FSC RANGE

Project & Engineering Management
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Environment & Sustainability

Technical Report

Coastal Adaption Strategy - Beachport

Wattle Range Council

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1 INTRODUCTION

1.1 The Project

Wattle Range Council, the District Council of Robe, and District Council of Grant are undertaking a process to develop coastal adaptation strategies for 11 townships located in the Limestone Coast region (Figure 1). The Limestone Coast Local Government Association (i.e., LCLGA), the Coast Protection Board, and Kingston District Council are key stakeholders in this project. The overall objective, to which this project contributes, is to develop a consistent coastal adaptation strategy for the region. The coastline in this region of South Australia has experienced coastal erosion and inundation and it is expected that these hazards are likely to intensify due to sea level rise in future years.

The aim of this project is to identify the coastal hazards and the associated risk up to 2100, and to evaluate potential adaptation options and pathways for implementation for the 11 coastal communities. This project specifically focused on the township of Beachport in Wattle Range Council and the hazards of coastal erosion and inundation (permanent and temporary).

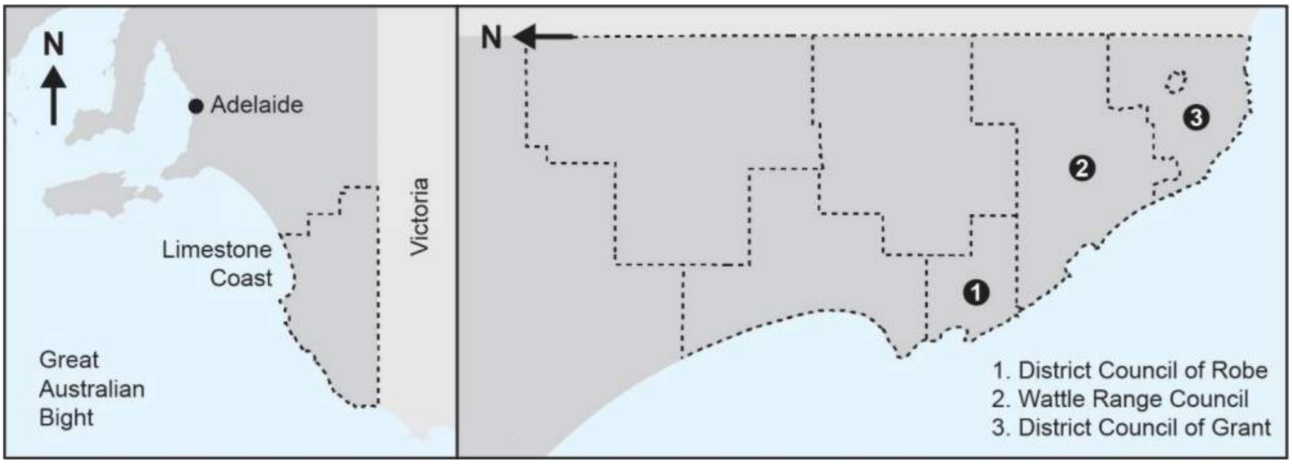


Figure 1: Map of the Limestone Coast region and relevant local government areas
(left) The location of Limestone Coast in relation to Adelaide. (right) The location of Wattle Range Council, District Council of Robe, and District Council of Grant in relation to the Limestone Coast.

1.2 General Approach

The approach used in this assessment is based on the Local Government Association of South Australia's Coastal Adaptation Guidelines (LGASA, 2020). These guidelines present six stages that should be considered as part of any coastal adaptation study:

1. Stocktake
2. Stakeholder engagement
3. Coastal hazard assessment
4. Risk assessment
5. Adaptation options
6. Adaptation strategy development

Each stage forms a separate chapter of this technical report and is described in greater detail within those respective chapters.

2 STOCKTAKE

2.1 Purpose

The purpose of the stocktake stage is to:

- Establish the scope of the assessment.
- Identify and obtain past work that may be relevant to the project.
- Collate available data and identify any data gaps.
- Determine the appropriate level of assessment.

2.2 Spatial Extent and Key Features

The Beachport town boundaries, as defined by the Attorney-General's Department (Government of South Australia, 2023), defines the spatial extent of this coastal adaptation assessment (Figure 2).

