gracetown: 5 sites within Cowaramup Bay.
  - Prevelly: 4 sites between the Rivermouth and Riflebutts Beach.
  - Gnarabup: 7 sites between Gnarabup and Gas Bay.
  - Augusta North: 7 sites along the western foreshore of the lower Blackwood River including the entrance.
  - Augusta South: 8 sites along Flinders Bay between the Blackwood River entrance and south of the Augusta Boat Harbour.
- Oblique aerial photographs from a light plane in winter and summer.
- Establishment of 42 beach profile sites.
- RTK beach survey profiles at the monitoring sites in summer, with a particular focus on Gnarabup Beach.

Annual implementation of this beach monitoring program is estimated to cost in the order of $30,000-$50,000[6], with costs influenced significantly by the extent, frequency and method of survey.

However, given the gap since the previous monitoring (7 years) and the significant development of survey technology in this time (Green Lidar / UAV Survey), $15,000 - $20,000 should be allowed for review and update of the wider Coastal Monitoring Program prior to implementation.

Monitoring sites are outlined in the following plans (sourced from the Shire's Monitoring Plan).

[6] Note all cost estimates are indicative and are exclusive of GST.

FIGURE 8.1 – GRACETOWN MONITORING LOCATION



FIGURE 8.2 – PREVELLY/GNARABUP MONITORING LOCATIONS



FIGURE 8.3 – AUGUSTA MONITORING LOCATIONS



8.3 Coastal structures – monitoring and structural integrity

Monitoring of stairs would include assessment of fall distance from lower stairs. This would involve measurements of the distance between the bottom step and the beach at all beach access stairs throughout the Coastal Management Areas. This would highlight any beach access stairs that have become unsafe and no longer meet Australian Standards. It would also inform the beach access stairs maintenance and adaptation requirements.

In addition, monitoring of stairs would include structural inspections of beach access stairs. This includes all beach access stairs and would determine the stability of the stairs and the risk of undermining of any foundations. Regular inspections would detect when the stairs become unsafe for public use and would highlight when works are required. These inspections should focus on how to improve the stairs so they can adapt to increased scour and wave exposure.

Example: The coastal stairs and lookouts at Gnarabup Beach provide access to popular swimming beaches and they are currently located within the high coastal exposure zone. Undermining of timber footings has been observed together with large fall distances from the lower stair to the beach.

Following a structural inspection, monitoring of these stairs and the adjacent beach would occur on at least a 6 monthly basis. Monitoring of the stairs and lookouts would identify if and when these stairs are damaged, start to fail and/or become vulnerable to coastal processes.

8.4 Monitoring – Storm Events

In the event of a significant storm, several monitoring actions are recommended. If there is sufficient time, pre-storm beach profiles and photos should be taken. Post-storm, updated beach profiles and photos should be captured. If there are significant changes in the profiles, a full survey and 3D beach scan should be considered. Coastal structures should also be inspected post-storm. Initially, this can be done by a Shire officer, but if significant damage is evident, a full condition inspection by a coastal engineer is recommended.

8.5 Beach profile monitoring

Annual beach profile surveys are recommended to capture pre- and post-winter profiles, which are required to inform several short-term triggers. Corresponding monitoring photos should be taken at the same time as beach surveys, particularly for inundation events, as it is often impractical to organise detailed surveys at short notice. The community can be engaged to support such activities.

8.6 Data Management and Sharing

GIS data collected should be stored by the Shire to ensure that information remains readily available over the longer-term. Data can be shared with relevant agencies such as Department of Transport and Department of Planning, Lands and Heritage, as required.

8.7 Review

The CHRMAP should be updated at least every ten years to maintain currency and should be considered a living document. An earlier review should be considered if:

- substantial storm events generate severe coastal hazards approaching or exceeding the CHRMAP projections
- significant changes to land-use planning occur
- new information becomes available that substantially affects the summary of local community values and assets
- updates occur in climate change science, specifically local sea level rise projections; or
- if triggers are reached.

Monitoring of CHRMAP outcomes, actions, and future updates should always include consultation with stakeholders and the community to ensure any changes are communicated and that stakeholders' positions are reflected in the coastal management outcomes.

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Appendix A
Hazard Assessment

Review of Coastal Hazard Risk Management and Adaptation Plan

Shire of Augusta Margaret River

Coastal Engineering Scope (Tasks 1 & 2)



Shore Coastal
October 2023

Report SC2305_01_01A

RevA

For: Landinsights and Shire of Augusta Margaret River

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Limitations of this Report

This report and the work undertaken for its preparation, is presented for the use of the client. The report may not contain sufficient or appropriate information to meet the purpose of other potential users. Shore Coastal does not accept any responsibility for the use of the information in the report by other parties

Acknowledgement

We acknowledge the Traditional custodians of the land and coast on which this report is concerned, the Wadandi/Wardandi people.

Document Control

Index	Author	Date	Review	Date	Comment
Rev A	H. Davis	31/10/2023	S.Barr	31/10/2023	
Rev B					
Rev O					[Final Revision]

1. Introduction

The review of the AMRSC 2015 Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) seeks to improve understanding of risks from coastal processes, impacts of coastal inundation upon public and private assets and further refine planning instruments to address coastal inundation.

The scope of this technical note is the technical components of Task 1 (Establish the Context) and Task 2 (Risk Identification) of the CHRMAP Review. This has included:

- Site Inspections of Gracetown, Prevelly/Gnarabup and Augusta.
- Literature Review of supplied documents and data including the 2017 Limestone Stability Assessment (1), Geophysical Coastal Investigation in Augusta in 2022 (2), the first year of coastal monitoring of for the Shire of Augusta Margaret River (3), and the 2017 Lidar survey completed (4).
- Review of mapping of Planning Allowances for Coastal Processes (10yr, 20yr, 100yr) at Gracetown, Gnarabup/Prevelly and the Flinders Bay coast of Augusta.



Figure 1-1 Selected images from Gracetown (above), Prevelly (centre) and Augusta (below)

2. Site Inspection

A site inspection of Gracetown, Gnarabup/Prevelly and Augusta was initially undertaken with Land-insights, the Shire of Augusta Margaret River, and the project Steering Group on 22nd May 2023.

Detailed site inspections were undertaken by Shore Coastal over the 2023 winter to inform the review of planning allowances for coastal processes on highly variable mixed sandy/rock coasts. These planning allowances are typically based on sandy coastlines and simplified models on the coastal response to sea level rise. Inspections were undertaken on the following dates and an inspection report is provide in Appendix A.

- Gracetown: 13/07, 16/10.
- Gnarabup/Prevelly: 11/08.
- Augusta (Flinders Bay): 22/05, 06/06, 04/07, 30/05, 25/10.



Figure 2-1 Gracetown (2023), view towards granite/gneiss headland and boat ramp at Northpoint.

3. Literature Review

3.1. SHIRE OF AUGUSTA MARGARET RIVER CHRMAP, SHORE COASTAL (2015)

The Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) was prepared by Shore Coastal for the Augusta-Margaret River Shire Council (AMRSC) in 2015 (5). This was the first CHRMAP completed by local government in Western Australia. The aim of the CHRMAP was to provide strategic guidance on management and adaptation in areas exposed to coastal processes within the key coastal settlements identified by the AMRSC.

The coastal settlements within the scope included Gracetown, Prevelly, Gnarabup, Hamelin Bay, Molloy Island, Augusta North (Blackwood River) and Augusta South (Flinders Bay). The CHRMAP followed a process outlined in the State Coastal Planning Policy of risk identification, risk analysis and risk evaluation; in order to make recommendations for risk management and adaptation. Coastal planning allowances for coastal process were mapped using the procedures outlined in Schedule 1 of SPP2.6 for the 10, 20 & 100 year planning periods.

Recommendations were provided regarding limestone cliff stability, systematic coastal monitoring and inspections, coastal adaptation of coastal stairs and platforms, planning for high-risk assets and coastal processes investigations.

A 5-year coastal monitoring and adaptation program detailing the recommended works was provided. The study also identified potential longer-term coastal management issues that will require strategic planning in the medium term. The assumed status of the 2015 CHRMAP recommendations is provided in Table 3.1.

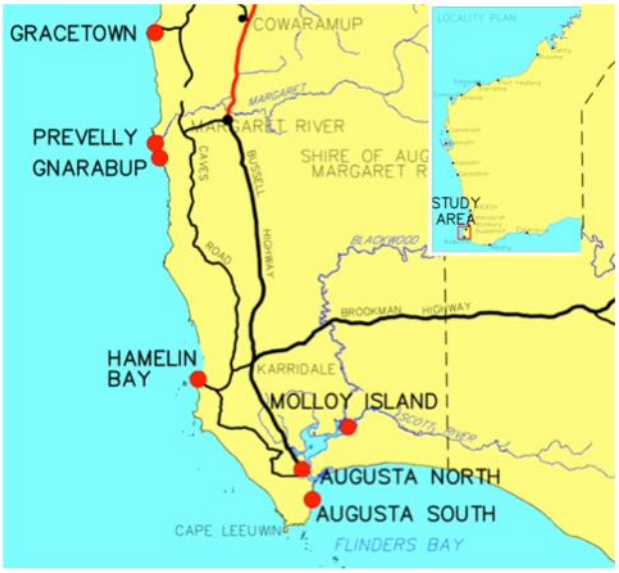


Figure 3-1 Overview of Shire of Augusta Margaret River showing the 2015 CHRMAP Sites

Table 3.1 Status of 2015 CHRMAP Recommendations

Recommended Task	Assumed Status
Coastal Monitoring	
Annual Inspections of fall distance from lower stair to beach (regular / post storm inspections)	TBC.
Annual structural inspections of timber/composite stairs/retaining walls (annual inspections)	TBC.
Annual beach profile surveys and photo monitoring, incl. Blackwood River cut migration (at least annual surveys)	Not completed. Year 1 only. Occasional Gnarabup surveys.
Geotechnical inspection of limestone cliffs and safety signage audit	Completed 2017 (Golder). Subsequent inspection by CMW Geosciences(2019)
Detailed baseline coastal survey of beaches and limestone cliffs	Completed 2017 (MNG)
Boat ramp and jetty inspections	Completed.
Investigations and Design	
Gnarabup/Prevelly/Rivermouth Coastal Processes	Considered in Shore Coastal 2020 (6).
Coastal adaptation of beach access stairs and platforms (GR, GN)	Designs for adaptation provided by structural engineer.
Coastal adaptation of White Elephant Cafe and Changerooms	Completed by Leaseholder (in part).
Weakly Lithified Sedimentary Rock Coast Investigation	Completed 2017 (Golder)
Blackwood River flood modelling under Sea Level Rise scenario.	TBC.
Planning	
Turner Caravan Park layout.	TBC
Prevelly/Gnarabup coastal walkway managed retreat, access stair relocation and consolidation	Designs completed 2019 (Shore Coastal, CSC)
Survey and inspection of private residences within 100yr floodway and fringe line	TBC.
South Point Carpark Layout	TBC.
Gnarabup and Ocean View carpark layouts	TBC.
Albany Terrace realignment or protection options	TBC.
Flinders Bay beach carpark and foreshore layout	TBC.
Rivermouth Carpark Layout	TBC.
Coastal Adaptation Works	
Coastal adaptation of beach access stairs and platforms	Progressive removal and adaptation of coastal stairs and platforms.

Note: TBC means status To Be Confirmed by the Shire.

3.2. LIDAR SURVEY, MNG (2017)

In December 2017, MNG completed an aerial survey (Lidar) of Gnarabup, Gracetown and Augusta coastal areas as recommended in the 2013 CHRMAP (5). Verification/audit surveys were undertaken using RTK GPS in various areas over the Prevelly, Gnarabup and Gracetown areas. Deliverables included a 1m Grid of DEM and DSM in ESRI ASCII grid format, 0.2m contours in ESRI shapefile format.

The results of the 2017 survey were used to map the allowance for coastal inundation (S4), which is based on elevation contours from 2017.

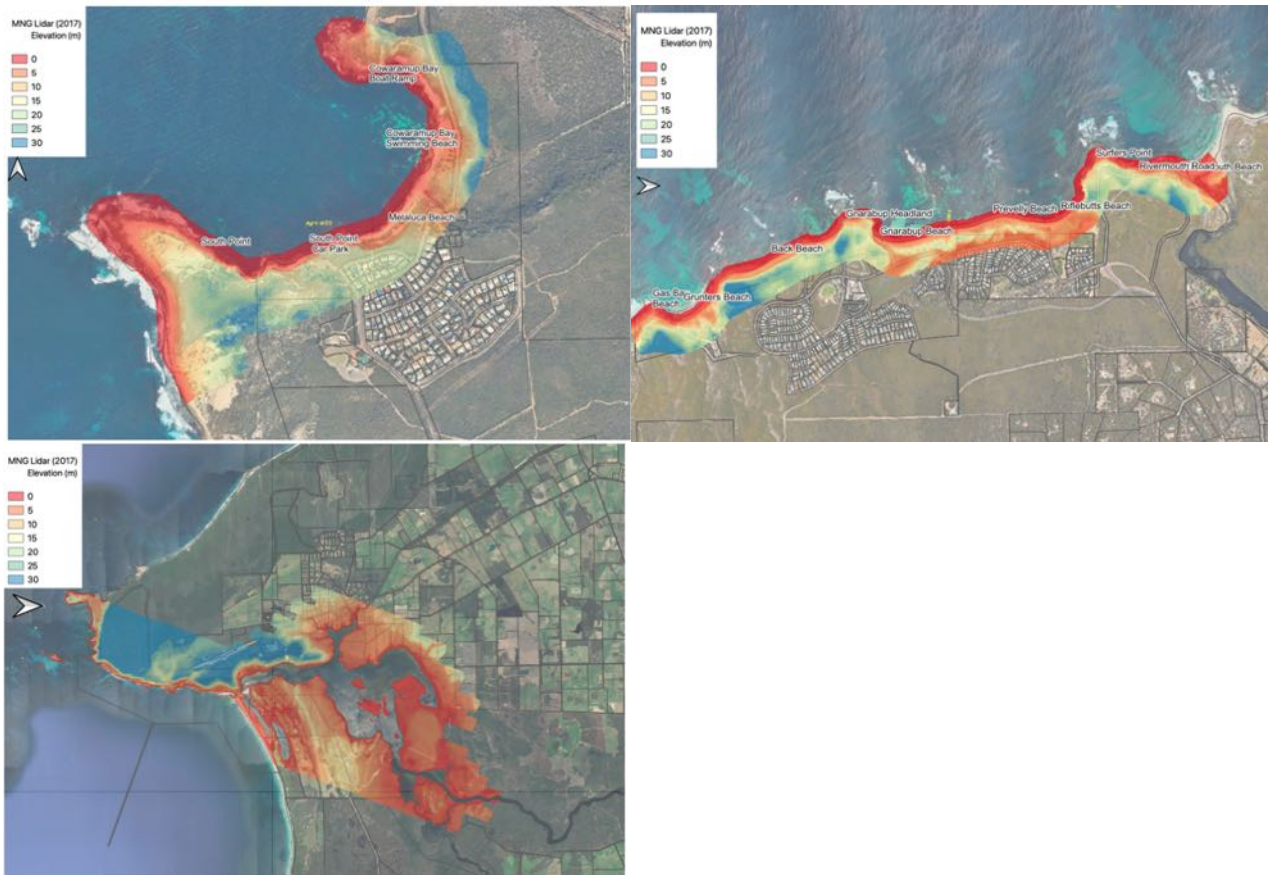


Figure 3-2 Survey extents at Gracetown (top left) and Gnarabup/Prevelly (top right) and Augusta (bottom left) completed in 2017 by MNG

3.3. LIMESTONE CLIFF STABILITY ASSESSMENT - GOLDER (2017)

Golder Associates Pty Ltd (Golder) undertook a study on limestone cliff geology and stability in the Margaret River region at the locations Gracetown, Prevelly and Gnarabup based on recommendations in the 2013 CHRMAP (1). A Risk Assessment was completed to evaluate the risk that limestone cliff instability poses to both recreational users and Shire assets, to inform longer term planning decisions.

At selected locations in Gracetown, Prevelly and Gnarabup, the definition of a landward extent of a hazard zone was outlined that was considered hazardous to Shire assets due to clifftop retrogression over a 100-year period. The 'Shire Assets' hazard zone "shows the landward extent of the zone considered hazardous to Shire assets due to clifftop retrogression over a 100-year period. It considers a notional 0.9 m of sea level rise over a period of 100 years as a significant trigger to initiating slope and cliff instability that ultimately results in cliff-edge retreat."

The 2017 cliff stability assessment generally showed allowances for the 100-year planning were lower than the allowances based on the application of SPP2.6 for sandy coasts, and the 2015 CHRMAP assumptions of a stable slope slumping to 2H:1V were reasonable. The hazard zone defined in the Golder 2017 report has been used as the 100-year planning allowance for coastal process for sedimentary rock coasts (where mapped).

3.4. SHIRE OF AUGUSTA MARGARET RIVER COASTAL MONITORING YEAR 1, SHORE COASTAL (2020)

The first Coastal Monitoring report for the Shire of Augusta Margaret River summarises relevant information on coastal change at Gracetown, Gnarabup, Prevelly, Augusta North and Augusta South, with a specific focus on beaches adjacent to public assets such as coastal carparks, walkways, and beach access stairs (3).

The monitoring techniques implemented in the first year's coastal monitoring included the collection of photo monitoring, oblique aerial photos and beach profile surveys from May 2018 to January 2019. The beach monitoring undertaken in Year 1 included establishment of 31 coastal monitoring sites and photo monitoring in winter and summer, oblique aerial photographs from a light plane, the establishment and survey of 42 beach profiles, and monthly beach width and photo monitoring at Gnarabup.

The data has been used to validate observations made when assessing coastline movements or survey data as a part of the CHRMAP review. However, coastal monitoring has not been continued, and is limited to this one year.