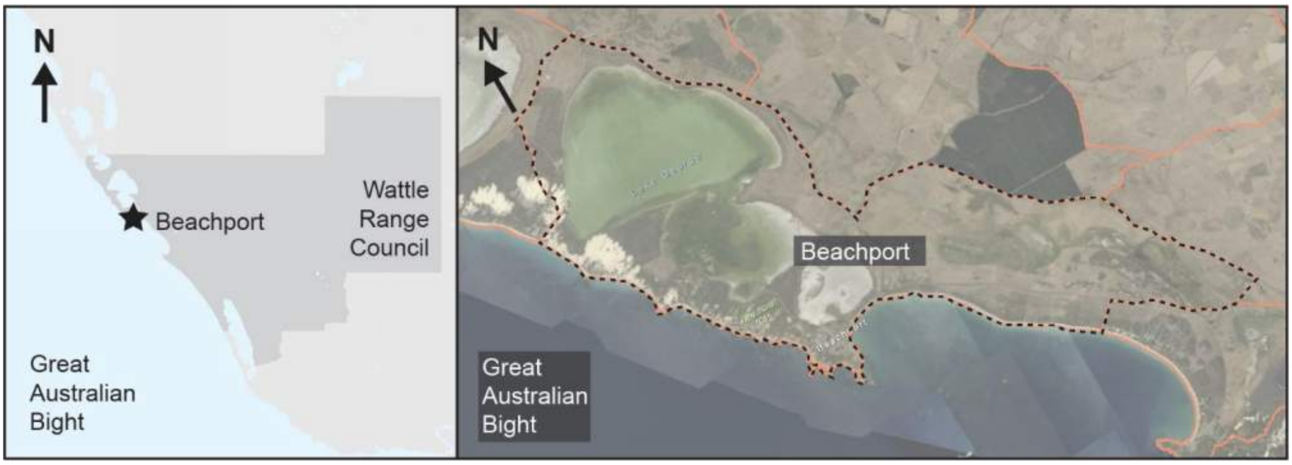


Figure 2: Map of the town boundaries
The township of Beachport is indicated by the dashed line.

Beachport occupies approximately 28 km of the South Australian coastline. The Beachport Conservation Park and Lake George occupy a substantial area within the township boundaries. Lake George is connected to Rivoli Bay by a managed drain, which has a gate at the bay interface. Much of the shoreline of the township has been modified by a groyne field, which seeks to control the foreshore shape and retain sand. The town is clustered on the southern and eastern sides of Lake George. Key public assets include a golf course, school, recreational centre and a surf life saving club. Key statistics associated with town are summarised in Table 1.

Table 1: Key statistics associated with the township
Population and private dwellings based on the 2021 Census (Australian Bureau of Statistics, 2021). Coastline has been approximated based on aerial imagery (Nearmap, 2023).

Township	Population (no.)	Private Dwellings (no.)	Coastline (m)
Beachport	745	562	27,840

2.3 Past Work

Several reports and other relevant documents were provided to FSC Range during this assessment (Appendix A). The key documents that are relevant to this assessment are summarised in Table 2. We note that the Rivoli Bay Study (Worley Parsons, 2015) was particularly relevant to this study, and it describes in detail the coastal processes both short and long term as well as much of the coastal infrastructure along the Rivoli Bay foreshore. The recent study by Baird supplements that assessment.

Table 2: Past work provided during this assessment.

Relevant documents identified during this project are summarised in this table, along with a brief comment on its applicability to the current assessment.

Document	Author	Comment
Rivoli Bay Data Collection and Modelling Summary Report	Baird	Report contains extensive metocean data collected, literature review, modelling outputs and recommendations (2021)
Rivoli Bay Summary Report	Wattle Range Council	Coastal processes and management options for Beachport derived from Baird Data Collection Report (2021)
Beachport Boat Ramp - Review of Maintenance Requirements	Wattle Range Council	Report provides sufficient technical insight into coastal processes surrounding the Beachport Boat Ramp (2017)
Sand Management Plan for Beachport Town Beaches	Wattle Range Council	Document identifies Beachport Town beaches with sand stores and deficits, as well as planned actions (2017)
Lake George - Appendix 1 - Tidal Inlet analysis	Worley Parsons	Analysis provides technical context into the Lake George Outlet condition based on coastal data (2015)
Lake George Study - Appendix 2 - Groyne Extension Concept Design	Technical Context	Document contains Beachport simulated local wave data and modelling outputs (2015)
Rivoli Bay Study	Worley Parsons	Study provides Beachport foreshore groyne assessment, including wave modelling and assessment of wave runup and overtopping (2015)
Rivoli Bay - Appendix 1 - Assessment of Existing Coastal Structures	Worley Parsons	Assessment of Beachport Groynes (2015)

2.4 Available Data and Gaps

FSC Range identified several datasets that were particularly relevant to this assessment (Table 3). We note that many more datasets exist that could have also been incorporated or used instead of others in this assessment. Our choice was based on what we believe would provide the most robust evaluation within the scope of this assessment.

The key data gap that affected the robustness of this assessment was the lack of high-resolution hydrodynamic and bathymetric data within the assessment area. Some localised surveys were noted in the most recent Baird assessment, along with a reasonably good hydrographic map of key contours. Nevertheless, a higher resolution bathymetry dataset would aid substantially in the estimate of shoreline erosion as well as wave related processes (e.g., setup), particularly over short time scales. Profiles in areas where no data were available were assumed from calculated equilibrium beach profiles and evaluated/adjusted using aerial imagery and engineering judgement.

Table 3: Data used in this assessment.
Relevant data that was identified for use in this assessment are summarised. There are many other data sources available that could also be used. These have not been listed.

Data	Source	Comment
Topography		
1m LiDAR DEM	Government of South Australia	Used to resolve important features such as drains.
5m DEM	GeoScience Australia	This includes the Government of South Australia's 1 m LiDAR land cover dataset. Used to define the regional (land) topography.
Merit DEM	University of Tokyo Global Hydrology Group	Multi-Error-Removed Improved-Terrain DEM at approximately 3 sec resolution (~90 m at the equator). Interpolated with the 5 m DEM to fill in data gaps.
Bathymetry		
250m DEM	GeoScience Australia	Only the bathymetric dataset was used and this is relatively coarse and has poor resolution in shallow water depths (<5 m). Hydrographic maps (where available) were used to check and to manually refine this dataset.
Surveys	Other surveys as conducted.	Local surveys have been conducted within Rivoli Bay. These have been included where available.
Shoreline		
DEA Shorelines	GeoScience Australia	1988 to present was used to assess long term shoreline position variability.
Shoreline Transects	Department of Environment and Water	Various durations and was used to assess typical shoreline profiles and long term position variability.