3.5. GEOTECHNICAL AND GEOPHYSICAL COASTAL INVESTIGATION, AUGUSTA WA – GBGMAPS (2022) (2)

A geophysical subsurface investigation was undertaken by GBGMAPS for The Shire of Augusta Margaret River in March 2022. The investigation was carried out along a 2.5km stretch of coastline along the Augusta Ocean front with the objective of the investigation to provide information on the subsurface material within the investigation, to define the underlying rock profile. Multi-channel Analysis of Surface Wave (MASW) and seismic refraction data as well as Cone Penetrometer Testing (CPT) was complect along transect sections. The level to the interpreted top of rock profile of the geophysical transects was provided in a set of drawings as well as digital files.

This generally showed rock levels are below 2mAHD. Isolated areas of rock to 4mAHD were noted but do not from continuous sections of rocky coast.

4. Review of Coastal Process Allowances

4.1. COASTAL PROCESS ALLOWANCE MAPPING

A review of the planning allowances for coastal processes has been undertaken using the procedures outlined in Schedule 1 of the State Coastal Planning Policy SPP2.6 (7). This mapping provides an interpretation of areas *potentially* exposed to coastal processes over the relevant planning timeframe.

The application of SPP2.6 for determining coastal processes allowances varies depending on the coastal type. The project scope is diverse and includes hard rock coast, weakly lithified sedimentary rock coast, sandy coasts, and dynamic estuary outlets/river mouths.

Sandy Coasts

The procedures outlined in Schedule 1 of SPP2.6. for coastal planning allowances sandy coasts requires consideration of four elements. This following has been assumed for the review of coastal planning allowances for this study:

- **S1 Erosion**: Allowance for Current Risk of Storm Erosion: Modelled storm erosion from 2015 using SBEACH has been reviewed and considered reasonable for planning allowances. Coastal monitoring has not been undertaken by the Shire to allow validation of updated numerical models (XBEACH), and S1 is a relatively minor component of the planning allowances.
- **S2 Erosion**: Allowance for Historic Shoreline Movement Trends: Analysis of vegetation line movement from 2000 and 2013 aerial imagery (2015 CHRMAP) have been updated using 2013 to 2022 imagery to assess current shoreline movement behaviour.
- **S3 Erosion**: Allowance for Erosion Caused by Future Sea Level Rise: Procedure as outlined in SPP2.6 (100 x Sea Level Rise (m))[1].
- **Factor of Safety**: 0.2m/year allowance for uncertainty in coastal assessments.

The sum of the four elements has been offset horizontally from the Horizontal Shoreline Datum (HSD), which has been updated based on the 2022 vegetation line (which typically represents the active limit of storm activity). An example of the application is shown in the figure below.

[1] The limitations of this simplified approach to determination of planning allowance for coastal response to sea level rise and the Bruun Model are outlined in Pilkey et al (9)



Figure 4-1 Representation of Planning Allowance for Coastal Processes on a Sandy Coast

Note: HSD – Horizontal Setback Datum, S1 – Allowance for Current Risk of Storm Erosion, S2 – Allowance for Historic Shoreline Movement Trends, S3 – Allowance for Erosion Caused by Future Sea Level Rise, FOS – Factor of Safety (Allowance for Uncertainty)

Hard Rock Coast

The State Coastal Planning Policy defines rocky coasts as those which comprise a continuous rocky substrate which extends to an elevation above the active limit of the shoreline, which "in most instances this elevation should be at least one metre above the HSD". The North Point rocky headland is an example of a "hard rock" type of rocky coast.

The underlying erosion rate on these coasts is typically zero, and The State Coastal Planning Policy outlines the future risk of erosion should be based on a geotechnical assessment of the shoreline stability (7). Where geotechnical studies are not available, areas seaward and lower than the 4.0mAHD contour have been nominally identified as subject to coastal processes for the 10-100 year planning timeframe.

Weakly Lithified Sedimentary Rocky Coast

Weakly Lithified sedimentary coast typically comprises poorly cemented or semi-lithified, discontinuous, relatively soft, or highly weathered, weak rock. The headland at Surfers Point in Prevelly is an example of a "weakly lithified sedimentary coast".

Where available, the 2017 limestone cliff stability assessment (1) has been used to outline the allowances on the rocky coasts within the study area. Planning allowances based on sandy coasts for limestone cliffs are conservative. However, there is a high degree of uncertainty in the response of weakly lithified sedimentary rock to sea level rise during the 100-year planning period.

Whilst the 100yr planning allowance has been defined for Weakly Lithified Sedimentary Rocky Coast in Golder 2017, the scope did not include assessment of 10yr and 20yr allowances.

Where hard rock is clearly visible during site inspections within the study area, the planning allowances have been adjusted locally (e.g. granite outcrops and cliffs east of the road at Gracetown, coastal rock at Trigg St, Augusta).

Where a transition between sandy coasts and harder rocky coasts/weakly lithified sedimentary coasts occurs, the 100yr allowance line has been interpolated at an angle of 45 degrees to the existing coastline.

4.2. GRACETOWN

Gracetown is a northwest facing embayment exposed to high energy waves. The shoreline position is controlled by a granite headland to the north (North Point) and a lower elongated granite headland, overlaid by sand dunes and weakly lithified sedimentary rock to the south (South Point). Within the bay there are numerous reefs that cause wave refraction and wave breaking, and along the shoreline there are rocky outcrops that provide a secondary control on shoreline position. A small creek drains to the beach along this section of coast. The coastal type includes sandy beaches backed by low dunes from the boat ramp to Melaleucas, weakly lithified sedimentary rock cliffs fronted by boulder beaches, limestone rock fall or narrow, thin perched sandy beaches. Development is associated with the Gracetown townsite and various beach and boating access nodes.

The storm erosion allowance (S1) for Gracetown is based on the 2015 CHRMAP SBEACH modelling. This has been applied to sandy coasts only. The historic shoreline change (S2) for each sector was assessed using the coastline movements from the 2015 CHRMAP (2000 – 2012), as well as the more recently available rectified aerial photography up to 2022. The long-term underlying erosion rate of the Gracetown sandy coasts (from Swimmers Beach to North Melaleuca is generally 0m/yr., however a 0.2m/yr. long term erosion rate at South Melaleuca Beach was observed.



Figure 4-2 Site photos as Melaleucas (South) following erosion in 2020 (left), and Gracetown Swimming Beach during a high-water level event (right)

The hard rock coast at North Point, and Weakly Lithified Sedimentary coasts towards South Point have underlying erosion rates of zero, and the future risk of erosion for the Weakly Lithified Sedimentary coast along South Point has been based on a geotechnical assessment of the shoreline stability (Golder 2017 (1)).

There are several large rocky features that are clearly visible landward of the sandy coasts from South Melaleucas to North Point. These rocky features are hard rock that typically extend well above the 5mAHD contour. Coastal rock has been considered in the 100yr planning allowances where it is likely to reduce the future extent of shoreline retreat.



Figure 4-3 Site photos at Gracetown showing exposed rock landward of the access road, where the 100yr Allowance has been adjusted locally to be seaward of these features.

Table 4.1 Planning Allowances for Coastal Processes – Gracetown

Coastal node	North Point Headland	Cowaramup Bay Swimming Beach	Melaleuca Beach	South Point Car Park	South Point
Coastal Type[1]	Hard Rock Coast	Sandy Coast	Sandy Coast	Weakly Lithified Sedimentary Rock Coast	Weakly Lithified Sedimentary Rock Coast
10yr Planning Allowance (m)	0	20	20	0	0
20yr Planning Allowance (m)	0	40	40	0	0
100yr Planning Allowance (m)	0 (approx. 4mAHD contour)	130	150	Variable (Golder 2017)	Variable (Golder 2017)

4.3. PREVELLY

Prevelly is a generally west facing coastline with inshore lagoons and offshore reefs exposed to high energy waves. Shoreline position is controlled by weakly lithified sedimentary headlands. Coastal types include the Margaret River mouth, weakly lithified sedimentary rock coast (Surfers Point) and sandy coast (Riflebutts Beach). Thin, perched beaches overlaying rock are evident at Surfers Point whilst the beach at Riflebutts is relatively steep, high and narrow. Development is associated with the Prevelly townsite and coastal nodes at Surfers Point and the Rivermouth.

The storm erosion allowance (S1) for Prevelly is based on the 2015 CHRMAP SBEACH modelling. This has been applied to sandy coasts only. The historic shoreline change (S2) for each sector was assessed using the coastline movements from the 2015 CHRMAP and the more recently available rectified aerial photography up to 2022.

A small section of sandy coast the Rivermouth shows variable behaviour and is subject to erosion and accretion depending on a northern or southern opening of the river and seasonal changes. However, no longer-term erosion trend was evident. Landward of the 20-year coastal process allowance (behind the Rivermouth carpark), the coast is backed by steep hills that extend to over 35m above mean sea level.

West of the Rivermouth carpark, the coast becomes a weakly lithified sedimentary coast, and the Golder 2017 geotechnical assessment has been used to delineate 100yr allowances. Riflebutts Beach typically demonstrates seasonal changes in beach shape and erosion during winter, but the longer-term coastline movements since 2000 is a net change of 0m.



Figure 4-4 Erosion under beach access stair near Surfers Point (left), and coastal rockfall signage and fencing at the base of the Riflebutts cliffs (right).

Table 4.2 Planning Allowances for Coastal Processes – Prevelly

Coastal Node	Rivermouth Beach	Rivermouth Road	Surfers Point	Riflebutts Beach	Prevelly (Dog Beach)
Coastal Type	Sandy Coast	Weakly Lithified Sedimentary Rock Coast	Weakly Lithified Sedimentary Rock Coast	Sandy Coast	Sandy Coast
10yr Planning Allowance (m)	20	0	0	20	20
20yr Planning Allowance (m)	40	0	0	40	40
100yr Planning Allowance (m)	NA	Variable (Golder 2017)	Variable (Golder 2017)	120	150

4.4. GNARABUP

Gnarabup is a generally west facing coastline with inshore lagoons and offshore reefs exposed to high energy waves. Shoreline position is controlled by weakly lithified sedimentary headlands. Coastal types include hard rock coast (Gas Point), weakly lithified sedimentary rock coast and sandy coast. The hard rock at Gas Point is overlayed with sand dunes. Steep high sandy beaches with coarse sediments are backed by high dunes with intermittent limestone outcrops and cliffs from Gas Point to Gnarabup Point.

The Gnarabup stretch of coastline contains the Shire of Augusta Margaret Rivers' only beachside cafe, one of the Shire's most popular swimming beaches, and the Gnarabup jetty and boat ramp. There is a popular sheltered swimming beach north of the White Elephant café that has undergone recent coastal management actions including sand nourishment and a local diversion of a coastal path that was eroded during storms in recent years.

The storm erosion allowance (S1) for Gnarabup is based on the 2015 CHRMAP SBEACH modelling. This has been applied to sandy coasts only. The beach at Gnarabup has experienced erosion in recent years (2017 – 2022) with the loss of mature dune vegetation, impacting coastal infrastructure such as stairs, fencing, café decking and threatening sections of the coastal walkway. There is an underlying long term erosion rate of historic shoreline change (S2) at Gnarabup (White Elephant) and Gnarabup (Back Beach).

The Gnarabup Headland and Grunters Headland are identified as weakly lithified sedimentary coast, and the Golder 2017 geotechnical assessment has been used to delineate 100yr allowances for the Gnarabup Headland and the Grunters headland. Between these two headlands (landward of Back Beach) a limestone ridge is visible approximately 40m landward of the vegetation line, extending to ~20m above mean sea level. However, as there is no geotechnical information on the continuity or composition of the ridge, the area has been treated as a sandy coast. Geotechnical investigations may reduce local planning allowances in this area.



Figure 4-5 Sand Nourishment at Gnarabup Beach in 2022 (left), and a local path diversion following storm erosion in 2018 (right).

Table 4.3 Planning Allowances for Coastal Processes – Gnarabup

Coastal Node	Gnarabup (White Elephant)	Gnarabup Headland	Gnarabup (Back Beach)	Sewers
Coastal Type	Sandy Coast	Weakly Lithified Sedimentary Rock Coast	Weakly Lithified Sedimentary Rock Coast	Sandy Coast
10yr Planning Allowance (m)	20	0	20	20
20yr Planning Allowance (m)	40	0	40	40
100yr Planning Allowance (m)	150	Variable (Golder 2017)	150	150

4.5. AUGUSTA

The Augusta South project site includes the Flinders Bay shoreline of the Augusta townsite and the Flinders Bay settlement. This is an east facing embayment sheltered from high energy Indian Ocean waves but with significant exposure to the southeast. Coastal types include hard rock coast and sandy coast. Public infrastructure and a coastal road are located along modest dunes with narrow setbacks. There are several thin perched sandy beaches controlled by granite outcrops in the Flinders Bay area. Augusta Boat Harbour, along the rocky coastline south of Flinders Bay, marks the southern extent of this project site.

The storm erosion allowance (S1) for Augusta is based on the 2015 CHRMAP SBEACH modelling. This has been applied to sandy coasts only.

The historic shoreline change (S2) was assessed using available rectified aerial photography. For the sandy coast adjacent to the Blackwood Rivermouth, caution of interpretation of the coastline movements is required due to the large-scale changes observed at the river entrance. Rates of change of more than 20m per year have been observed as the river entrance morphology evolves. The inlet channel is highly dynamic, with sediment behaviour influenced by marine processes (waves and tides), inlet processes (tidal currents, spit development, delta formation) and occasional flooding. For this section of sandy coast "Albany Terrace – Blackwood River Cut", the median erosion rate of ~2.5m/yr has been applied for the 10-year Coastal Process Allowance. However, for the longer term (100yr) allowance, the longer-term coastline movements average of 0m/yr has been applied. This aims to capture the risk due to the potential for rapid short-term shoreline changes but apply a considered allowance for the longer changes that are less volatile.



Figure 4-6 Aerial imagery showing August Blackwood Rivermouth Dynamics in 2010 (prior to new alignment), and changes in the past five years from 2017 to 2022.

The section of coast "Albany Terrace – Sandy/Rocky Coast" consists of visible hard rock along the shoreline, and has been stable in the long term. However, the rock is relatively low; the GBGMAPS (2022) investigations identify the level of the top of rock as typically between 0 and 2mAHD while the 2017 MNG Lidar typically demonstrates the crest of the hard visible rock is at ~2mAHD. Based on SPP2.6 this is too low to consider this section of coast as "hard rock" for the 100yr planning period, particularly with lower areas evidence of dune erosion behind the rock. The coastal process allowances are based on a long-term coastline movements trend of 0m/year, but have allowances for acute storm erosion (s1), sea level rise (s3) and a factor of safety.



Figure 4-7 visible rock along Albany Terrace (top and bottom left), and GBGMAPS "top of rock" levels (right)

Table 4.4 Planning Allowances for Coastal Processes – Augusta

Coastal Nodes	Albany Terrace – Blackwood River Cut	Albany Terrace – Rocky Coast	Albany Terrace – Sandy Coast	Flinders Bay Caravan Park	Flinders Bay
Coastal Type	Sandy Coast	Sandy Coast/Rocky Coast	Sandy Coast	Sandy Coast	Sandy Coast/Rocky Coast
10yr Planning Allowance (m)	40	10	10	10	10
20yr Planning Allowance (m)	NA	30	30	30	30
100yr Planning Allowance (m)	120	120	120	120	120

4.6. LIMITATIONS

The review of the coastal process allowances for the next 10, 20 and 100 years provides an indication of the potential area of influence of coastal processes within the Shire for different timeframes. However, Planning allowances for coastal processes are based on methods outlined in schedule 1 of the WA State Coastal Planning policy (SPP2.6), and Allowances are **not a prediction** of the shoreline position at the end of the respective planning periods.

Other key limitations are outlined below:

- These plans do not have the precision required to define the erosion risk to individual properties or landholdings.
- The assessment of sea level rise impacts on the shoreline is limited to a simplistic application of the Bruun rule for sandy coasts as per SPP2.6. However, coastal rock has been considered in the 100yr planning allowances where it is likely to reduce the future extent of shoreline retreat.
- Allowances for sedimentary rock coasts (weakly lithified sedimentary cliffs) are based on geotechnical investigations by Golder (2017).
- There is a high degree of uncertainty in the response of weakly lithified sedimentary rock to sea level rise during the 100-year planning period.

5. Coastal Inundation (S4 Allowances)

SPP2.6 outlines the allowance for coastal inundation should be the maximum extent of inundation calculated as the sum of S4 Inundation plus the predicted extent of sea level rise. The allowance for the current risk of inundation is the maximum extent of storm inundation, defined as the peak steady water level plus wave run-up. Furthermore, the storm event for storm surge inundation should be based on ocean forces and coastal processes that have a 0.2 percent or one-in-five hundred probability of being equalled or exceeded in any given year over the planning time frame.

S4 Allowances for Gracetown to Augusta have been based on the application of the Design Storm for Western Australia (8) for the southwest region of Busselton to Augusta. A 500yr ARI water level of 2.9mAHD, and an additional 0.9m allowance for sea-level rise over the 100 year planning period, result in the mapping of the 4mAHD contour as the allowance for S4 over the 100year timeframe. The 2017 MNG Lidar has been used to map this contour for the coastal areas for this study.

6. References

1. Golder Associates. Limestone Cliff Stability Assessment. Report Number. 1666765-001-R-Rev0. 2017.
2. GBGMAPS. Geotechnical and Geophysical Coastal Investigation, Augusta WA. Report Ref: 70676. 2022.
3. Shore Coastal. Shire of Augusta Margaret River Coastal Monitoring (YEAR 1). 2020.
4. MNG. 2017 Lidar Survey. 2017.
5. Shore Coastal. Shire of Augusta Margaret River Coastal Hazard Risk Management and Adaptation Plan FINAL Report SCR1507. 2015.
6. Shore Coastal. Gnarabup Coastal Planning and Adaptation – Conceptual Design Report. 2020.
7. Government of Western Australia. State Coastal Protection Policy (SPP2.6). 2012.
8. Seashore Engineering. Design Storms for Western Australian Coastal Planning: Tropical Cyclones. 2018.
9. Cooper A, Pilkey O. Sea-level rise and shoreline retreat: Time to abandon the Bruun Rule. Glob Planet Change. 2004 Nov 1;43:157–71.

Appendix A Site Inspection

SITE INSPECTION REPORT No.01	**Gracetown, Gnarabup/Prevelly, Augusta (Flinders Bay)**	Date: Winter 2023 Time: Various
Client	AMRSC	
Inspection by:	Stuart Barr (Principal Coastal Engineer, Shore Coastal)	
Synopsis	Inspection of three sites over 2023 winter under variable beach states for longer term coastal adaptation planning.	
Contract Personnel	Michael Taylforth, Landinsights. Jarred Drummond, AMRSC.	
Weather	Variable conditions.	
Observations - Coastal Geomorphology /Processes	<u>Cowaramup Bay (Gracetown)</u> Cowaramup Bay is a roughly semi-circular, 800 m wide, northwest-facing bay, bordered by the dune-capped granulite of South Point and a sloping granulite headland of North Point. The sandy beach south of the boat ramp is backed by a low foredune with coastal rock outcrops. A large headland separates this beach from the Swimming Beach, which is a sheltered relatively wide beach in the lee of a small island which controls the seasonal planform of the beach. Cowaramup Brook outlet is sited to the south, and Melaleuca Beach is a sandy beach subject to recent erosion that extends to the limestone cliffs. The coast from Huzzas through to South Point is backed by variable 20m high crumbling calcarenite bluffs, with perched beaches subject to regular erosion and replenishment of sand. Steep cliffs and overhangs are evident. <u>Rivermouth/Prevelly/Gnarabup</u> Rivermouth beach faces southwest and curves for 500m between calcarenite bluffs to the south and a low reef to the north, where it forms a sandy foreland. Scour of the southern foredune beneath the stairs was evident during the inspection. The coast to the south are calcarenite bluffs with perched sandy beaches. The Prevelly/Gnarabup beaches are three curved sandy embayments in the lee of offshore reefs and a lagoon. The northern and central beaches are relatively stable but the southern beach (Gnarabup) is subject to occasional severe erosion with a sensitivity to storm wave direction. Beaches to the south of Gnarabup Headland are sandy beaches backs by high dunes, with limestone outcrops evident north of Grunters Headland. The high energy sandy beach south of Gnarabup Headland is backed by high dunes with rehabilitated blowouts, and a granite headland to the south.	

SITE INSPECTION REPORT No.01	Gracetown, Gnarabup/Prevelly, Augusta (Flinders Bay)	Date: Winter 2023 Time: Various
	Augusta (Flinders Bay). The Blackwood River entrance is a highly mobile landform subject to typically eastward migration and occasional mechanical openings for flood control or amenity. The beach to the south is backed by a narrow foredune and Albany Tce. Rock is evident along the shoreline, particularly adjacent to Trigg St. Foredunes fronting the caravan park show evidence of erosion and the low clay embankments south of the swimming beach are undercut. Perched beaches are evident at Granny Pool with a narrow beach and rocky coastline through to Augusta Boat Harbour.	
Design Considerations (Coastal Adaptation)	Cowaramup Bay (Gracetown) Key design considerations for coastal adaptation include: • The influence of highly variable rock in mitigating and/or modifying the coastal response to erosion. • Coastal infrastructure planning for the Swimming Beach. • Managing erosion at Melaleuca Beach. • Inspection and maintenance of beach access stairs on calcarenite bluffs (Huzzas, South Point). • Mitigating rock fall hazards. Rivermouth/Prevelly/Gnarabup Key design considerations for coastal adaptation include: • Foredune erosion and beach access stairs (Rivermouth, Gnarabup). • Coastal infrastructure planning for the Swimming Beach. • Managing erosion at Gnarabup Beach. • Mitigating rock fall hazards. • Inspection and maintenance of beach access stairs on calcarenite bluffs (Mainbreak, Gnarabup, Backbeach). Rivermouth/Prevelly/Gnarabup Key design considerations for coastal adaptation include: • The influence of highly variable rock in mitigating and/or modifying the coastal response to erosion. • Blackwood River mouth coastal monitoring (highly variable landform). • Managing erosion at Flinders Bay Swimming Beach. • Monitoring buffers in foreshore reserve to Albany Terrace.	

SITE INSPECTION REPORT No.01	**Gracetown, Gnarabup/Prevelly, Augusta (Flinders Bay)**	Date: Winter 2023 Time: Various

General Notes:

The sites inspected are highly variable coastal landforms with complex responses to variable metocean conditions (tides, waves, river flow). These inspections provide background to interpretation of planning allowances for coastal processes, which are based on highly uniform sandy coastlines and highly simplified models for coastal response to sea level rise.



Gracetown, view towards granite/gneiss headland and boat ramp at Northpoint. Coastal rock with sandy beach and foredunes showing some evidence of occasional overwash.

SITE INSPECTION REPORT No.01	**Gracetown, Gnarabup/Prevelly, Augusta (Flinders Bay)**	Date: Winter 2023 Time: Various



Gracetown Swimming Beach in foreground generally stable and Melaleucas Beach in background with sections of the beach showing evidence of coastal erosion. Gracetown townsite elevated and setback from coast behind limestone rock coast.

SITE INSPECTION REPORT No.01	Gracetown, Gnarabup/Prevelly, Augusta (Flinders Bay)	Date: Winter 2023 Time: Various



Melaleuca Beach where fencing has been rebuilt in response to foredune erosion (1), exposed cobbles beneath sandy beach and beach access stairs at Huzzas (2), limestone cliffs and beach access stairs at South Point (3, 4)



Margaret River entrance, with erosion beneath access stairs to the carpark.



Limestone coast at Main Break (left) and Riffle Butts (right) with rockfall hazard signs.

SITE INSPECTION REPORT No.01	Gracetown, Gnarabup/Prevelly, Augusta (Flinders Bay)	Date: Winter 2023 Time: Various



Undulating planform of beaches at Prevelly and Gnarabup with limestone headland in background.



Gnarabup coastal path diversion in response to foredune erosion (left), sand nourishment works and beac response to wrack depositions (right).



Backbeach with eroding fordune backed by limestone at southern end of beach (left) and sandy beach and dunes south of Grunters Headland (right).

SITE INSPECTION REPORT No.01	Gracetown, Gnarabup/Prevelly, Augusta (Flinders Bay)	Date: Winter 2023 Time: Various



Blackwood River Entrance.



Looking towards rocky coast at Albany Terrace during high tide-high swell (July-2023) and low tide-low swell (Oct-2023)



Rocky coast at Albany Terrace. Survey shows rock up to 2.0mAHD but with lower areas backed by sandy foredune have potential for erosion with higher sea level.

SITE INSPECTION REPORT No.01	Gracetown, Gnarabup/Prevelly, Augusta (Flinders Bay)	Date: Winter 2023 Time: Various



Flinders Bay swimmng beach with rocky outcrops and sandy foredunes infront of caravan park.





Swimming beach at high tide (left) and erosion to the south of old boat ramp (right)





ERodding foredune at Storm Bay (left) and Augusta Boat Harbour (right)

Appendix B Planning Allowances for Coastal Processes - Maps

LEGEND

- Horizontal Setback Datum (HSD)
- Gracetown Planning Allowance for Coastal Processes (10yr)
- Gracetown Planning Allowance for Coastal Processes (20yr)
- Gracetown Planning Allowance for Coastal Processes (100yr)
- Geological Hazard Zones Landward Boundary (Golder 2017)
- Shire Assets (100yr)

LIMITATIONS:

1.Planning allowances for coastal processes are based on methods outlined in Schedule 1 of the WA state coastal planning policy (spp2.6).
2.Allowances are not a prediction of the shoreline position at the end of the respective planning periods.
3.These plans do not have the precision required to define the erosion risk to individual properties or landholdings.
4.The assessment of sea level rise impacts on the shoreline is limited to a simplistic application of the Bruun rule for sandy coasts as per SPP2.6. However, coastal rock has been considered in the 100yr planning allowances where it is likely to reduce the future extent of shoreline retreat.
5.Allowances for sedimentary rock coasts are based on geotechnical investigations by Golder (2017).
6.There is a high degree of uncertainty in the response of weakly lithified sedimentary rock to sea level rise during the 100 year planning period

Note:
Geotechnical investigations may reduce local planning allowances for coastal processes.

1
2
3
4
5

Cowaramup Bay Boat Ramp

April 2023

Cowaramup Bay Swimming Beach

Melaluca Beach

South Point

South Point Car Park

April 2023

April 2023



1 North Point



2 Rock at Boat Ramp



3 Rock East of Road



4 Rock Cliffs East of Swimming Beach



5 Rock Behind Melaluca

PRELIMINARY

A	16/10/23	PRELIMINARY	HD	SB
REVN	DATE	AMENDMENT	DRN	DESIGN APPROVAL

ORIG SIZE A3 | ARCHIVE \\bl10nnp\ecoastal.local\ShoreCoastal\2 Shore Coastal Projects\1411 AMRSC Coastal Hazards\2 References\Drawings\WIP\GIS | PROJECT No 2305

NOTES:
1.AERIAL IMAGE 2023.
2.ALLOWANCES ARE BASED ON AVAILABLE DATA AT THE TIME OF STUDY.

SCALE 1:5,000
50 0 50 100 150 200
DATUM
VERTICAL AUSTRALIAN HEIGHT DATUM (AHD)
HORIZONTAL MAP GRID OF AUSTRALIA, BASED ON GDA94

ACTION	NAME	SIGNATURE	DATE
ENGINEER	SB		10/10/23
DRAWN	HD		10/10/23
ENGINEERING CHECK			
DRAFTING CHECK			
APPROVED PROJECT MANAGER	SB		10/10/23

SHIRE OF AUGUSTA MARGARET RIVER
SHORE COASTAL

AUGUSTA MARGARET RIVER SHIRE
REVIEW OF CHRMAP
GRACETOWN
SPP2.6 PLANNING ALLOWANCES FOR COASTAL PROCESSES

DRAWING NUMBER SC2305-1-1 REVN A

PRELIMINARY

LEGEND

- Horizontal Setback Datum (HSD)
- Prevelly Planning Allowance for Coastal Processes (10yr)
- Prevelly Planning Allowance for Coastal Processes (20yr)
- Prevelly Planning Allowance for Coastal Processes (100yr)
- Geological Hazard Zones Landward Boundary (GOLDER 2017)
- Shire Assets (100yr)

LIMITATIONS:

1.Planning allowances for coastal processes are based on methods outlined in Schedule 1 of the WA state coastal planning policy (spp2.6).
2.Allowances are not a prediction of the shoreline position at the end of the respective planning periods.
3.These plans do not have the precision required to define the erosion risk to individual properties or landholdings.
4.The assessment of sea level rise impacts on the shoreline is limited to a simplistic application of the Bruun rule for sandy coasts as per SPP2.6. However, coastal rock has been considered in the 100yr planning allowances where it is likely to reduce the future extent of shoreline retreat.
5.Allowances for sedimentary rock coasts are based on geotechnical investigations by Golder (2017).
6.There is a high degree of uncertainty in the response of weakly lithified sedimentary rock to sea level rise during the 100 year planning period

Surfers Point
Rivermouth Road
Rivermouth Beach
Riflebutts Beach
Prevelly Beach
February 2023

A	14/10/23	PRELIMINARY	HD	SB
REVN	DATE	AMENDMENT	DRN	DESIGN APPROVAL

ORIG SIZE A3 | ARCHIVE ab:\\hhfecoastal.local/ShoreCoastal/2 Shore Coastal Projects/1411 AMRSC Coastal Hazards/2 References/Drawings/WIP/GIS | PROJECT No 2305

NOTES:
1.Aerial image 2023.
2.Allowances are based on available data at the time of study.

SCALE 1:5,000
50 0 50 100 150 200
DATUM
VERTICAL AUSTRALIAN HEIGHT DATUM (AHD)
HORIZONTAL MAP GRID OF AUSTRALIA, BASED ON GDA94

ACTION	NAME	SIGNATURE	DATE
ENGINEER	SB		10/10/23
DRAWN	HD		10/10/23
ENGINEERING CHECK			
DRAFTING CHECK			
APPROVED PROJECT MANAGER	SB		10/10/23

SHIRE OF AUGUSTA MARGARET RIVER
SHORE COASTAL

AUGUSTA MARGARET RIVER SHIRE
REVIEW OF CHRMAP
PREVELLY
SPP2.6 PLANNING ALLOWANCES FOR COASTAL PROCESSES

DRAWING NUMBER SC2305-1-2 REVN A

PRELIMINARY

LEGEND

- Horizontal Setback Datum (HSD)
- Gnarabup Planning Allowance for Coastal Processes (10yr)
- Gnarabup Planning Allowance for Coastal Processes (20yr)
- Gnarabup Planning Allowance for Coastal Processes (100yr)
- Geological Hazard Zones Landward Boundary (GOLDER 2017)
- Shire Assets (100yr)

LIMITATIONS:

1.Planning allowances for coastal processes are based on methods outlined in Schedule 1 of the WA state coastal planning policy (SPP2.6).
2.Allowances are not a prediction of the shoreline position at the end of the respective planning periods.
3.These plans do not have the precision required to define the erosion risk to individual properties or landholdings.
4.The assessment of sea level rise impacts on the shoreline is limited to a simplistic application of the Bruun rule for sandy coasts as per SPP2.6. However, coastal rock has been considered in the 100yr planning allowances where it is likely to reduce the future extent of shoreline retreat.
5.Allowances for sedimentary rock coasts are based on geotechnical investigations by Golder (2017).
6.There is a high degree of uncertainty in the response of weakly lithified sedimentary rock to sea level rise during the 100 year planning period

NOTE:
Geotechnical investigations may reduce local planning allowances for coastal processes.



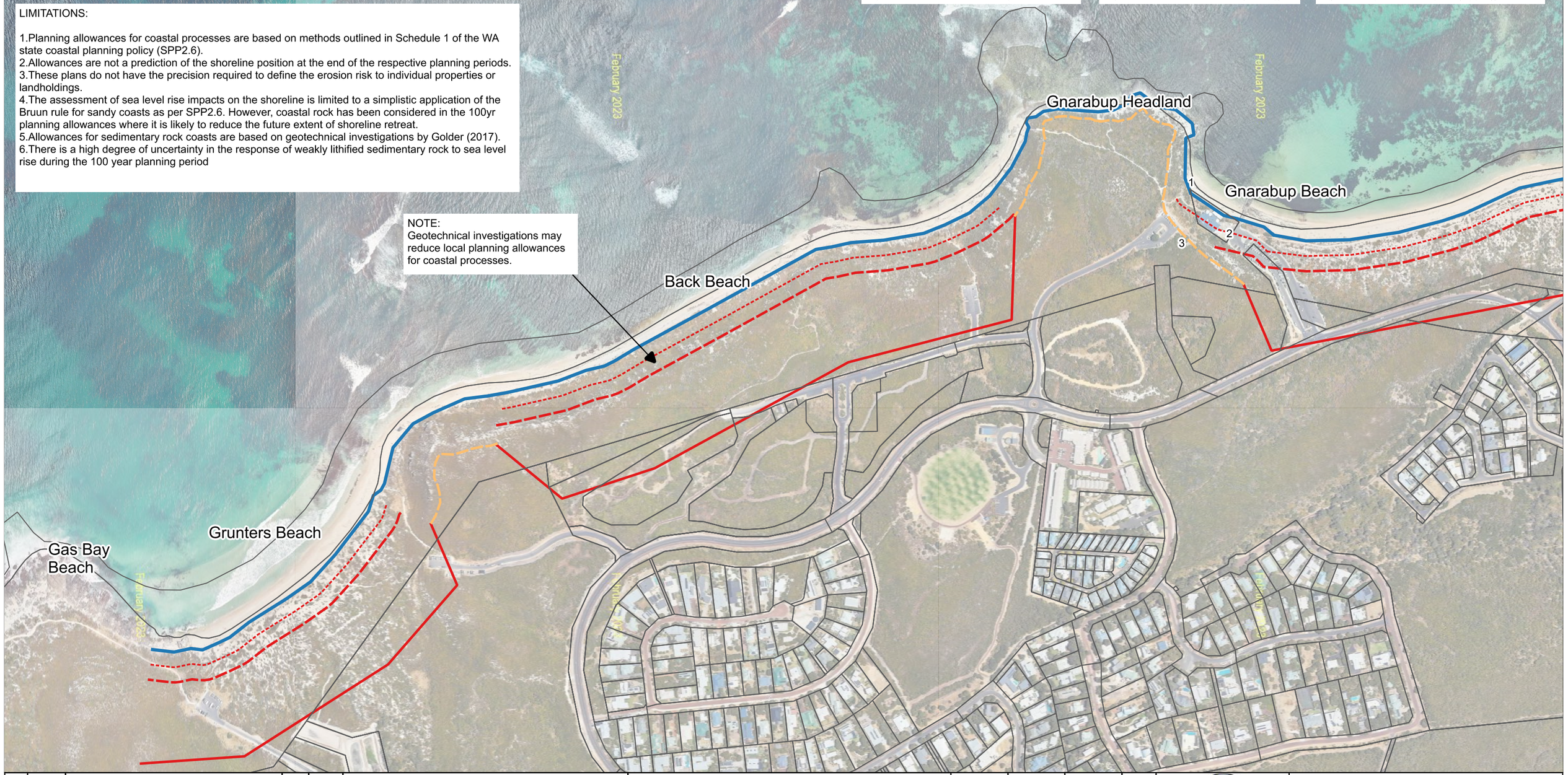
1 (Gnarabup Beach/Headland)



2 (Gnarabup Beach Carpark (Lower))



3 (Gnarabup Beach Carpark (Upper))



A	10/10/23	PRELIMINARY	HD	SB
REVN	DATE	AMENDMENT	DRN	DESIGN APPROVAL

ORIG SIZE A3 | ARCHIVE \\BUNKR\ecoastal.local\ShoreCoastal\2 Shore Coastal Projects\1411 AMRSC Coastal Hazards\2 References\Drawings\WIP\GIS | PROJECT No 2305

NOTES:
1.Aerial image 2023.
2.Allowances are based on available data at the time of study.