Data	Source	Comment
Characteristics	FSC Range site inspection	On-ground assessment of beach composition, shape, and characteristics to inform erosion mapping.
Water Level Data		
Tidal Planes	Australian Hydrographic Office	Used to define the tidal planes.
Sea Level Rise	Coastal Adaptation Guidelines (2020) Local Government Association of South Australia	References the Coastal Protection Board's Sea Level Rise benchmarks.
Storm Tide	CSIRO CANUTE 3	100-year Annual Recurrence Interval (ARI) storm tide water level includes the contribution of astronomical tide and atmospheric storm surge.
Wave Data		
1% Annual Exceedance Probability (AEP) Storm	CSIRO CANUTE 3 + CAWCR	Cross-checked against entries in the FAST Database (Foreshore Assessment using Space Technology) and used to define the incident storm.
Wave Setup	CSIRO CANUTE 3	100-year Annual Recurrence Interval (ARI) wave setup estimated based on local beach slopes where data available. These were cross-compared with the setup calculated during the erosion analysis.
Other Data		
Asset Data	Aerial Mapping	Cross-referenced on site during site inspection.

2.5 Level of Assessment

Three levels of assessment are defined in the LGASA Guidelines (2020) based on Tonmoy et al. (2019), essentially building up from a rapid to detailed level of risk assessment. Key features of each tier are:

1. First-pass risk screening – A rapid and qualitative process that can be used for resource-constrained organisations with limited data and information, who seek awareness of the risks they face from climate change.
2. Second-pass risk assessment – Involves conducting a risk assessment workshop with relevant stakeholders to identify and evaluate specific climate change risks, their likelihood and consequences. This should align with ISO31000 and existing organisational risk management frameworks, helping with internal uptake.
3. A third-pass risk assessment focuses on more detailed investigation of prioritised, short-listed and site-specific risks identified during a second-pass assessment stage. It is highly resource intensive and is mostly likely to be required to underpin risk mitigation or adaptation actions that will need expensive, long design and/or controversial solutions.

Based upon the data available at this location as well as the aims of this assessment, the level of assessment adopted is defined in Table 4.

Table 4: Scales, complexity and resolution of assessment

The extents and purposes of assessment are outlined below.

Purpose of Coastal Process Assessment	Spatial Scale	Complexity of Assessment	Pass Equivalence	Applicable Sediment Compartment
▪ National trends (or State comparison to national trends) ▪ Sensitivity or broad scale assessments to indicate general areas of higher exposure using limited processes	10 - 100 km	Low	First Pass	Primary
▪ Regional or state-wide scoping studies ▪ Indicative estimates of broad-scale change to identify trends and future focus areas ▪ Regional coastal hazard assessments	1 - 10 km	Low - Medium	First Pass	Primary / Secondary
▪ Local coastal hazard assessments ▪ Hotspot studies ▪ Adaptation planning ▪ Informing planning scheme updates	10 - 1000 m	Medium – High (Medium Adopted)	Second Pass	Tertiary
▪ Site-specific hazard assessment ▪ On-ground design and construct of works ▪ Informing development consent	<10 m	High – Very High	Third Pass	-
▪ **Low:** Captures the processes in a way that allows for long timescale duration of analysis (forecasting) and/or large spatial scales. Typically, reduced physics or parameterised approaches with lower data requirements. ▪ **Medium:** Balances the need for specific process detail with spatial resolution (and thus computational and data needs). Typical empirical methods or transect based analysis. ▪ **High:** Includes key physical processes with higher data requirement usually for validation and seeks to describe these at spatial and temporal scales that are efficient but informative such as by employing scaling approaches. ▪ **Very High:** Includes the greatest number of physical processes and seeks to describe as much of the physical process as possible in high spatial and temporal resolution. These approaches typically have the highest data requirements for both process resolution and validation.				

3 STAKEHOLDERS AND ENGAGEMENT

Several project Stakeholders were identified at the commencement of the project (section 3.1). In addition to these project Stakeholders, a key component of this project was to engage with the Community on projected hazards, risks and proposed adaptation approach. This engagement was undertaken in several stages (section 3.2).

3.1 Project Stakeholders

The following project stakeholders were identified at the commencement of the project and have been separated into those who were core to the project, and those who had an interest in the project.

3.1.1 Core Stakeholders

- **Wattle Range Council**
  Project Client.

- **Coastal Protection Board (DEW)**
  Adjacent LGA who is part of the broader Limestone Coast Association to which this assessment is to align.

- **District Council of Grant**
  Adjacent LGA who is part of the broader Limestone Coast Association and had previously undertaken a similar project to which this assessment is to align.

- **District Council of Robe**
  Adjacent LGA who is part of the broader Limestone Coast Association to which this assessment is to align.

3.1.2 Other Stakeholders

- **Kingston District Council**
  Adjacent LGA who is part of the broader Limestone Coast Association and had previously undertaken a similar project to which this assessment is to align.

- **Limestone Coast Association**
  Overall project management for this project and coordinator of Project Control Group.

- **South Eastern Water Conservation and Drainage Board**
  Surface water drainage that is channelled to the coastline via various drains.

- **Limestone Coast Landscape Board**
  Partners to deliver practical, on-ground programs to manage landscapes.

3.2 Engagement strategy

A comprehensive engagement strategy was developed for this project, which included the generation of materials, Elected Member and Community meetings, Key Stakeholder discussions and Online Survey/Feedback activities.

3.2.1 Materials

A number of supporting documents were prepared to assist the community in interpreting the CAS, which can download from the Wattle Range Council website:

- Fact Sheet 1 – What is a Coastal Adaptation Strategy?
- Fact Sheet 2 – Coastal Erosion Mapping of Your Community
- Fact Sheet 3 – Inundation Mapping of Your Community
- Fact Sheet 4 – Coastal Hazard Mapping of Your Community
- Frequently Asked Questions.

3.2.2 Community

Engagement with the community was undertaken and consisted a public forum with comments invited via feedback surveys.

Understanding the coastal hazards and adaptation approaches (Forum)

Date: Wednesday 6 November 2024 from 5pm onwards.

Duration: 2 hr forum (Beachport Golf Club)

The agenda for this forum included:

- Introductions and Overview of the Project (5 mins)
- Questions about the project (5 mins)
- How the assessment was undertaken and a summary of the results (15 min)
- Detailed review of the results in different areas via GIS system (45 min)
- Large format plots for Community Review & Discussion (45 min)

Public Comment (Online by Council/Shire)

Community members invited to submit comments in response to the in writing to the Council office or via the online engagement platform using a pre-prepared survey. This data has been collated by Wattle Range Council.

3.2.3 Key Stakeholders

- A draft of this report was provided to the Coastal Protection Board / DEW for their review. A workshop was held with DEW online in August 2024 and written feedback was received on the 23 August 2024. This feedback has been incorporated into this report.

4 COASTAL PROCESSES DESCRIPTION

4.1 Site Context

4.1.1 Topography and Bathymetry

Topographic (land) data is available in high resolution (1 m) for the entire study area. Much of the land has an elevation of >5 m. However, a thin narrow strip of land between Lake George and Rivoli Bay is lower in elevation with only a thin narrow dune-type feature. The bathymetric data is of much lower resolution (250 m). While this is suitable for offshore wave transformation, closer to the shoreline in less than 3 m of water, the water-land transition is poorly resolved. This affects the accuracy of the inundation and erosion assessment. The bathymetry of Rivoli Bay is relatively shallow (<5 m).

Figure 3: Beachport Bathymetry data

Combined topography and bathymetry data sources used in this assessment. Topography uses the 5 m LiDAR dataset while the bathymetry data uses the 250 m bathymetry dataset. Datasets are interpolated, patched and smoothed prior to use in the inundation and erosion models.

4.1.2 Cross-shore Profiles

Several cross-shore profiles are obtained at various intervals by the Department of Environment, Water and Natural Resources (Table 5). These profiles are not obtained at a temporal resolution that is suitable for shoreline change assessment, however they do provide a clear reference that can be used to quantify typical shoreline movement as well as the profile of the shoreline. These profiles were used to compile and validate cross-shore profiles that were synthesised for this assessment. Figure 4 shows an example profile adjacent to Railway Terrace at Beachport. Analysis of the available cross-shore data shows that the nearshore profiles are in equilibrium down to a depth of between 2 – 4 m. Beyond these depths, the profile is relatively flat offshore compared with the respective equilibrium beach profile. The bay is relatively shallow with a very wide sand shoal over which waves propagate shoreward, causing onshore sediment transport.

Table 5: Beachport Beach line profile IDs (Nature Maps, 2023)

Profile ID	Town
710004	Beachport
710003	Beachport
710005	Beachport
710002	Beachport
710034	Beachport
710033	Beachport
710006	Beachport

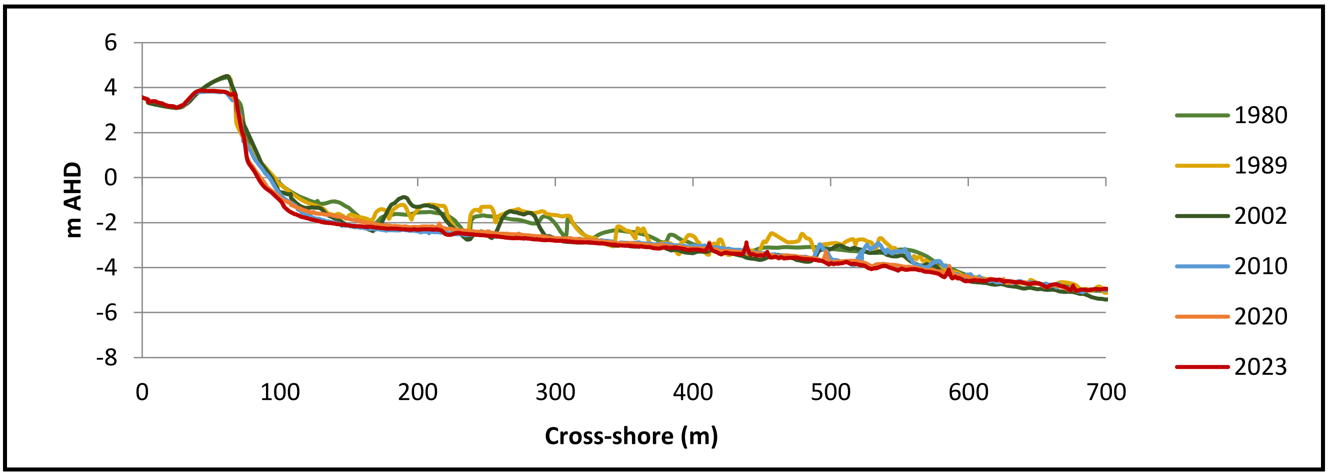


Figure 4: Cross-shore profile at Profile 710003 (Nature Maps, 2023)