SCALE 1:5,000
50 0 50 100 150 200
DATUM
VERTICAL AUSTRALIAN HEIGHT DATUM (AHD)
HORIZONTAL MAP GRID OF AUSTRALIA, BASED ON GDA94

ACTION	NAME	SIGNATURE	DATE
ENGINEER	SB		10/10/23
DRAWN	HD		10/10/23
ENGINEERING CHECK			
DRAFTING CHECK			
APPROVED PROJECT MANAGER	SB		10/10/23

SHIRE OF AUGUSTA MARGARET RIVER

SHORE COASTAL

AUGUSTA MARGARET RIVER SHIRE
REVIEW OF CHRMAP
GNARABUP
SPP2.6 PLANNING ALLOWANCES FOR COASTAL PROCESSES

DRAWING NUMBER SC2305-1-3 REVN A

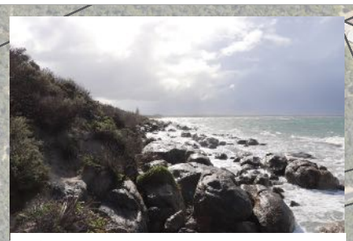
PRELIMINARY

LEGEND

- Horizontal Setback Datum (HSD)
- Augusta Planning Allowance for Coastal Processes (10yr)
- Augusta Planning Allowance for Coastal Processes (20yr)
- Augusta Planning Allowance for Coastal Processes (100yr)
- Geological Hazard Zones Landward Boundary (GOLDER 2017)
- Shire Assets (100yr)

LIMITATIONS:

1. Planning allowances for coastal processes are based on methods outlined in Schedule 1 of the WA State Coastal Planning Policy (SPP2.6).
2. Allowances are NOT A PREDICTION of the shoreline position at the end of the respective planning periods.
3. These plans do not have the precision required to define the erosion risk to individual properties or landholdings.
4. The assessment of sea level rise impacts on the shoreline is limited to a simplistic application of the Bruun rule for sandy coasts as per SPP2.6. However, coastal rock has been considered in the 100yr planning allowances where it is likely to reduce the future extent of shoreline retreat.
5. Allowances for sedimentary rock coasts are based on geotechnical investigations by Golder (2017).
6. There is a high degree of uncertainty in the response of weakly lithified sedimentary rock to sea level rise during the 100 year planning period



1 Rock along Albany Terrace

Flinders Bay Caravan Park

Flinders Bay

Albany Terrace - Sandy Coast

Albany Terrace - Rocky Coast

Albany Terrace - Blackwood River Cut

Turner Street Caravan Park

Colour Patch

The Blackwood River entrance channel is highly dynamic. The coast can demonstrate high levels of shoreline change over short periods of time.

February 2023

REVN	DATE	AMENDMENT	DRN	DESIGN APPROVAL
B	30/10/23	REVISED ISSUE	HD	SB
A	14/10/23	PRELIMINARY	HD	SB

ORIG SIZE A3 | ARCHIVE \\SD1\Shorecoastal.local\ShoreCoastal\2 Shore Coastal Projects\1411 AMRSC Coastal Hazards\2 References\Drawings\WIP\GIS | PROJECT No 2305

NOTES:

1.Aerial image 2023.
2.Allowances are based on available data at the time of study.

SCALE 1:7,500

75 0 75 150 225 300

DATUM

VERTICAL AUSTRALIAN HEIGHT DATUM (AHD)

HORIZONTAL MAP GRID OF AUSTRALIA, BASED ON GDA94

ACTION	NAME	SIGNATURE	DATE
ENGINEER	SB		30/10/23
DRAWN	HD		30/10/23
ENGINEERING CHECK			
DRAFTING CHECK			
APPROVED PROJECT MANAGER	HD		12/10/23

SHIRE OF AUGUSTA MARGARET RIVER

SHORE COASTAL

AUGUSTA MARGARET RIVER SHIRE
COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN
AUGUSTA SOUTH
AREAS EXPOSED TO COASTAL PROCESSES

DRAWING NUMBER SC2305-1-4 REVN B

LEGEND

Allowance for Coastal Inundation

PRELIMINARY







A	30/10/23	PRELIMINARY	HD	SB
REVN	DATE	AMENDMENT	DRN	DESIGN APPROVAL

ORIG SIZE A3 | ARCHIVE \\Bunbury\ecoastal.local\ShoreCoastal\2 Shore Coastal Projects\1411 AMRSC Coastal Hazards\2 References\Drawings\WIP\GIS | PROJECT No 2305

NOTES:

1. AERIAL IMAGE 2023.
2. ALLOWANCES ARE BASED ON AVAILABLE DATA AT THE TIME OF STUDY.

SCALE VARIABLE: REFER SCALE BAR

DATUM

VERTICAL AUSTRALIAN HEIGHT DATUM (AHD)

HORIZONTAL MAP GRID OF AUSTRALIA, BASED ON GDA94

ACTION	NAME	SIGNATURE	DATE
ENGINEER	SB		10/10/23
DRAWN	HD		10/10/23
ENGINEERING CHECK			
DRAFTING CHECK			
APPROVED PROJECT MANAGER	SB		10/10/23

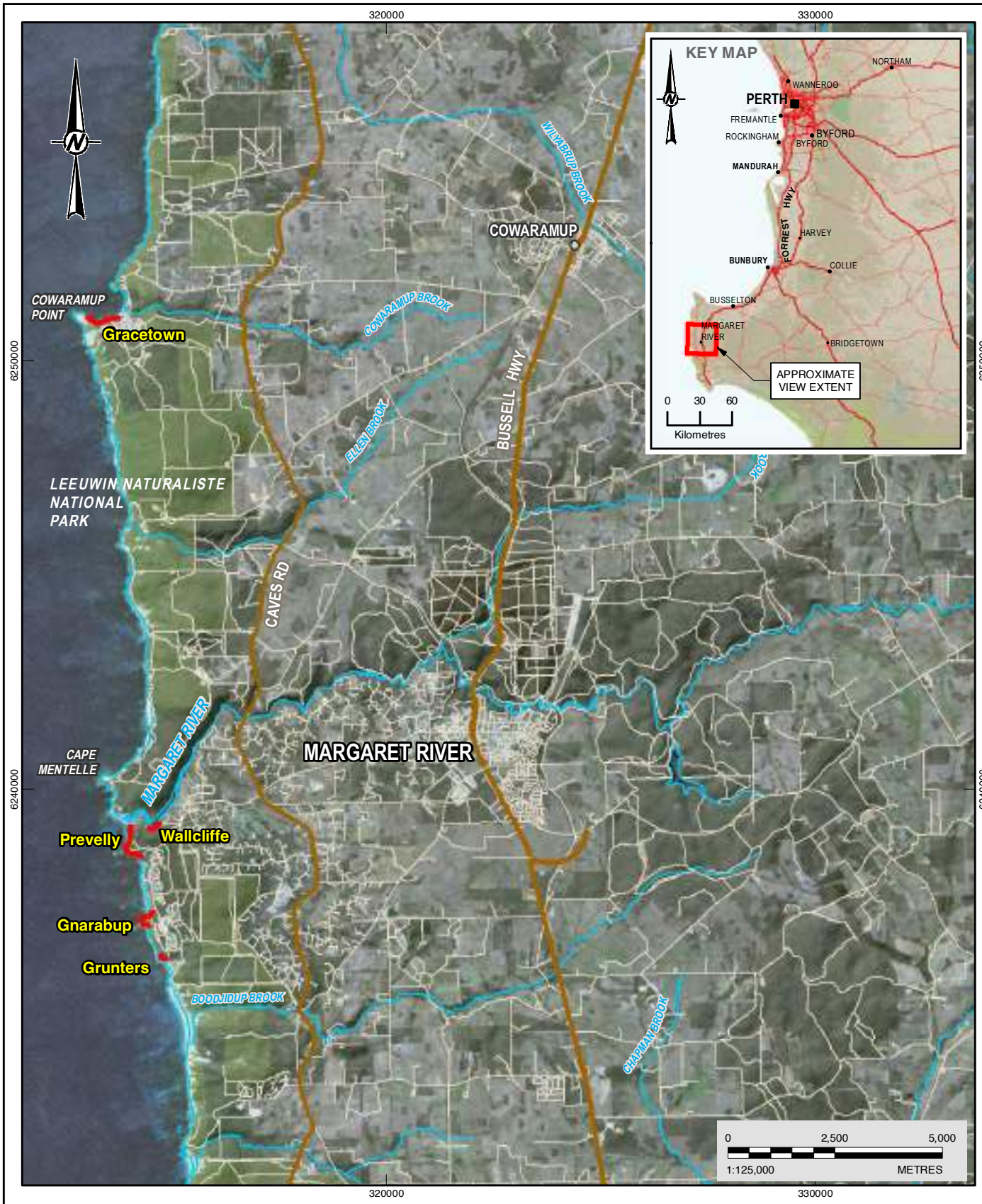
SHIRE OF AUGUSTA MARGARET RIVER

SHORE COASTAL

AUGUSTA MARGARET RIVER SHIRE
REVIEW OF CHRMAP
GRACETOWN TO AUGUSTA
SPP2.6 PLANNING ALLOWANCES FOR COASTAL INUNDATION

DRAWING NUMBER SC2305-2-1 REVN A

Appendix C Golder 2017 Limestone Cliff Analysis - Mapping



LEGEND

- STUDY AREA
- FREEWAY; NATIONAL HIGHWAY
- MAIN ROAD
- MINOR ROAD
- ACCESS ROAD / TRACK

REFERENCE

ROADS © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2011)
INSET BASE DATA, DRAINAGE AND RAIL SOURCED FROM STREET PRO DATA 2009.
BASE IMAGE AND TOPOGRAPHY SOURCED FROM GEOSCIENCE AUSTRALIA.

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SR
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

TITLE
SITE LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A4

Path: B:\Shire_of_Augusta\Margaret_River\99_PROJECTS\1666765-Limestone_Cliff_Stability\02_PRODUCTION\MXD\001-RPRev0\1666765-001-R-F001-Rev0.mxd

313000
313100
313200
6251000
6250900
6250800

M 14

V CROWN LAND

P049922 303

R 8428

GC1-25
GC1-50
GC1
GCA_1
DPAW SOUTH POINT
STAIRS AND WALKWAY
GC2-25
GC2
GC2-85
GC2-100
GC2
GC3-50
GC3

KEY MAP



LEGEND

SHIRE ASSET RISK
- MEDIUM

GEOMORPHOLOGICAL ZONES
- 1B
- 2B

HAZARD ZONES
- SHIRE ASSETS
- RECREATIONAL USERS

SLOPE COLLAPSE HAZARD
- MEDIUM
- LOW

CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50
1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
GRACETOWN GEOMORPHOLOGY AND RISK MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	**2A**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25mm
0

Path: B:\Shire_of_Augusta\Margaret_River\99_PROJECTS\1666765\Limestone_Cliff_Stability\02_PRODUCTION\MXD\001-R\Rev0\1666765-001-R-Rev0.mxd

313300 313400 313500

6251000 6250900 6250800

M 14

V CROWN LAND

P049922 303

R 8428

P240093 85

R 27618

GC6 GC6-60 GC6-15 GC5 GC5-75 GC4 GC4-60 GC3 GC3-50

GCA_5 SOUTH POINT STAIRS

GCA_6 SOUTH POINT CAR PARK

GCA_4 VOLUNTEERS REST AND ACCESS PATH TO SOUTH POINT CAR PARK

GCA_3 ACCESS ROAD TO SOUTH POINT

GCA_2 HUZZA CLIFFS MEMORIAL

153 154 155 156 315

KEY MAP



LEGEND

- LOCATION OF EXISTING SIGN

SHIRE ASSET RISK

- MEDIUM
- LOW

GEOMORPHOLOGICAL ZONES

- 1B
- 2B
- 2C

HAZARD ZONES

- SHIRE ASSETS
- RECREATIONAL USERS

SLOPE COLLAPSE HAZARD

- HIGH
- MEDIUM
- LOW
- CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50
1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
GRACETOWN GEOMORPHOLOGY AND RISK MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	**2B**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

0

Path: B:\Shire_of_Augusta\Margaret_River\99_PROJECTS\1666765\4_mxd\mxd\Cliff_Stability\02_PRODUCTION\MXD\001-RRev3-1666765-001-R-Rev0.mxd

313500 313600 313700

6251000

6250900

6250800

M 14

V CROWN LAND

125

127

123

GC6

GC7

GC6-100

GC6-60

GC7

GCA_7
STAIRS TO
PICNIC AREA

P240093 85

PERCY ST

P208804 7

P208804 6

P208804 9

P208804 5

P208804 4

P208804 2

P208804 3

P208804 11

P208804 12

P208804 1

P208804 13

S003630

P208804 15

SALTER ST

BAYVIEW DR

R 27618

P208804 21

P208804 20

P208804 19

P208804 18

P208804 25

P208804 26

P208804 27

P208804 28

P091417 175 R 37456

KEY MAP



LEGEND

S LOCATION OF EXISTING SIGN

SHIRE ASSET RISK

LOW

GEOMORPHOLOGICAL ZONES

1B

2C

HAZARD ZONES

SHIRE ASSETS

RECREATIONAL USERS

SLOPE COLLAPSE HAZARD

HIGH

LOW

CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50

1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
GRACETOWN GEOMORPHOLOGY AND RISK MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	**2C**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25mm

0

Path: B:\Shire_of_Augusta\Margaret_River\99_PROJECTS\1666765-Limestone_Cliff_Stability\02_PRODUCTION\MXD\001-R\Rev0\1666765-001-R-Fig02_6-Rev0.mxd

313900
314000
314100
6239100
6239000
6238900

PR1
PRA_1
RIVERMOUTH
ROAD NTH END

ROCK OUTCROP

RIVERMOUTH RD

R 41545

P091785 4862

PRA_2
RIVERMOUTH ROAD
STAIRS AND BBQ AREA

M 14

PR1

PRA_3
RIVERMOUTH ROAD

PR2

V CROWN LAND

ROCK OUTCROP

KEY MAP



LEGEND

SHIRE ASSET RISK

- LOW

GEOMORPHOLOGICAL ZONES

- 2B
- 2C

HAZARD ZONES

- SHIRE ASSETS
- RECREATIONAL USERS
- GRANITIC ROCK OUTCROP
- CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50
1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
PREVELLY GEOMORPHOLOGY AND RISK MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	**3A**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25mm
0

Path: B:\Shire_of_Augusta\Margaret_River\99_PROJECTS\1666765\4.0 mainstore_Cliff Stability\02_PRODUCTION\MXD\001-R\Rev0\1666765-001-R-Rev0.mxd

313900
314000
314100
6238800
6238700

ROCK OUTCROP
PR2
PRA_4
STAIRS AND
LANDSCAPED AREA
RIVERMOUTH RD
PR2
PRA_5
CAR PARK
M 14
PR3
PRA_6
FOOTPATH
AND LANDSCAPED AREA
R 41545
P091765 4862
PR3-165
V CROWN LAND
PR4
PRA_7
SHADE STRUCTURE
AND FOOTPATH
PRA_8
STAIRS,
BENCH, WALKWAY

KEY MAP



LEGEND

LOCATION OF EXISTING SIGN

SHIRE ASSET RISK

MEDIUM

LOW

GEOMORPHOLOGICAL ZONES

1C

2A

2B

HAZARD ZONES

SHIRE ASSETS

RECREATIONAL USERS

SLOPE COLLAPSE HAZARD

HIGH

GRANITIC ROCK OUTCROP

CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50
1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
PREVELLY GEOMORPHOLOGY AND RISK MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	**3B**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25mm
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313900
314000
314100
6238600
6238500
6238400

PR4
PRA_8
STAIRS, BENCH,
WALKWAY
348
PR4-30
PR4-40
345
343
342
PR4
PRA_9
STAIRS,
WALKWAY
SURFERS POINT RD
PR4-100
341
PR5
P091785 4862
340
PR5-50
R 41545
PR5
PR6
PR5-150
V CROWN LAND
M 14

KEY MAP
3B
RIVERMOUTH RD
SURFERS POINT RD
3D
0 125 250
Metres

LEGEND

S LOCATION OF EXISTING SIGN

SHIRE ASSET RISK

MEDIUM

GEOMORPHOLOGICAL ZONES

1A
1B
1C

HAZARD ZONES

SHIRE ASSETS
RECREATIONAL USERS

SLOPE COLLAPSE HAZARD

HIGH
LOW

CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50
1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
PREVELLY GEOMORPHOLOGY AND RISK MAP