4.1.3 Shoreline Characteristics

Coast Adapt Shoreline Explorer provided diagrams with categorised shorelines by erodibility. That assessment largely classifies the Beachport shoreline as being predominantly *'Dominantly sandy shores'* with very high erodibility. FSC Range has undertaken a high-resolution on-ground shoreline assessment to define the characteristics of the shoreline throughout the primary study area. The shoreline consists of a mix of sandy beach, rocky shoreline and engineered coastline (Figure 5). The engineered coastline is principally located adjacent to the township and was implemented to reduce shoreline erosion and to maintain beach amenity. We note that during our on-site assessment, terminal erosion was observed in some locations, particularly to the east of the town.

In this assessment, where the shoreline is highly erodible (i.e., sandy or similar), we have estimated the likely erosion that may occur (discussed in greater detail in section 6). Where the shoreline was determined to be hard (i.e., rock or limestone), erosion of that section of shoreline was assessed but can generally be considered to be negligible. Finally, for engineered shorelines (i.e., revetments or seawalls), it was assumed that these coastal defences would be maintained over the assessment timeframe.

Figure 5: Town of Beachport Shoreline Classification
Shoreline classification based on a visual inspection by FSC Range (Aerial imagery: ESRI).

4.1.4 Shoreline Position

Analysis of the shoreline position (as defined by the land-water interface) using satellite derive data indicates that some sections of the coastline have accreted while other sections of the coastline have eroded (Figure 6). Directly adjacent to the Beachport township, most of the coastline has accreted due to the ongoing supply of sand from the shallower areas of the Bay and from the coastline to the west. The exception to this is at the area adjacent to Railway Terrace, with long term recession identified there resulting in dune-face recession of around 5 m (Figure 4). Erosion in this area is likely due to waves reflecting off the vertical seawall which may have caused a local deepening of the beach profile here. In addition, studies (Worley Parsons 2015, Baird 2021) have concluded that the long distance between the groynes, incident wave angle, and short length of the groynes in this area does not allow the formation of a beach spanning the entire compartment between these two groynes. West of the township (within the Beachport Conservation Park) the shoreline has also accreted. However, at Salmon Hole, substantial shoreline erosion has been observed since 1988. This long-term erosive trend appears to be continuing and is likely to breach the dune along this section of the coastline in the coming years. The trends observed in the shoreline have been included in the erosion hazard assessment.

Figure 6: Beachport Coastline Retreat 1988-2021 (Geoscience Australia, 2021)
Warmer colours indicate more recent shoreline position.

4.2 Water Levels

4.2.1 Storm Tide

A storm tide water level includes the contribution of astronomical tide and atmospheric storm surge. CSIRO CANUTE 3 provides estimates for the 100-year average recurrence interval (ARI) storm tide. DEW also supplied estimates for the 100-year ARI storm tide. To address uncertainties due to limited historical water level data, this assessment adopts the range of values presented in Table 6.

Table 6: Storm Tide Level

Scenario	Storm Tide (m AHD)
100-year ARI	1.27 – 1.40

4.2.2 Tidal Planes

The water level variations along this section of coastline are classified as mixed-semidiurnal conditions, and also exhibit diurnal characteristics. There are two high tides and two low tides on some days and only a single high and low tide on other days. Tidal levels are shown in Table 7.

Table 7: Beachport Tidal Planes
The typical tidal range varies from 0.4 m during neap tides to 0.8 m during spring tides.

Datum	Tidal Level (m LAT)
Highest Astronomical Tide	1.6
Mean High High Water	1.1
Mean Low High Water	0.9
Mean Sea Level	0.7
Mean High Low Water	0.5
Mean Low Low Water	0.3

4.2.3 Sea level rise

The state planning policy specifies the sea level rise allowance for coastal flooding and long-term recession effects and planning for coastal development (Table 8). These values are adopted in this assessment.

Table 8: Sea level rise scenarios
Relevant data that were identified for use in this assessment are summarised. There are many other data sources available that could also be used. These have not been listed.

Scenario	Sea level rise (m)
Present	0.0
2050	0.3
2100	1.0

4.3 Waves

The offshore swell wave climate (wave height and period) has been recorded by the Bureau of Meteorology with a Waverider buoy located at Cape du Couedic, off the south-west coast of Kangaroo Island (approximately 300 km west of Rivoli Bay). This dataset along with the wave buoy data at Cape Bridgewater, approximately 150 km south-east of Rivoli Bay, were reanalysed by WRL (2013). More recently, the future wave climate offshore of Beachport was assessed by CSIRO as well as by the FAST project. The results from all assessments are similar. The predominant wave direction for extreme waves affecting this portion of the coast is from the south-west sector with a typical offshore wave height of approximately 9.8 m and period of about 16 s.

Wave patterns at Beachport are complex and strongly influenced by the shape of Rivoli Bay, as well as by both wave refraction and diffraction around Penguin Island. The relatively shallow water depth in Rivoli Bay limits the height of the incident waves that impact the coast, although we note that substantial storm tide and wave setup occurs due to this same shallow water depth and the embayed nature. For this assessment, the duration of the incident waves is important as the duration of these depth limited waves (rather than the absolute magnitude of the offshore incident waves) drives shoreline erosion. Previous assessments by WRL (2013) have suggested that storm events along this section of coastline have a duration of approximately 43 hours.

4.4 General Description of Key Processes

The key hydrodynamic and sediment transport processes within Rivoli Bay have been assessed in both the Worley Parsons (2015) and Baird (2021) studies. These studies demonstrate that the predominant wave climate drives northerly sediment transport towards the Lake George Outlet principally during storms. During these storm events, sand is eroded from the shore and transported offshore and later transported back to the shore by waves during calmer weather. As a result, the beaches in this area are seasonally variable; the beaches are typically wider over summer and narrower in winter. Given the shallow nature of Rivoli Bay, the littoral zone (offshore extent of sediment movement) is considered to extend a significant distance offshore.

Nearshore currents vary at Beachport. Stronger wave-driven currents are directed to the north, which transport sediment along the shoreface (as observed by the orientation of sediment within the groyne compartments). Thus, the width of beaches along the Beachport foreshore is influenced by the shape and dimension of the groynes and their alignment with incoming waves. Further offshore, weak currents travel southward driven by the tidal circulation within Rivoli Bay. Outside of Rivoli Bay, the shoreline is exposed to incident waves that propagate from far offshore and drive sediment transport both along the shoreline as well as offshore during storm events.

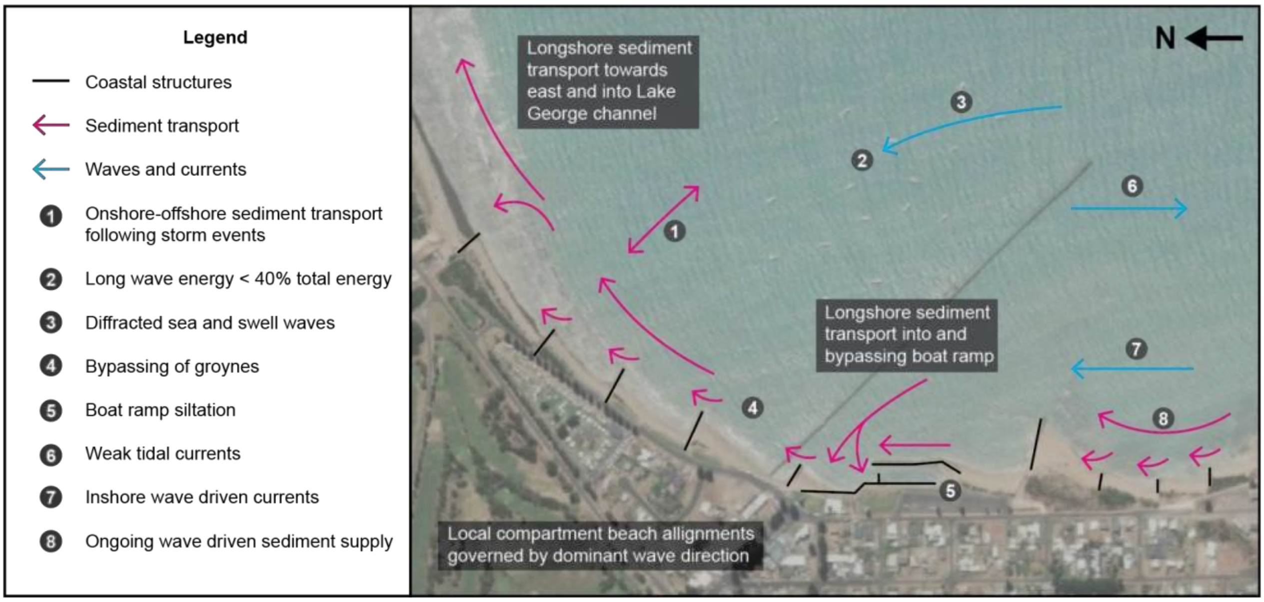


Figure 7 – Conceptual diagram of key coastal processes

5 COASTAL HAZARDS: INUNDATION

5.1 Previous Assessments

Past assessments have adopted a Bathtub model approach. This approach draws a horizontal plane across a digital elevation model (DEM) and any area of land that is lower than that plane is identified as being flooded or inundated. There are several limitations associated with the Bathtub model approach with the most prominent being that this approach can overestimate the inundation extents due to the lack of direct flow paths from the coast (connectivity not considered) and the large flood volumes required to fill this area (duration of the inundation event is not considered). Furthermore, for open coasts that are exposed to dynamic wind and wave processes, Bathtub models may under-estimate the potential for flooding from extreme events.