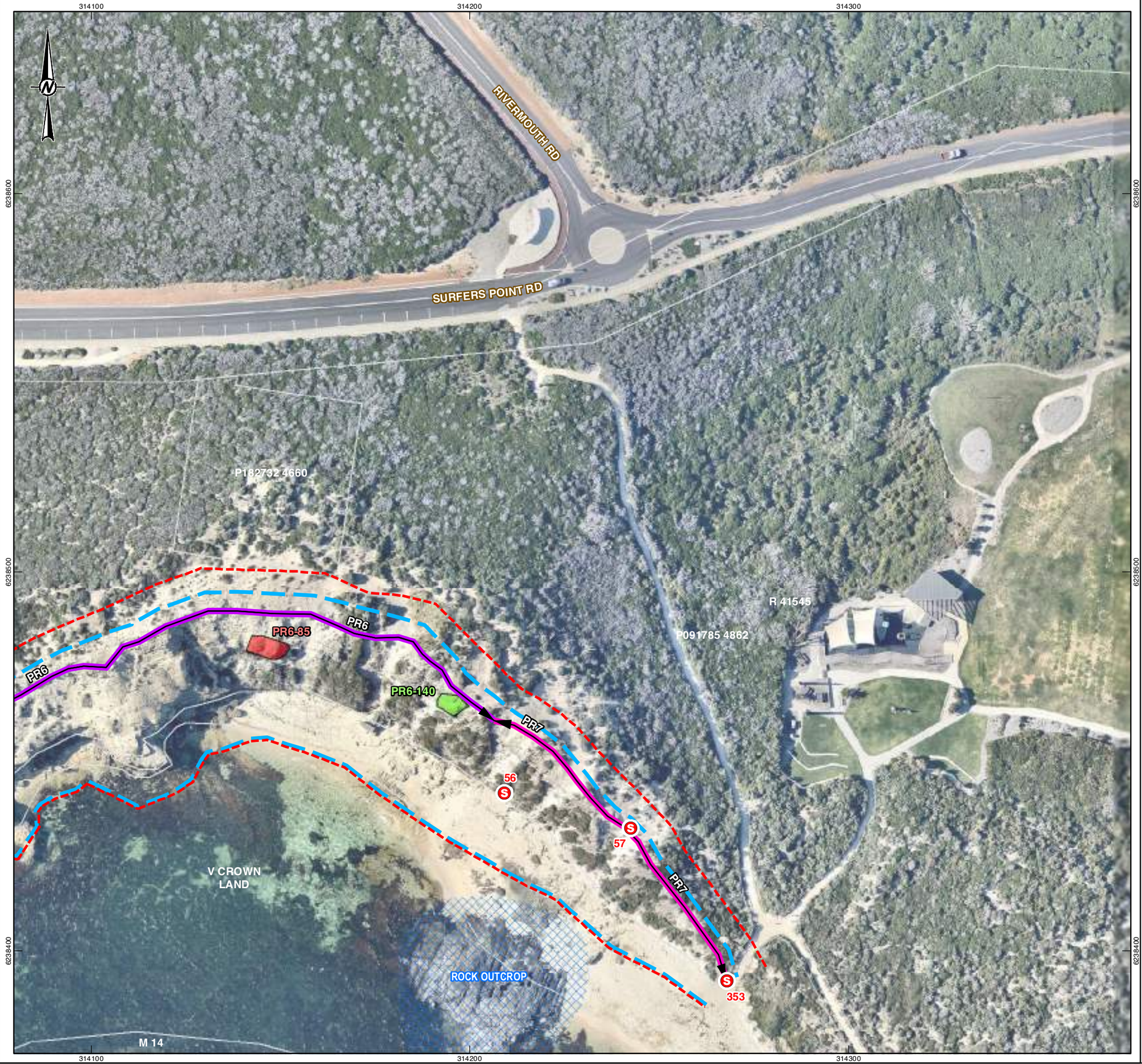
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	3C

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25mm
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LEGEND

- LOCATION OF EXISTING SIGN

GEOMORPHOLOGICAL ZONES

- 1A
- 1B

HAZARD ZONES

- SHIRE ASSETS
- RECREATIONAL USERS

SLOPE COLLAPSE HAZARD

- HIGH
- LOW
- GRANITIC ROCK OUTCROP
- CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50
1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
PREVELLY GEOMORPHOLOGY AND RISK MAP

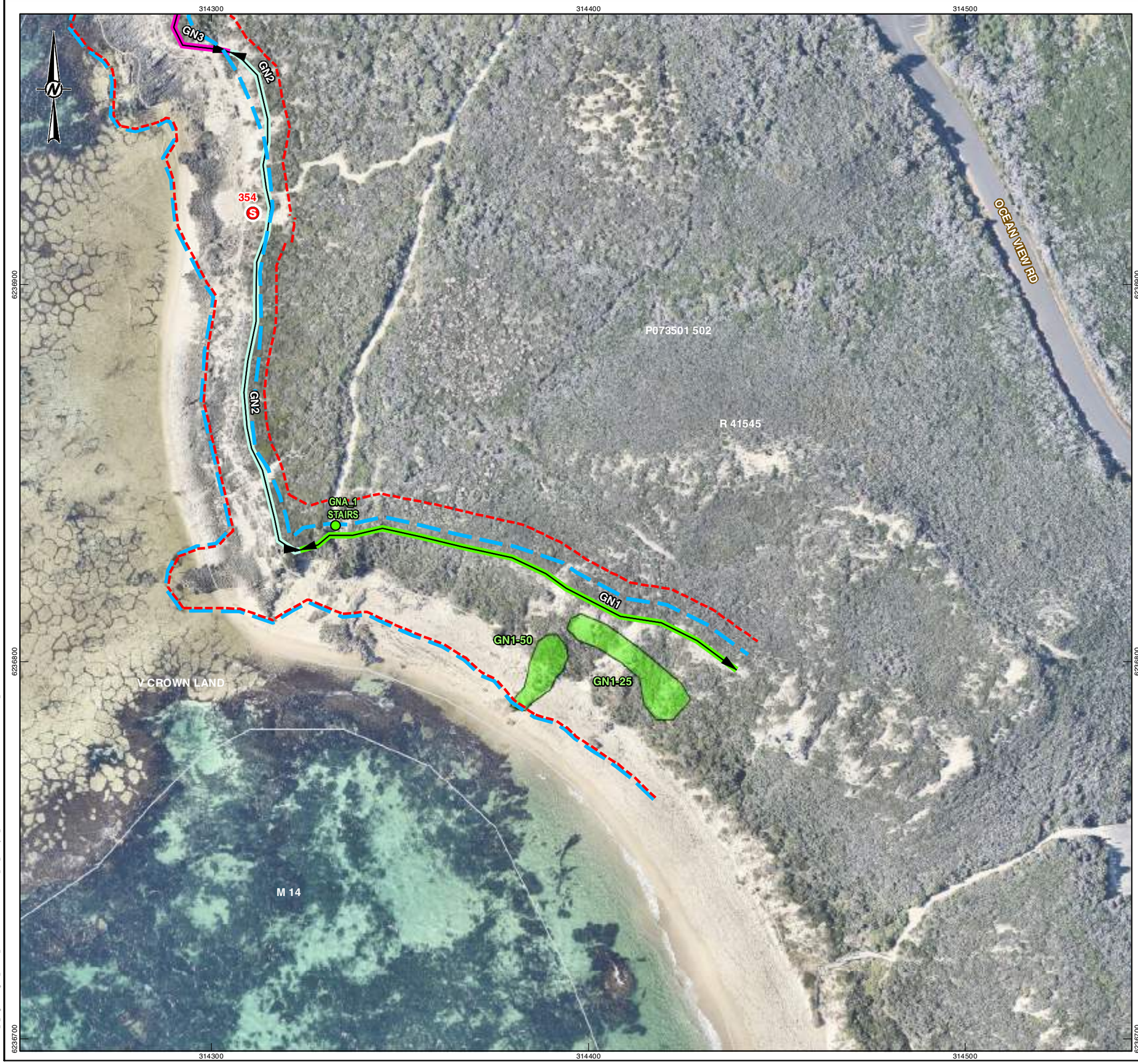
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	**3D**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25mm
0

Path: B:\Shire_of_Augusta\Margaret_River\99_PROJECTS\1666765\4_Investigation_Cliff_Stability\02_PRODUCTION\MXD\001-RRev0\1666765-001-R-Rev0_6-Rev0.mxd





LEGEND

S LOCATION OF EXISTING SIGN

SHIRE ASSET RISK

LOW

GEOMORPHOLOGICAL ZONES

1B

2A

2C

HAZARD ZONES

SHIRE ASSETS

RECREATIONAL USERS

SLOPE COLLAPSE HAZARD

LOW

CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50

1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
GNARABUP GEOMORPHOLOGY AND RISK MAP

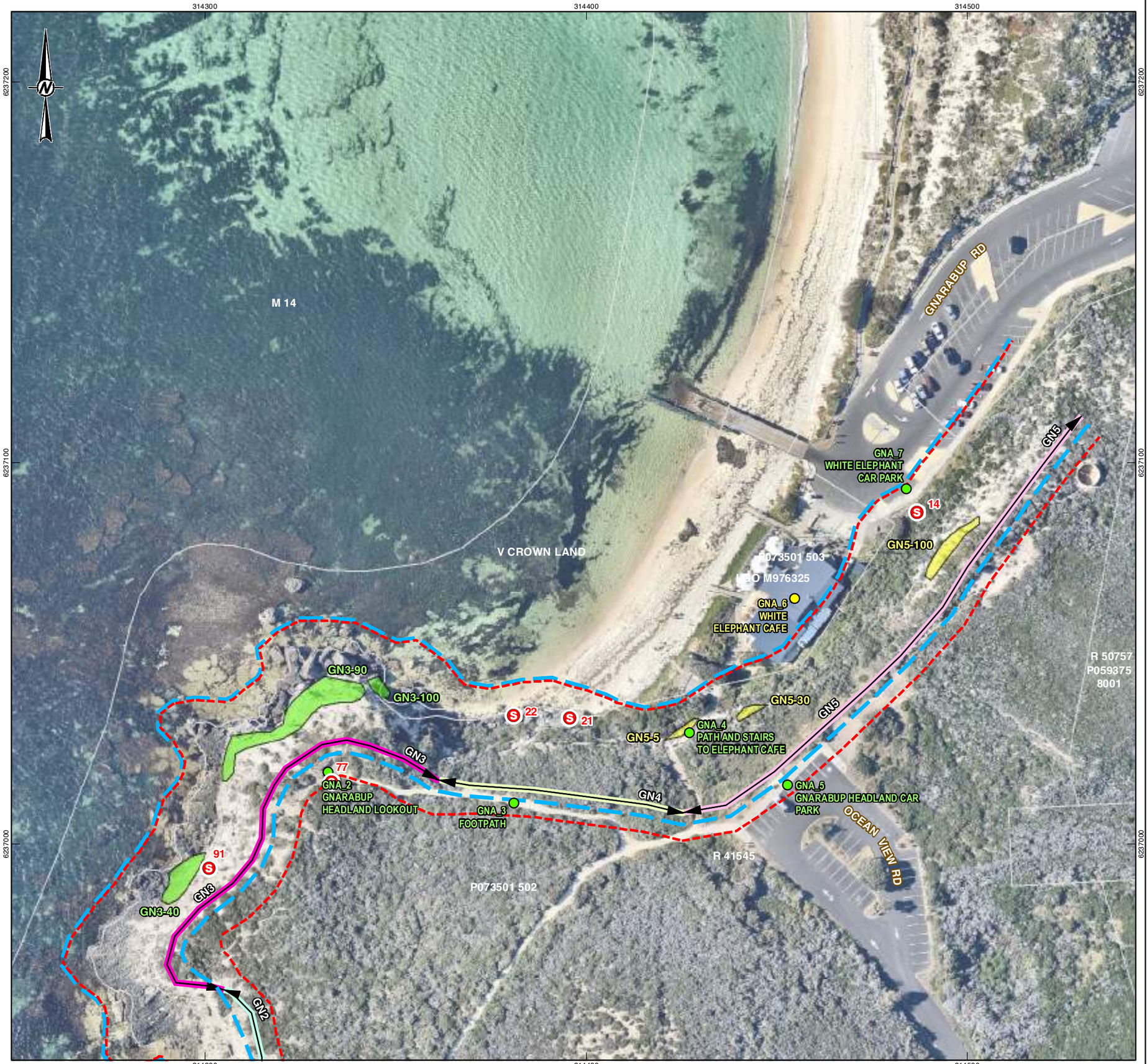
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	**4A**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25mm
0

Path: B:\Shire_of_Augusta\Margaret_River\99_PROJECTS\1666765\4_Investigate_Cliff_Stability\02_PRODUCTION\MXD\001-RRev0\1666765-001-R-Rev0_6-Rev0.mxd





LEGEND

- LOCATION OF EXISTING SIGN

SHIRE ASSET RISK

- MEDIUM
- LOW

GEOMORPHOLOGICAL ZONES

- 1B
- 1C
- 2B
- 2C

HAZARD ZONES

- SHIRE ASSETS
- RECREATIONAL USERS

SLOPE COLLAPSE HAZARD

- MEDIUM
- LOW
- CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50
1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
GNARABUP GEOMORPHOLOGY AND RISK MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
1666765	001 R	0	**4B**

Path: B:\Shire_of_Augusta\Margaret_River\99_PROJECTS\1666765\4.Limestone_Cliff_Stability\02_PRODUCTION\MXD\001-RR\rev0\1666765-001-R-Rev0.mxd
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25mm
0





LEGEND

- LOCATION OF EXISTING SIGN

GEOMORPHOLOGICAL ZONES

- 1B
- 1C

HAZARD ZONES

- SHIRE ASSETS
- RECREATIONAL USERS

SLOPE COLLAPSE HAZARD

- HIGH
- LOW
- CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50
1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
GRUNTERS GEOMORPHOLOGY AND RISK MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

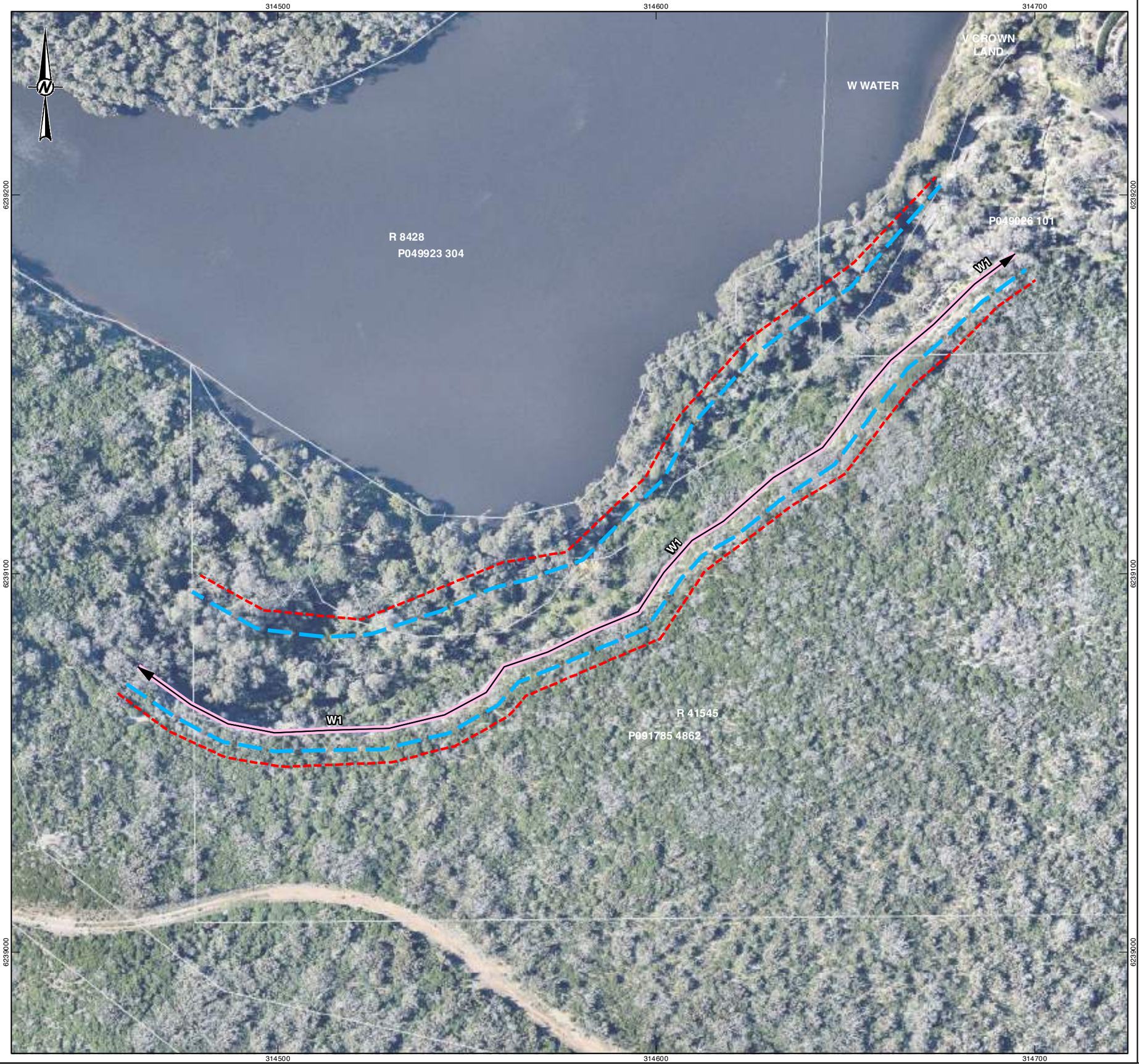
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LEGEND

GEOMORPHOLOGICAL ZONES

1C

HAZARD ZONES

SHIRE ASSETS

RECREATIONAL USERS

CADASTRE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE

AERIAL IMAGE SOURCED FROM NEARMAP (NOV.2016)

ROADS AND CADASTRE © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2016)

0 25 50

1:1,000 METRES

CLIENT
SHIRE OF AUGUSTA AND MARGARET RIVER

PROJECT
CLIFF STABILITY ASSESSMENT

TITLE
WALLCLIFFE GEOMORPHOLOGY

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-05-12
DESIGNED	SWG
PREPARED	SR
REVIEWED	MAT
APPROVED	MAT

PROJECT NO.	CONTROL	REV.	FIGURE
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Appendix D GBGMAPS 2022 – Geotechnical and Geophysical Investigations - Mapping

APPENDIX C.
MODELLED TOP OF ROCK

GBGMAPS
Advanced Subsurface Investigations

COASTAL GEOPHYSICAL SUBSURFACE INVESTIGATION - AUGUSTA (SOUTH) WESTERN AUSTRALIA

MODELLED LEVEL TO TOP OF ROCK (SHEET 1)



NOTES

Drawing to be used in conjunction with Report 70676.
Map Projection GDA2020, MGA Zone 50
Aerial image from MetroMap 22 January 2021.

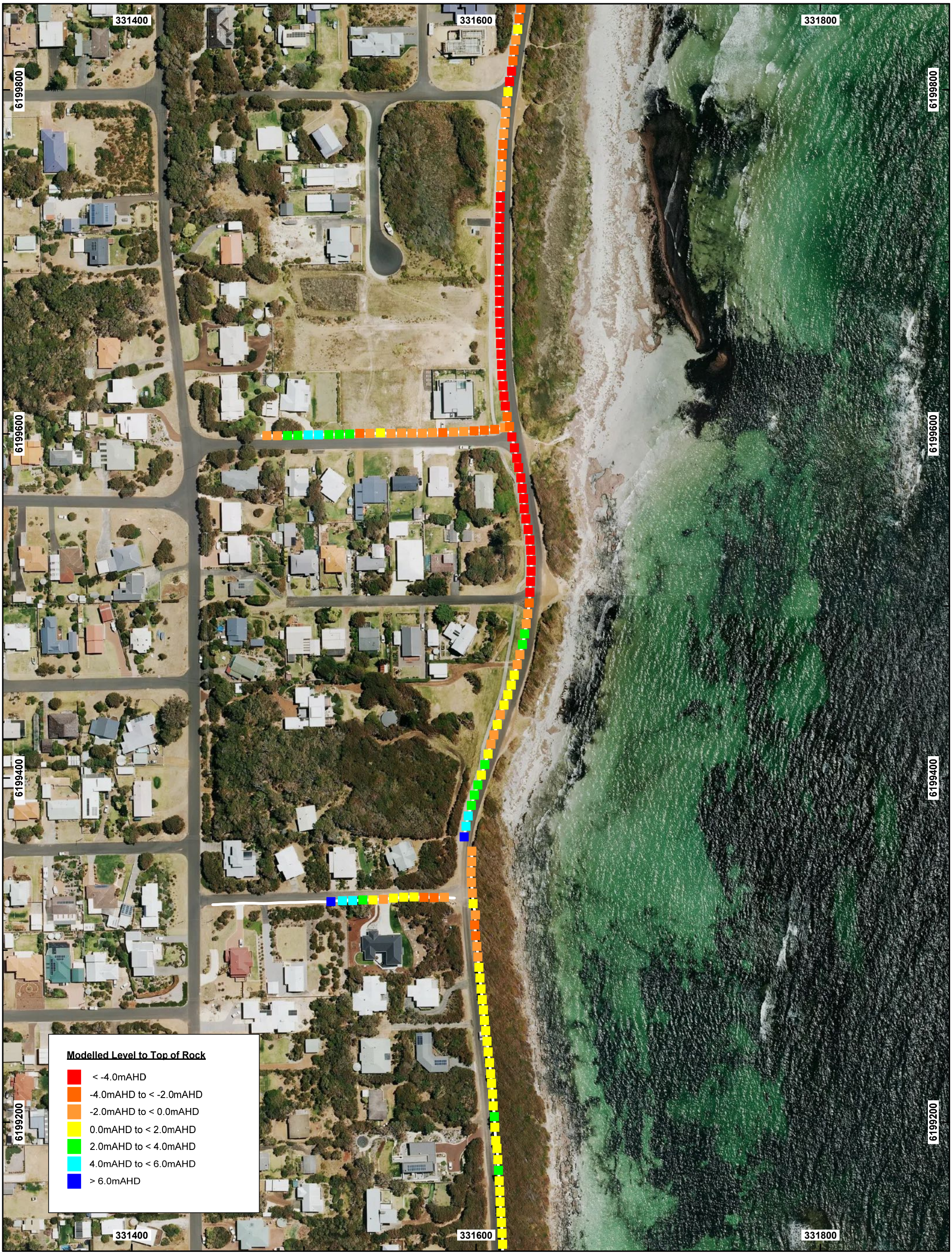
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		Drawing	70676-17	Revision 0

GBGMAPS
Advanced Subsurface Investigations
Level 1, 2 Sabre Crescent,
Jandakot WA 6164
Telephone: (08) 6436 1599
Email: info@gbgmaps.com.au

GBGMAPS
Advanced Subsurface Investigations

COASTAL GEOPHYSICAL SUBSURFACE INVESTIGATION - AUGUSTA (SOUTH) WESTERN AUSTRALIA

MODELLED LEVEL TO TOP OF ROCK (SHEET 2)



NOTES

Drawing to be used in conjunction with Report 70676.
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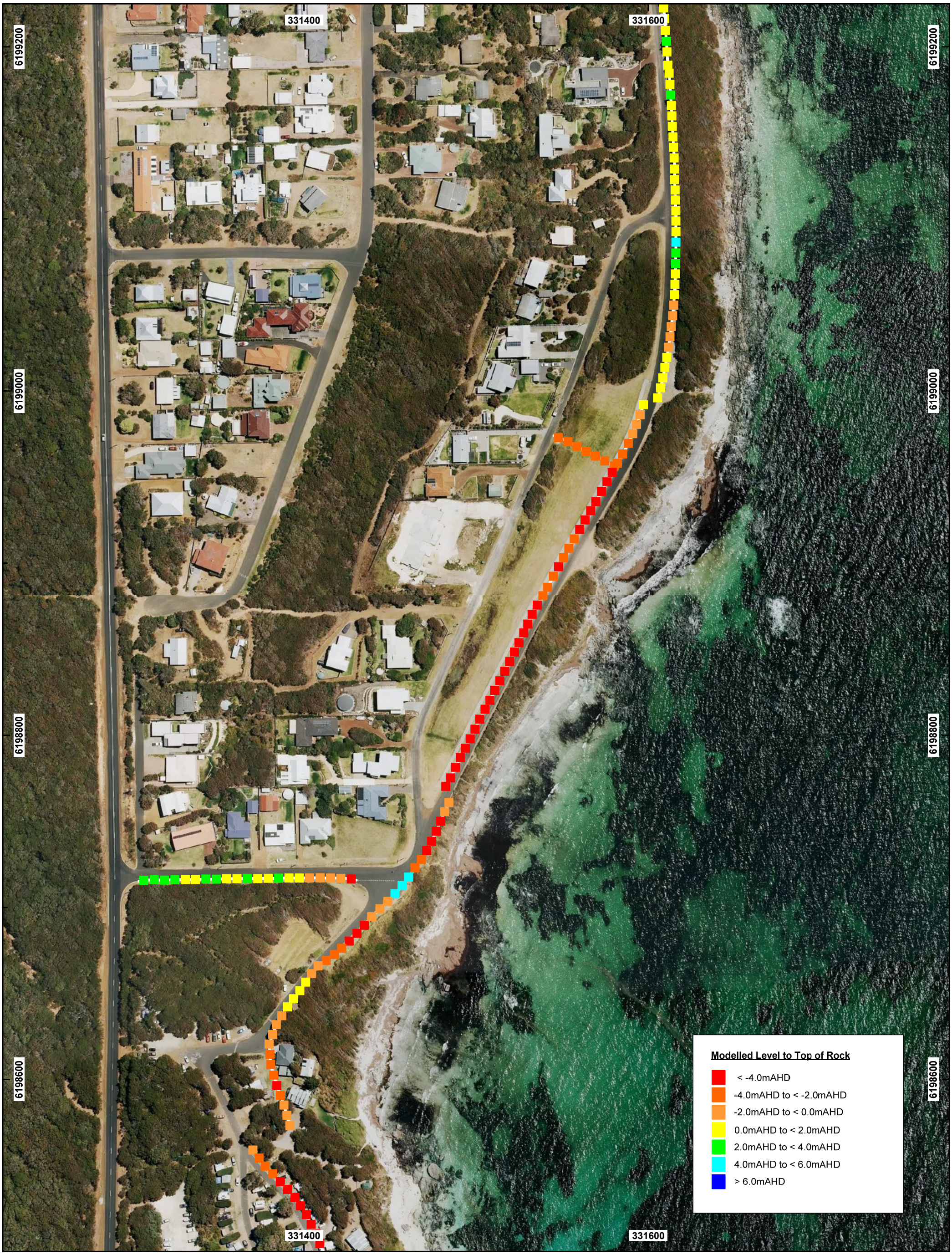
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Advanced Subsurface Investigations

COASTAL GEOPHYSICAL SUBSURFACE INVESTIGATION - AUGUSTA (SOUTH) WESTERN AUSTRALIA

MODELLED LEVEL TO TOP OF ROCK (SHEET 3)



NOTES

Drawing to be used in conjunction with Report 70676.
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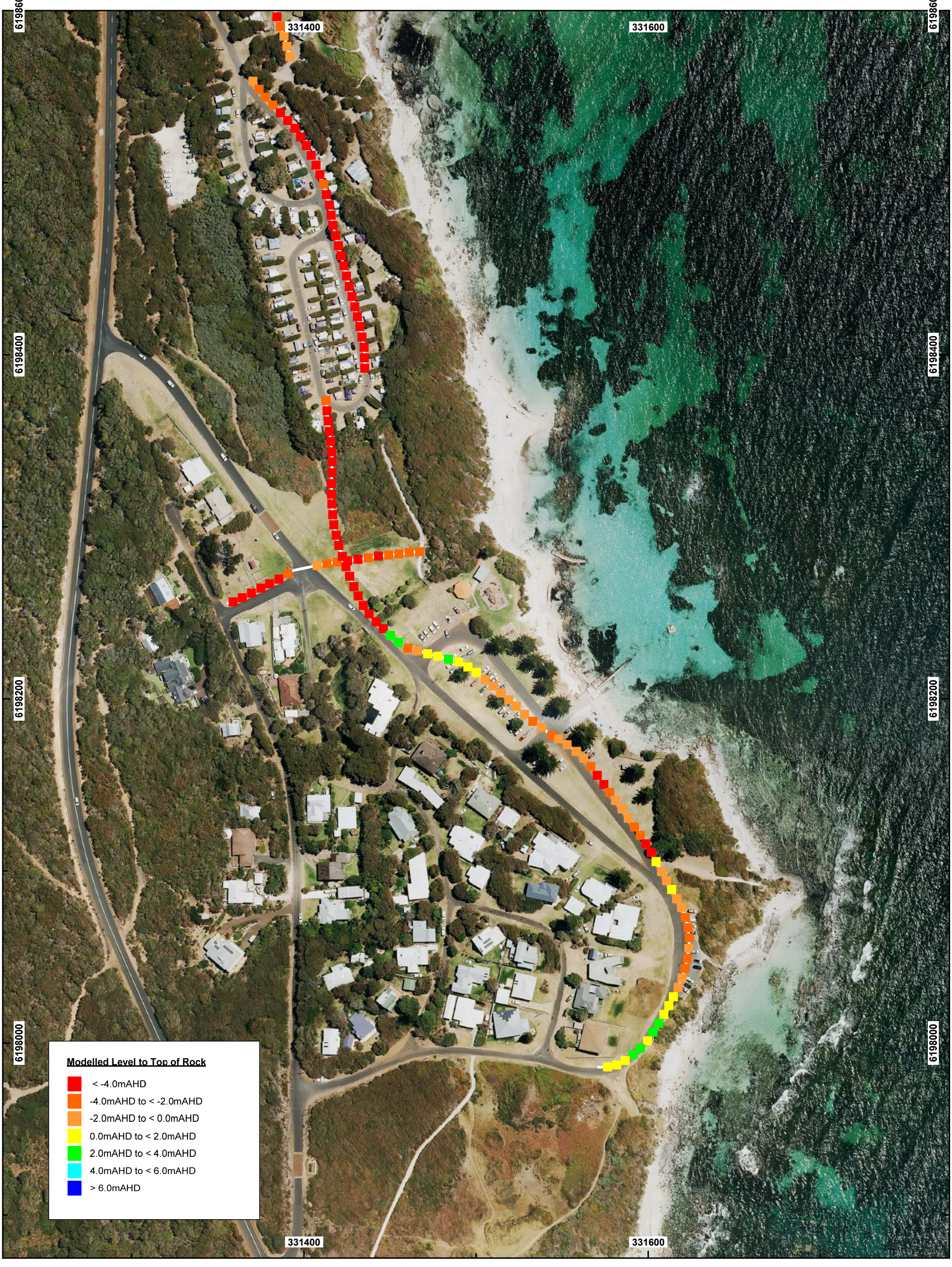
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		Drawing	70676-19	Revision	0

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Advanced Subsurface Investigations

COASTAL GEOPHYSICAL SUBSURFACE INVESTIGATION - AUGUSTA (SOUTH) WESTERN AUSTRALIA

MODELLED LEVEL TO TOP OF ROCK (SHEET 4)



NOTES

Drawing to be used in conjunction with Report 70676.
Map Projection GDA2020, MGA Zone 50
Aerial image from MetroMap 22 January 2021.

Shire of Augusta Margaret River		Date	30 March 2022	Paper Size A3
COASTAL GEOPHYSICAL SUBSUFACE INVESTIGATION AUGUSTA (SOUTH) WESTERN AUSTRALIA		Scale	1:2,000	Drawn AHWS
		Drawing	70676-20	Revision 0

GBGMAPS
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Appendix B
Adaptation Toolkit

APPENDIX B - Adaptation toolkit

CATEGORY	DESCRIPTION	POSSIBLE ACTIONS	COMMENT / SUITABILITY
AVOID	**CODE: AV | NAME: AVOID DEVELOPMENT**		
	Avoiding new development within areas potentially impacted by coastal hazards (low, medium and high) and locating assets in areas that will not be vulnerable to coastal hazards.	1. Amend local planning scheme to include Special Control Area (SCA) which encompasses all areas affected by planning 10-, 20- and 100-year planning allowances (refer hazard assessment. 2. Establish planning-based controls that only allow development in the SCA that can address coastal hazard. 3. Reserve land in the Local Planning Scheme as required. 4. The Shire's Asset Management program to consider location for future public assets.	Financial resources will not be required to be spent on risk management. There are limited options to 'avoid' development within the CHRMAP study area where existing infrastructure is located, however can be implemented in undeveloped areas.
PLANNED OR MANAGED RETREAT	**CODE: MR1 | NAME: LEAVE ASSETS UNPROTECTED**		
	Accept functional loss of an asset following a coastal hazard event. Assets are not repaired to usable condition (only to ensure public safety is maintained).	5. Determine assets that are deemed sacrificial. 6. Monitoring (NR1) to identify when trigger is reached. 7. The Shire's Asset Management program to consider location for future public assets and update Council's Asset register to reflect likely timeframe for impact to assist in prioritising asset relocation.	Saves financial resources for alternative uses and allows for retreat that enables natural recession of the shoreline over the long-term.
	CODE: MR2 | NAME: REMOVE / RELOCATE		
	Assets located in the hazard zone are permanently removed or relocated.	8. Determine assets that are deemed sacrificial or relocatable, and update Council's Asset register to reflect likely timeframe for impact to assist in prioritising asset relocation. 9. Monitoring (see NR1) to identify when trigger is reached for removal or relocation.	For residential and commercial property, this option may require voluntary or compulsory acquisition of land, transferrable development rights and land swaps. Enables the social and economic values of assets to be utilised until such time that the asset needs to be relocated. Can often coincide with asset replacement and allows the cost of relocation to be shared with the cost of asset replacement.
	CODE: MR3 | NAME: PLANNING CONTROLS FOR MANAGED RETREAT /PROHIBIT EXPANDING EXISTING USE RIGHTS		
	Use planning controls to allow continued use of the current infrastructure until such time that impacts arise, but restrict further or new development	10. Amend local planning scheme to include Special Control Area. 11. Notifications on title regarding the limits on expanding and/or modification of existing use rights.	This enables existing development and use rights to continue without increasing them, until such time that risk arising from coastal hazards is intolerable. Includes mechanisms for ensuring that the Shire, landowners and prospective buyers are made aware of the risk. Generally applicable where protection of assets is not viable. Works generally on zoned land (not local scheme reserves).
	CODE: MR4 | NAME: VOLUNTARY ACQUISITION		
	Acquisition of affected properties on a voluntary basis.	12. Investigate/put in place funding for acquisition of priority properties. 13. Offer voluntary acquisitions reflecting asset value in light of hazard. 14. Reservation of land in a Local Planning Scheme.	This enables removal of private property(s) located within a land use that would otherwise be permitted, to ensure land in the coastal zone is continuously provided for coastal foreshore management, public access, recreation and conservation, and where alternative risk treatment options are not viable for the property and adjacent land. Early acquisition and leaseback could be used as an alternative to help reduce overall costs. Reservation of land in a local planning scheme signals the intent of the local government to acquire the land, and also activates provisions in the Planning and Development Act 2005 regarding acquisition, resumption and compensation.

CATEGORY	DESCRIPTION	POSSIBLE ACTIONS	COMMENT / SUITABILITY
ACCOMMODATE	**CODE: AC1 | NAME: DESIGN ASSETS TO WITHSTAND IMPACTS**		
	Design of assets to withstand the impact of inundation, for example, building houses on stilts or raising building pads above the expected inundation levels	15. Planning response to stipulate building requirements. 16. Appropriate design requirements to be incorporated into the Shire's Asset Management Plan for public assets.	This is aimed at retaining existing assets in their current locations but reducing the consequences of the inundation hazard. It is often cheaper to mitigate the impacts with initial design outcomes as opposed to retrofitting (adapting) existing assets in the future.
	CODE: AC2 | NAME: PLANNING CONTROLS FOR ACCOMMODATION		
	Amend local planning frameworks to require assets to be designed to be able to accommodate hazards.	17. Amend local planning scheme to include a Special Control Area that identifies affected areas, requires any development to be approved by the Local Government, and outlines what requirements for accommodating the potential inundation risk need to be addressed. 18. Prepare local planning policy outlining relevant planning controls. This will generally be read in conjunction with the SCA. 19. Notifications on title when a development application is lodged/approved to advise of the potential risk.	Indicates to current and future landholders that an asset is at risk from coastal hazards over the planning timeframe. and that risk management and adaptation is likely to be required at some stage. Helps owners to make informed decisions about the level of risk they are willing to accept. This is a low-cost option that does not prohibit the use of other management options in the future. Limited application – would only apply where a Development Application is lodged with Council.