5.2 Assessment methodology

In this assessment a dynamic inundation model, the Super-Fast INundation of CoastS (SFINCS) model, was used to quantify the inundation hazard zone for various scenarios. The model was forced offshore of the site and translated to the -2 m contour. A high resolution (10 m) dynamic simulation was then undertaken for a reduced numerical domain (Figure 8) for six scenarios (Table 9). Scenarios considered water levels resulting from the 1% AEP Storm Tide plus wave effects (including wave runup and wave setup) plus SLR for the 2050 and 2100 time frames. Scenarios 1 and 2 used data provided by DEW, scenarios 3 and 4 used data provided by DEW with wave setup calculated from SWAN model results, and scenarios 5 and 6 used data from CSIRO CANUTE 3. Scenarios 5 and 6 did not consider an additional component for wave runup as the wave setup estimate provided by CANUTE was seen as an upper limit of potential wave effects on inundation levels. The configuration of the model is summarised in Appendix D.

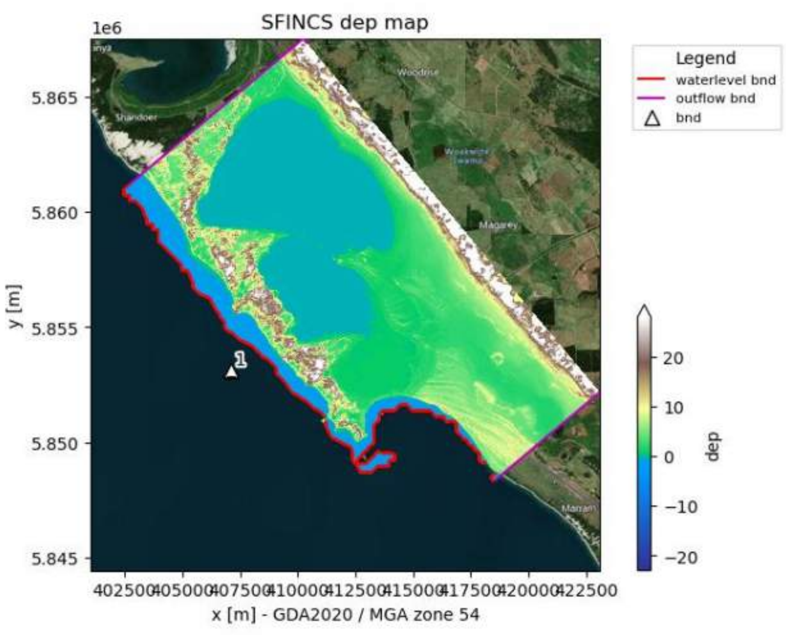


Figure 8: Inundation model configuration
The resolution of the model was 10 m x 10 m and was assembled from a range of data sources (Table 3).

Table 9: Inundation hazard scenarios

Six scenarios were simulated in this assessment, which considered 1% AEP Storm Tide + 1% AEP wave setup and runup + sea level rise.

Case	Unit	Scenarios						Comment
		1	2	3	4	5	6	
Time reference	Year	2050	2100	2050	2100	2050	2100	Consistent with other assessments in this region
(a) Storm Tide	m	1.4	1.4	1.4	1.4	1.27	1.27	1% AEP Storm Tide includes astronomical tide and storm surge
(b) Wave effects	m	0.8	0.8	1.3	1.3	2.95	2.95	1% AEP Wave Event, values include wave setup and wave runup
(c) Sea level rise*	m	0.3	1.0	0.3	1.0	0.3	1.0	Consistent with other assessments in this region.
(d) 1% AEP Water Level (a + b + c)	m AHD	2.50	3.20	3.00	3.70	4.52	5.22	1% AEP event is specified as a triangular distribution.
(h) 1% AEP Water Level (Duration)	hr	72	72	72	72	72	72	

* Sea level rise values are relative to 1990 baseline. The data used in this analysis is based on 2005 baseline mean sea level. We have not corrected for this as, when all uncertainty is considered, this difference is not of first order importance. The average rate of sea level rise across South Australia is estimated to be 1.5 mm/yr.

5.3 Mapping considerations

The presented results should be interpreted based on the following considerations:

- The analysis results are presented as the maximum inundation extent that occurred over the duration of the event and are relative to the land topography. The extent has been classified as likely, possible and rare. The key process that affects the extent of impact is wave-driven effects (i.e., wave runup and setup).
- Mapping does not account for infiltration as there was insufficient data available within the scope of this assessment to accurately account of infiltration or dissipation by drainage systems. This is consistent with other assessments.
- The magnitude of the inundation is accounted for in the risk assessment.
- The spatial resolution of the presented results is 10 m.
- The results are averaged over 10 m and may not fully account for structures or their shape and thus their impact on the flow pathways.

5.4 Results

The inundation hazard mapping indicates that by approximately 2050, limited inundation can be anticipated. However, during a 1% AEP wave event, the associated wave setup will substantially increase the water elevation along the shoreline. When wave setup is included in the assessment, there is an increase in the spatial extent of the inundation. This inundation includes areas around the Beachport Lagoon as well as much of the township.

The additional sea level rise up to 2100 is anticipated to result in inundation of areas around the golf course. When for higher wave-induced inundation is included, very large areas of the town are likely to substantially impacted. This is principally due to the increase water elevation being able to breach the narrow foreshore dune system during storm events.