CATEGORY	DESCRIPTION	POSSIBLE ACTIONS	COMMENT / SUITABILITY
PROTECT	**CODE: PR1 | NAME: DUNE CARE/ MANAGEMENT**		
	Development of a long-term program for revegetation and rehabilitation of dune system	20. Update existing Foreshore Management Plans to ensure that actions associated with dune management, within the context of coastal hazards, is adequately addressed.	Program needs to be considered in context of cost of replenishment and resources to undertake actions. Would require continued funding sources. This is a largely suitable option for the Shire's foreshore and is currently being implemented via existing Foreshore Management Plans.
	CODE: PR2 | NAME: GROYNE		
	Construct rock groynes along the beach approximately perpendicular to the shoreline to restrict longshore sediment movement and stabilise sections of shoreline. This option is often accompanied by beach nourishment.	21. Undertake a coastal investigation to assess effectiveness and feasibility.	Hard protection can divert erosion issues elsewhere, such as to the down drift side of a groyne, and can have significant impact on coastal ecosystems when accompanied by beach nourishment. Groynes are not effective as a means of managing short-term storm erosion. Can be expensive and rock sources may not be readily available or affordable. Groynes change the nature and appearance of the coast and can impact walking and beach use. Assessment of this option needs to consider long term maintenance, as this will extend the life of the groyne.
	CODE: PR3 | NAME: SEAWALL		
	Construct seawall in front of assets or along length of coastline to protect them from coastal hazards.	22. Undertake a feasibility and design study to guide construction.	Hard protection can divert erosion issues elsewhere, such as to beaches either side of, and directly in front of, a seawall. They can also have significant impact on coastal ecosystems Seawalls are expensive and change the nature and appearance of the coast, typically resulting in long term loss of the beach in front. Rock sources may not be readily available or affordable. They need to be accompanied by beach nourishment/ replenishment, which adds to the cost of option. Assessment of this option needs to consider long term maintenance, as this will extend the life of the wall.
	CODE: PR4 | NAME: NEARSHORE REEF/ BREAKWATER/ ARTIFICIAL REEF		
	Construct offshore reef(s)/ breakwater(s) or raise existing natural nearshore reef structures to maintain level of protection as sea level rises.	23. Undertake a feasibility and design study to guide construction.	The impacts of these structures are relatively unknown, and untested in the local context. May have significant impact on coastal ecosystems in adjacent areas. Reefs are unlikely to be effective over time as sea levels rise, or the crest would need to be raised in height in response. Are very expensive to design, build and maintain and rock sources may not be readily available or affordable. Assessment of this option needs to consider long term maintenance, as this will extend the life of the structure.
	CODE: PR5 | NAME: BEACH (SAND) NOURISHMENT		
	Addition of sand to the beach, dune and/or nearshore area to replace lost material and/or create additional buffer.	24. Undertake a feasibility and design study to guide construction.	This option is a temporary measure and can be more effective in association with other options. Renourishment currently occurs along some sections of coast, namely around Gnarabup. The sand may be from an external source or from a nearby part of that coastal area, as such availability of suitable sand sources may be an issue. Where suitable sources are not readily available or a considerable distance away, costs are increased. If the nourishment sand is significantly finer than the existing beach sand the nourishment sand will be lost quickly.

CATEGORY	DESCRIPTION	POSSIBLE ACTIONS	COMMENT / SUITABILITY
NO REGRETS	**CODE: NR1 | NAME: MONITORING**		
	Long term baseline monitoring and event-based monitoring following storm erosion events	25. Set up a baseline monitoring programme for long term trend and condition following major events. 26. Review results for particular asset triggers regularly. 27. Re-run risk assessment based on monitoring results and revise risk management measures if risk level changes (i.e. increase or decrease in level of risk).	Monitoring enables assessment of the frequency and severity of coastal hazard events (along with their impacts). This information is useful as part of an ongoing review process for the CHRMAP, and can is also useful in the identification of triggers that lead to particular management actions.
	CODE: NR2 | NAME: PROTECTION STRUCTURE AUDIT		
	Involves undertaking an audit of existing protection structures, to determine their current condition, effectiveness and future protection potential/adaptability.	28. Conduct audit of existing protection structures. 29. Update planning allowances lines where relevant to account for existing protection structures. 30. Update CHRMAP proposed actions to account for condition (life) of existing protection structures.	Depending upon the expected life and future protection from existing protection structures, there may be updates to the hazard estimates. This will flow on to affect other risk treatment options, including implementation of risk management measures. Limited applicability to Shire given limited existing structures.
	CODE: NR3 | NAME: NOTIFICATION ON TITLE		
	Using the Planning and Development Act 2005 and the Land Administration Act 1997 to place a notification on the titles of potentially affected properties.	31. Implement in accordance with the planning framework, and as conditions of approval for subdivision and development.	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 decision 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. Allows vulnerability of asset to hazards to be conveyed to existing and future owners. One means of implementation that is low cost, is through subdivision and development decision making
	CODE: NR4 | NAME: EMERGENCY EVACUATION PLANS		
	Establishing emergency evacuation management plans where existing assets may be affected by erosion and/ or inundation to manage the safety of community and stakeholders	32. Develop evacuation plans for each site considered by the CHRMAP. 33. Update evacuation plans with latest inundation mapping available or include coastal inundation area into existing evacuation plans.	This option is a low-cost option in addressing the consequences of erosion / inundation regarding safety to lives as the impact occurs. It is unlikely to be required, except perhaps in the very-long term.
DO NOTHING	**CODE: DN | NAME: DO NOTHING**		
	This is managed retreat at its most basic form. The asset will be lost after a hazard event. Repairs are carried out for public safety purposes only. Take no action. No limitations on development or implementation of adaptation planning. Accept risk	34. Take no action and accept risk.	Does not involve any new actions. Where existing levels of risk are low, accepting the risk may be appropriate. However, it may not be appropriate for high-risk locations/assets. The cost of Do Nothing may be substantially greater in the future than the current cost of implementing planning controls. This is because the value of land at risk continues to increase, as does the cost of mitigating recession impacts over time (such as retrofit, or even abandoning lost lands). Further, as the value of land at risk continues to increase over time, implementation of retreat risk treatment options in the future, to ensure land in the coastal zone is continuously provided for coastal foreshore management, public access, recreation and conservation, become increasingly desirable while more difficult to implement.

Adapted from WAPC, 2019, (Baird, 2023) and Shape Urban (2023)

Appendix C

MCA Assessment Framework

APPENDIX C - MCA assessment framework

RATING; SCORE	EFFECTIVENESS	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	AESTHETIC IMPACT	COST (CAPITAL & ONGOING)	FUTURE ADAPTABILITY	FINAL SCORE
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**

Adapted from Water Technology 2022, WAPC 2019

Appendix D

CBA/BDA Report

Cost-Benefit and Benefit Distribution Analysis of Gracetown, Prevelly-Gnarabup and Augusta South Coastal Assets

FINAL DRAFT

Prepared by SEARCH Research Services for the Shire of Augusta Margaret River Review of Coastal Hazard Risk Management & Adaptation Plan [CHRMAP]

October 2024

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Executive Summary

This Cost-Benefit Analysis (CBA) of three study sites selected for the AMRSC Review of Coastal Hazard Risk Management and Adaptation Plan involves a financial and economic valuation of coastal assets at risk of inundation over a 100-year timeframe. Avoidance of the damage or loss of these assets, including roads, carparks, pathways, boardwalks, marine structures and beaches can ensure that the benefits of coastal access and use can be maintained into the future.

It should be noted that not all of the economic benefits arising from the use and non-use of coastal sites are captured in the basic asset values of the infrastructure that facilitate access to these sites. The perceived value of benefits arising from the use (access, recreation, environmental health, heritage) and non-use (existence, bequest, option) values are dependent upon multiple factors including location (urban or non-urban), development (highly developed or undeveloped), population (residents and visitors), time of year (seasonal) and types of beach use (active/passive).

The previous AMRSC CHRMAP used the benefit transfer approach to estimating the value of beach access in the study areas. These values were derived from multiple studies of comparable coastal areas in Australia that employed a range of methods to estimate economic values. In the absence of any primary research data for the economic value of beaches in the three study sites for this CBA, these values have been CPI adjusted for use in this report.

In the previous AMRSC CHRMAP (Seashore Engineering 2016), beach areas were valued at $200 per square metre, based on actual primary data from comparable study sites. Adjusting for the sum of trimmed mean CPI increases 2016 to 2023 of 20 percent provides a 2023 value per square metre of $240. By comparison, a 2016-17 study of seven urban and regional coastal areas in NSW (Pascoe *et al,* 2017) indicated that sandy beaches had an average value of $219 per square metre, equivalent to $254 in 2023 (CPI adjusted).

Summary of Costs-Benefits Values and Ratios

The cost of coastal assets within the low-, medium- and high-risk zones in the three study sites is based on the replacement values of the assets provided by the Shire Assets Management staff. Asset values also included costings for the relevant projects in the Gracetown Infrastructure Plan approved by the Shire Council in May 2024.

Net benefits = Total Benefit (Area of sandy beach * $240) minus Total Cost (Replacement Value of Assets at risk)

Cost Benefit Ratio = Total Benefit/Total Cost.

CBA Summary Table

Study Site	Net Benefit ($)	Cost Benefit Ratio
Gracetown	219,236	1.17
Prevelly-Gnarabup	4,198,098	2.13
Augusta South	5,117,248	1.74

FINAL DRAFT

Summary of Benefit Distribution Analysis

The Benefits Distribution Analysis indicates that the study site most highly impacted in the event of coastal inundation is Augusta South, followed by Prevelly-Gnarabup and then Gracetown. Although Prevelly-Gnarabup has a higher number of resident stakeholders (800), then Augusta South (630), the roads, pathways, boardwalks, carparks and marine structures in Augusta South, as well as the FBHP represent substantial Shire assets that generate significant benefits for both the residents of Augusta South and the Shire. Additionally, the residential properties and vacant land in Augusta South generates rates income, estimated at $2,0242,310 for 2024-25 as well as an average of $707, 866 in net operating income from FBHP in the period 2020/21 to 2023/24.

In terms of the ratio of benefits per stakeholder, again it is Augusta South that has the highest value ($8,122.62) followed by Prevelly-Gnarabup (5,247.62) then Gracetown ($921.16). Any and all future coastal hazard adaptation measures across the Shire should take into consideration both the value of net benefits to the residents in each location, the relative ratio of average benefit per stakeholder and the financial value of coastal assets managed and operated by the Shire. These considerations should apply to the allocation of both the benefits and costs for each adaptation project as well as the distribution of those benefits and costs in each case.

BDA Summary Table

Study Site	Net Benefits	Number of Stakeholders	Net Benefits per Stakeholder
Gracetown	$219,236	238	$921.16
Prevelly-Gnarabup	$4,198,098	800	$5,247.62
Augusta South	$5,117,248	630	$8,122.62

FINAL DRAFT

Introduction

The purpose of this report is to provide Cost Benefit Analysis (CBA) and Benefit Distribution Analysis (BDA) of adaptation options identified and prioritised in the update of the AMRSC CHRMAP. CBA will be based on the financial value of assets at risk of inundation over the timeframe of the planning period and the three study sites.

A range of adaptation scenarios with respect to risk levels, coastal inundation and erosion, adaptation options and coastal planning will be incorporated into a matrix of risk management and adaptation options that will inform future decision making with respect to coastal planning and management. Where potential risk options dictate, a Benefit Distribution Analysis will assist in understanding the relative benefits and costs associated with particular risk adaptation management measures.

Approach

The Margaret River region is renowned for its coastal amenity and the marine activities for the estimated 18,260 (ABS 2023) residents of the Shire. In addition, the Shire also hosted an estimated 809,000 domestic, international and day-trip visitors in 2023, generating 2,873,000 visitor nights and spending $663 million (TWA 2024)

Previous studies have shown that the coastal areas of the Shire produce significant socio-economic benefits for both residents and visitors and any loss of access or beach amenity due to inundation, erosion and loss of infrastructure will impact these values.

However, whilst the tourism and socioeconomic values of the study sites estimate their use and non-use values, the methods used to estimate these values and utility of these estimates for planning and land management purposes is limited. Furthermore, Shire budgeting and grant applications require financial valuations prior to allocation of funds for coastal management and adaptation measures, based on actual costings, not just theoretical benefits.

Hence there is a need to approach CBA from an accounting perspective, while acknowledging that not all of the economic benefits arising from the use and non-use of coastal sites are captured in the basic asset values of the roads, carparks, buildings, pathways and utilities that facilitate access to these sites.

Whereas the economic approach has predominantly been used to inform public policy and determining priorities in coastal management, it has limited use for Local Government in terms of coastal risk adaptation planning and policy of the coastal sites under management. Therefore, an accounting approach to evaluating the values of ‘at risk’ assets within the three study sites will provide the basis for the analysis of adaptation options and priorities, and benefits will be based on those identified in previous studies of comparable study sites.

Where possible, the unit of measurement for evaluation of study sites will be dollars per square metre. This will provide Shire planners and asset managers with a common and physical basis upon which to estimate, evaluate and allocate resources to future adaptation options in the three study sites.

FINAL DRAFT

Socioeconomic Considerations

The population and economy of the Shire have increased significantly over the last decade and all indications are that this trend will continue over the next tent to twenty years. This growth creates increased pressure on the coastal environment, both in terms of infrastructure development and environmental impact. Consequently, the demands on Shire assets and the allocation of resources to building and maintaining those assets are also increasing, so coastal planning processes must include consideration of coastal values in terms of community and visitor use and associated benefits arising from these use values.

The population of the Shire of Augusta Margaret River increased by 20% between 2016 and 2023 and is currently estimated at 18,620 persons. The districts that are adjacent to the three study sites are experiencing the highest growth rates within the Shire, with Cowaramup and District increasing by 29% to 3,487 persons, Margaret River and District with a 22% increase to 11,008 persons in and Augusta-Hamelin Bay an 18% increase to 1,846 persons between 2016 and 2023.

Visitor numbers are also increasing again, especially domestic visitors from Perth and interstate following the easing of travel restrictions after the Covid 19 lockdowns ended. Estimated total visitors in 2023 were 809,000, comprising 748,000 domestic visitors and 61,000 international visitors (TWA Overnight Visitor Factsheet 2024). This equates to 5,370,000 visitor nights in 2023, or the equivalent of an additional 14,712 permanent residents across the Shire. In terms of population pressure on the coastal zones and adjacent towns, visitor numbers add another 80 percent to the current resident population, placing further demands on coastal assets, both built and natural.

Cost Benefit Analysis

Benefits arising from the use (access, recreation, environmental health, heritage) and non-use (existence, bequest, option) values of the coastal zone are based on previous studies of the value of beaches in Northern NSW (Carlsen, 1997), Sunshine Coast, Clarence Valley, Surf Coast and Augusta-Margaret River Shires (Raybould et. al. 2013), Peron-Naturaliste Coastal Region (ACIL Tasman 2012), and Capel to Leschenault (Marsden Jacob Associates 2023). Pascoe *et al* (2017) estimated the value of sandy beaches in seven study sites along the NSW coast, including Eurobodalla, Byron Bay, Coffs Harbour and the Tweed Coast.

It should be noted that there are many limitations to the estimates provided in these studies, and are largely dependent on the beach type and frequency of use. The extent of coastal development in the form of residential and commercial land also has a large effect on beach values, with highly developed urban coastlines, such as the Sunshine Coast in Queensland and the Surf Coast in Victoria having substantially higher values than the Clarence Valley, Augusta-Margaret River or Peron-Naturaliste coastlines.

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The estimates of use and non-use benefits are based on the benefits transfer method whereby studies of comparable sites across Australia inform the evaluation of the sites in this report. In the absence of sufficient time and resources to collect primary data from users in the three study sites, this approach is considered to be sufficient for the purposes of informing and prioritising coastal adaptation options.

Using the approach used for estimating the value of sandy beaches in the previous AMRSC CHRMAP (Seashore Engineering 2016) and in NSW (Pascoe *et al* 2017), valuation based on a per square metres was considered appropriate for this report. It is implied that loss of coastal assets such as roads, carparks, pathways and marine structures due to coastal inundation or erosion would impact the use and non-use values of sandy beaches adjacent to these assets.

In the previous AMRSC CHRMAP, beach areas were valued at $200 per square metre, based on actual primary data from comparable study sites. Adjusting for the sum of trimmed mean CPI increases 2016 to 2023 of 20 percent provides a 2023 value per square metre of $240. By comparison, a 2016-17 study of seven urban and regional coastal areas in NSW (Pascoe *et al,* 2017) indicated that sandy beaches had an average value of $219 per square metre, equivalent to $254 in 2023 (CPI adjusted). In WA, a 2018 CHRMAP Project for the City of Geraldton was based on a beach area valuation of $200 per square metre for both Drummond Cove and Bluff Point (Rhelm, 2018).

Costs are based on the replacement value of Shire assets as provided by the Shire Assets staff.

Method

Net benefits and Cost Benefit Ratios for the three sites are estimated as follows:

Net benefits = Total Benefit (Area of sandy beach * $240) minus Total Cost (Replacement Value of Assets at risk)

Cost Benefit Ratio = Total Benefit/Total Cost.

The decision rule for projects, (in this case adaptation projects) using the Cost Benefit Ratio requires a value greater than one. Any adaptation project with ratio value less than one should not proceed as the total replacement value of the assets will exceed the estimated use and non-use benefits that the coastal sites yields. The ratio is also useful for comparing and prioritising adaptation options across study sites, with higher values indicating greater socio-economic benefits arising from adaptation options. It can also be used to inform funding and budgeting amounts when preparing grant applications for infrastructure projects and public works associated with adaptation options.

Gracetown Analysis

The following costs and benefits analysis applies to the public assets (roads, carparks, boardwalks, marine structures and amenities) located within the 10-, 20- and 100-year hazard risk zones modelled in previous chapters for Gracetown. The costs are based on the replacement value (RV) of infrastructure, as provided by the Shire Assets team (Table 1).

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Table 1 – Replacement Values of Gracetown Assets

Asset Category	Total Replacement Value
Roads	**$39,921**
Car Parks	**$184,163**
Boardwalks	**253,470**
Marine Structures	**$333,600**
Amenities	**$505,610**
TOTAL	**$1,316,764**

Source: AMRSC Assets

Note that the AMRSC approved the Gracetown Infrastructure Plan in May 2024, that included an estimated budget allocation of $513,648 for additional carparks, pathways and amenities adjacent to Swimmers Beach and Melaleuca Public Open Space. The Gracetown Infrastructure Plan also includes the sealing of the Swimmers Beach carpark but the costing is TBC once the decision on the sealing option is determined.

Assuming that the known replacement costs include the current and planned infrastructure in Gracetown, the total cost of AMRSC assets for the purposes of analysis is $1,316,714.

In terms of beach access and utilisation, the beach area accessed from the Swimmers Beach Carpark provides the majority of user value. The area of this beach is approximately 6,400m^2 . Using the CPI adjusted value of $240 per square metre applied to the 6,400m^2 of Swimmers Beach provides an estimated total benefit of $1,536,000.

Using the calculation of net benefits as the sum of total benefit minus total cost and the B/C ratio can inform decisions that align with the adaptation options for each study site.

For Gracetown, the Net Benefit is $1,536,000 - $1,316,764 = $219,236

The B/C Ratio is 1,536,000/1,316,764 = 1.17

In the case of Gracetown, then replacement value of assets in the low-, medium and high-risk zones, including the works approved in the Gracetown Infrastructure Plan, exceeds the use value of the beach areas. The B/C Ratio for adaptation options in Gracetown is 1.17 and the current Net Benefit estimate is $219,236. This figure could also inform any decision regarding further public works that require a budget allocation, for example the Swimmers Beach Carpark sealing costs.

Prevelly-Gnarabup Analysis

The following costs and benefits analysis applies to the public assets (carparks, pathways, marine structures and amenities) located within the 10-, 20- and 100-year risk lines modelled in previous chapters for Prevelly-Gnarabup. The costs are based on the replacement value (RV) of infrastructure, as provided by the Shire Assets team (Table 2).

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Table 2 – Replacement Values of Prevelly-Gnarabup Assets

Asset Category	Total Replacement Value ($)
Car Parks	**260,347**
Pathways	**136,470**
Boardwalks	**838,210**
Marine Structures	**270,000**
Amenities	**1,766,875**
TOTAL	**3,271,902**

Source: AMRSC Assets

The estimated replacement costs for current AMRSC assets within the low-medium and high-risk zones in Prevelly-Gnarabup is $3,271,902. Note that this estimate does not include the recent upgrades to the Gnarabup Café.

In terms of beach access and utilisation, the main beach areas accessed from the River Mouth and Gnarabup (upper and lower) carparks provide the majority of user value. The beach area is approximately 33,000m^2 . Using the CPI adjusted value of $240 per square metre applied to the 33,000m^2 of beach provides an estimated total benefit of $7,920,000.

Using the calculation of net benefits as the sum of total benefit minus total cost and the B/C ratio can inform decisions that align with the adaptation options for each study site.

For Prevelly-Gnarabup, the Net Benefit is $7,920,000 - $3,721,902 = $4,198,098

The B/C Ratio is 7,920,000/3,721,902 = 2.13

In the case of Prevelly-Gnarabup, the replacement value of assets (not including the recent upgrades to the Café) in the low-, medium- and high-risk zones exceeds the user value of the beach areas. The B/C Ratio for adaptation options is 2.13 and the current Net Benefit estimate is $4,198,098. This figure could also inform any decision regarding prioritisation of adaptation options compared with other study sites, with the B/C Ratio for Prevelly-Gnarabup assets exceeding Gracetown assets, for example.

Augusta Analysis

The following costs and benefits analysis applies to the public assets (roads, pathways, boardwalks, carparks, marine structures and Flinders Bay Holiday Park and amenities,) located within the 10-, 20- and 100-year risk lines modelled in previous chapters Augusta. The costs are based on the replacement value (RV) of infrastructure, as provided by the Shire Assets team (Table 3).

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Table 3 – Replacement Values of Augusta Assets

Asset Category	Total Replacement Value ($)
Roads	**4,896,019**
Pathways	**64,687**
Boardwalks	**105,730**
Car Parks	**120,652**
Marine Structures	**639,000**
Flinders Bay HP & Amenities	**1,056,634**
TOTAL	**6,882,752**

Source: AMRSC Assets

The estimated replacement costs for current AMRSC assets within the low-medium and high-risk zones in Augusta is $6,882,752. Note that this estimate does not include the value of private property

In terms of beach access and utilisation, the main beach areas accessed from the Blackwood River mouth cut to Flinders Bay Holiday Park provide the majority of user value. The beach area is approximately 50,000m^2. Using the CPI adjusted value of $240 per square metre applied to the 50,000m^2 of beach area provides an estimated total benefit of $12,000,000.

Using the calculation of net benefits as the sum of total benefit minus total cost and the B/C ratio can inform decisions that align with the adaptation options for each study site.

For Augusta, the Net Benefit is $12,000,000 - $6,882,752 = $5,117,248

The B/C Ratio is = 1.74

In the case of Augusta, the replacement value of assets in the low-, medium- and high-risk zones exceeds the user value of the beach areas. The B/C Ratio for adaptation options is 1.74 and the current Net Benefit estimate is $$5,117,248. This figure could also inform any decision regarding prioritisation of adaptation options compared with other study sites, with the B/C Ratio for Augusta assets exceeding that for Gracetown assets (1.17) but less than that for Prevelly (2.13).

Summary

This Cost-Benefit Analysis (CBA) of three study sites selected for the AMRSC Review of Coastal Hazard Risk Management and Adaptation Plan provides a financial and economic valuation of coastal assets at risk of inundation over a 100-year timeframe. Avoidance of the damage or loss of these assets, including roads, carparks, pathways, boardwalks, marine structures and beaches can ensure that the benefits of coastal access and use can be maintained into the future.

The estimates of use and non-use benefits are based on the benefits transfer method whereby studies of comparable sites across Australia inform the evaluation of the sites in this report. In the absence of

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sufficient time and resources to collect primary data from users in the three study sites, this approach is considered to be sufficient for the purposes of informing and prioritising coastal adaptation options.

The cost of coastal assets within the low-, medium- and high-risk zones in the three study sites is based on the replacement values of the assets provided by the Shire Assets Management staff. Asset values also included costings for the relevant projects in the Gracetown Infrastructure Plan approved by the Shire Council in May 2024.

The Summary Table below indicates the Net Benefit and Cost Benefit Ratio for each of the study sites.

Table 4 - CBA Summary Table

Study Site	Net Benefit ($)	Cost Benefit Ratio
Gracetown	219,236	1.17
Prevelly-Gnarabup	4,198,098	2.13
Augusta South	5,117,248	1.74

The decision rule for projects, (in this case adaptation projects) using the Cost Benefit Ratio requires a value greater than one. Any adaptation project with ratio value less than one should not proceed as the total replacement value of the assets will exceed the estimated use and non-use benefits that the coastal sites yields. The ratio is also useful for comparing and prioritising adaptation options across study sites, with higher values indicating greater socio-economic benefits arising from adaptation options. It can also be used to inform funding and budgeting amounts when preparing grant applications for infrastructure projects and public works associated with adaptation options.

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Benefit Distribution Analysis

Benefit distribution analysis (BDA) is an extension of cost-benefit analysis (CBA) that examines how the benefits and costs of a project or policy are distributed among different groups within society. This type of analysis is crucial for understanding the equity implications of decisions and ensuring that the impacts are fairly shared.

Key aspects of benefits distribution analysis:

1. **Identification of Stakeholders**: Determine which groups or individuals will be affected by the project or policy. This can include different income groups, geographic regions, or demographic categories.
2. **Quantification of Benefits and Costs**: Measure the benefits and costs in monetary terms. This allows for a direct comparison and helps in understanding the trade-offs involved.
3. **Distributional Effects**: Analyse how the benefits and costs are distributed among the identified stakeholders. This can reveal whether certain groups are disproportionately benefiting or bearing the costs.
4. **Equity Considerations**: Assess the fairness of the distribution. This involves evaluating whether the distribution aligns with societal values and goals, such as reducing inequality or supporting vulnerable populations.
5. **Policy Implications**: Use the findings to inform decision-making. policymakers can adjust the design of the project or policy to address any identified inequities.

Distributional costs and benefits will be analysed for the three study sites in the Shire to determine the annualized distribution of the net benefits as estimated in the CBA.

Stakeholders

There is a range of stakeholders across the three study sites that benefit from the coastal access and amenities supported by the Shire assets within the low-, medium- and high-risk zones. It is important to note that currently, all costs for building and maintaining assets within these zones are incurred directly by the Shire and indirectly by all ratepayers of the Shire. There is also a number of volunteer groups that conduct coastal dune protection works such as planting, brushing and fencing. These include local school groups and the community groups Friends of Gracetown Cowaramup Bay and Nature Conservation Margaret River

Gracetown Stakeholders

Gracetown stakeholders include residents and visitors to Cowaramup Bay who enjoy the activities of swimming, surfing, fishing and coastal walks. There is one retail business located in Gracetown. Data from the 2021 Census indicates that the resident population of Gracetown is 238 in 227 private

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dwellings. A significant proportion of these dwellings are available for private holiday rental and an internet search shows as many as 59 properties (25%) available as holiday rentals. During the peak holiday periods the number of temporary residents may well match or exceed the permanent population, taking the total number of residents to over 500. There is also an unknown number of daytrips to, and through, Gracetown for the purposes of swimming and beach activities. However, in the event that the Cowaramup Bay Swimming beach access and amenity became inaccessible for daytrip and overnight visitors, it assumed that these visitors would substitute another coastal location for their holiday accommodation and coastal activities. Therefore, daytrip and overnight visitors to Gracetown are not considered as stakeholders for the purposes of this analysis.

Prevelly-Gnarabup Stakeholders

Prevelly-Gnarabup stakeholders include residents and visitors to the beaches, surf breaks, fishing locations and coastal walks. There is also a number of commercial accommodation and retail businesses within the study site. The resident population was estimated to be 800 in 2023, living in 472 dwellings.

There is also an estimated 145 of dwellings available for private holiday rental (31%) which, together with the commercial accommodation available at Prevelly and Gnarabup would swell the total number of permanent and temporary stakeholders to several thousand. There is also a significant number of day-trip visitors to Prevelly-Gnarabup for beach and fishing activities as well as dining at coastal cafes, walks and viewpoints. However, in the event that the Prevelly-Gnarabup beach access and amenity became inaccessible for daytrip and overnight visitors, it assumed that these visitors would substitute another coastal location for their holiday accommodation and activities. Therefore, daytrip and overnight visitors to Prevelly-Gnarabup are not considered as stakeholders for the purposes of this analysis.

Augusta South Stakeholders

Augusta South stakeholders include residents and visitors to the beach for fishing and coastal walks. Augusta South also generates annual rate revenue for the Shire, and Flinders Bay Holiday Park (FBHP) is also a revenue generating asset. Therefore, the Shire of Augusta Margaret River is also a stakeholder in Augusta South.

The estimated number of dwellings in the Augusta South coastal zone is 112, including 70 within the potential impact zone. Based on the average household size for Augusta, the resident population of Augusta South is estimated to be 630. There is also 120 powered and unpowered campsites in FBHP which is operated by the Shire. Both FBHP and the dwellings and vacant land within the impact zone generate financial benefits for the Shire.

As for the other two study sites in the event that the Augusta South coastal zone became temporarily inaccessible for overnight and daytrip visitors, it assumed that these visitors would substitute another

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coastal location for their holiday accommodation and activities. Therefore, daytrip and overnight visitors to Augusta South are not considered as stakeholders for the purposes of this analysis.

Benefits and Costs

The Benefit Cost Analysis indicates that the net benefits from the coastal access and amenity supported by the Shire assets, including roads, carparks, pathways and marine structures within the potentially impacted coastal areas are:

- Gracetown $219,236
- Prevelly-Gnarabup $4,198,098
- Augusta South $5,117,248

Augusta South provides the additional amenity from Flinders Bay Holiday Park, with 120 powered and unpowered camping sites. The four-year average annual revenue (2020/21 to 2023/24), less the cost of operating FBHP accruing to the AMRSC is $707,866.

In addition, there is 112 rateable properties in Augusta South with a Gross Rental Value (GRV) of $2,042,310. These residential properties generate an estimated $215,500 in Shire rates, based on 2024/25 valuations and rate calculations.

In terms of comparative benefits and costs, Augusta South generates the highest amount of net benefits to the stakeholders, including the Shire, with an estimated net benefit of $5,117,248.

Prevelly-Gnarabup generates nominal net benefits of $4,198,098, based on beach amenity value and estimated replacement cost of the Shire's coastal assets.

Gracetown generates nominal benefits of $219,236, based on beach amenity value and estimated replacement cost of the Shire's coastal assets.

Distribution of Benefits

In terms of the distribution of benefits per stakeholder, as defined above, the ratios are as follows:

Table 5 – BDA Summary Table

Study Site	Net Benefits	Number of Stakeholders	Net Benefits per Stakeholder
Gracetown	$219,236	238	$921.16
Prevelly-Gnarabup	$4,198,098	800	$5,247.62
Augusta South	$5,117,248	630	$8,122.62

Based on net benefits per stakeholder, Augusta South stakeholders are receiving the highest ratio ($8,122.62) in relation to the coastal access and amenity and the replacement values of Shire assets. It should also be notes that the Shire also benefits from the receipt of an estimated $215,500 in annual rates revenue and a net income of $707,886 from Flinders Bay Holiday Park. Prevelly-Gnarabup stakeholders also receive a high net benefit per stakeholder ($5,247.52) based on the replacement value

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of the Shire assets that support beach access and amenity. Gracetown stakeholders receive the lowest ratio of benefits per stakeholder ($921.16) despite the planned addition of a budgeted $505,610 in coastal asset improvements as detailed in the Gracetown Infrastructure Plan.

Equity Considerations

Recognising that Shire rates are levied equally across the Shire, with some differential between rural and residential zoning, it is possible to make some comparisons between the three potentially impacted study sites in terms of distributional benefits.

It is apparent that the Shire assets in Augusta South provide the highest value of benefits to stakeholders, along with the additional value of rates revenue and income from FBHP. flowing to the Shire. The impact from any loss in these assets and values would not only be borne by the 630 residents of Augusta South, but also by the Shire budget and ratepayers. Additionally, the private property damage associated with any potential impact on the 70 dwellings within the low-risk impact zone would need to be calculated and considered.

Similarly, any impact on property values in both Augusta South and Prevelly-Gnarabup would need consideration in any calculation of the distributional benefits of coastal hazard and risk adaptation options. It is worth noting that no residential properties are located within the potential impact zones for Prevelly-Gnarabup, so no potential damage to private property is considered likely.

Current benefits per stakeholders for both locations are considerably greater than those for Gracetown stakeholders, although property values may be similarly impacted to the other coastal locations.

In terms of equity, it is apparent Augusta South residents, especially those within the potential impact zone, bear a disproportionate loss value of potential benefits under the low-impact scenario. Potential loss of benefits in Prevelly-Gnarabup is also considerably high, but does not involve any private property damage. Under any impact scenario it is the Shire that will bear the cost of coastal inundation impacts on Shire assets, with this cost being exacerbated in Augusta South through the additional loss of rate revenue and income from Flinders Bay Holiday Park.

Policy Implications

Shire decision making in relation to coastal adaptation options should take into consideration both the current net benefits generated in the three coastal areas evaluated, as well as the relative distributional benefits flowing to stakeholders in the three areas. The adaptation options based on the MCA in Chapter Three are primarily planning responses, not coastal engineering responses. These preferred planning responses (Avoid Development, Accommodate, Monitoring, Design to Standards, Planning Controls), do not have explicit costings attached to them. However, if coastal engineering responses such as Dune Management/Beach Nourishment or Seawalls (estimated to cost $10,00 per lineal metre) are to be considered as viable adaptation options in the future, these distributional benefits should inform policy implications and funding decision criteria.

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Summary

The Benefits Distribution Analysis indicates that the study site most highly impacted in the event of coastal inundation is Augusta South, followed by Prevelly-Gnarabup and then Gracetown. Although Prevelly-Gnarabup has a higher number of resident stakeholders (800), then Augusta South (630), the roads, pathways, boardwalks, carparks and marine structures in Augusta South, as well as the FBHP represent substantial Shire assets that generate significant benefits for both the residents of Augusta South and the Shire. Additionally, the residential properties and vacant land in Augusta South generates rates income, estimated at $2,0242,310 for 2024-25 as well as an average of $707, 866 in net operating income from FBHP in the period 2020/21 to 2023/24.

In terms of the ratio of benefits per stakeholder, again it is Augusta South that has the highest value ($8,122.62) followed by Prevelly-Gnarabup (5,247.62) then Gracetown ($921.16). Any and all future coastal hazard adaptation measures across the Shire should take into consideration both the value of net benefits to the residents in each location, the relative ratio of average benefit per stakeholder and the financial value of coastal assets managed and operated by the Shire. These considerations should apply to the allocation of both the benefits and costs for each adaptation project as well as the distribution of those benefits and costs in each case.

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