5.4.1 Limitations

Several assumptions and exclusions affect this inundation assessment:

- Tidal variations were not accounted for in inundation modelling. Neglecting tidal variations was a deliberate choice made to adopt a conservative approach and remain within the project's defined scope. Sensitivity modelling was completed to assess the impact of this approach and it was determined that the impact of tidal variation was small relative to other contributors.

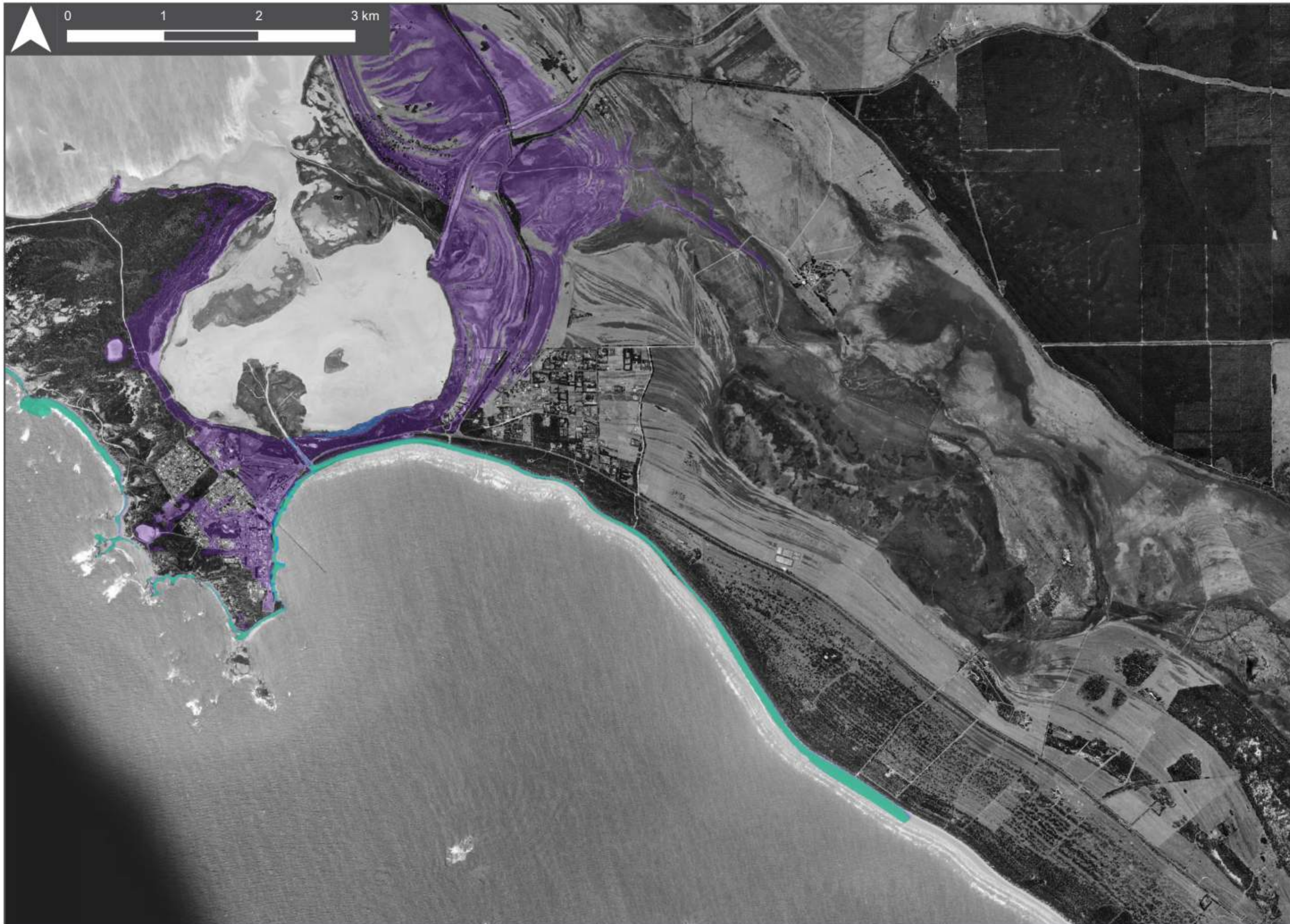
- This assessment includes data gaps, particularly in nearshore bathymetry. Detailed nearshore bathymetry data is necessary to constrain nearshore wave processes and necessary for accurate estimation of wave setup.

- Infiltration and spatially varied roughness were not considered as there was insufficient data available to quantify these values and may affect the rate of inundation propagation and dissipation. Typical values have been used. Infiltration in particular may reduce the overall magnitude of inundation.

- This study intentionally excluded considerations for rainfall and river flow or discharge, which may impact the inundation during compound events (i.e., when a large wave event occurs with high rainfall). Compound modelling was out of scope for the defined coastal hazard assessment.

- The role of drainage systems has been excluded. This is consistent with other coastal hazard assessments.

- This inundation assessment has been undertaken based on the current topography and bathymetry. The inundation and erosion hazards are treated as discrete events. Erosion that may occur at the same time, or prior to, an inundation event may change the results of this assessment.



Legend

- Likely
- Possible
- Rare

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FSC RANGE

Beachport 2050 Inundation Map
Limestone Coast Coastal Adaptation Asessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 1 of 4
Date: 27/07/2025

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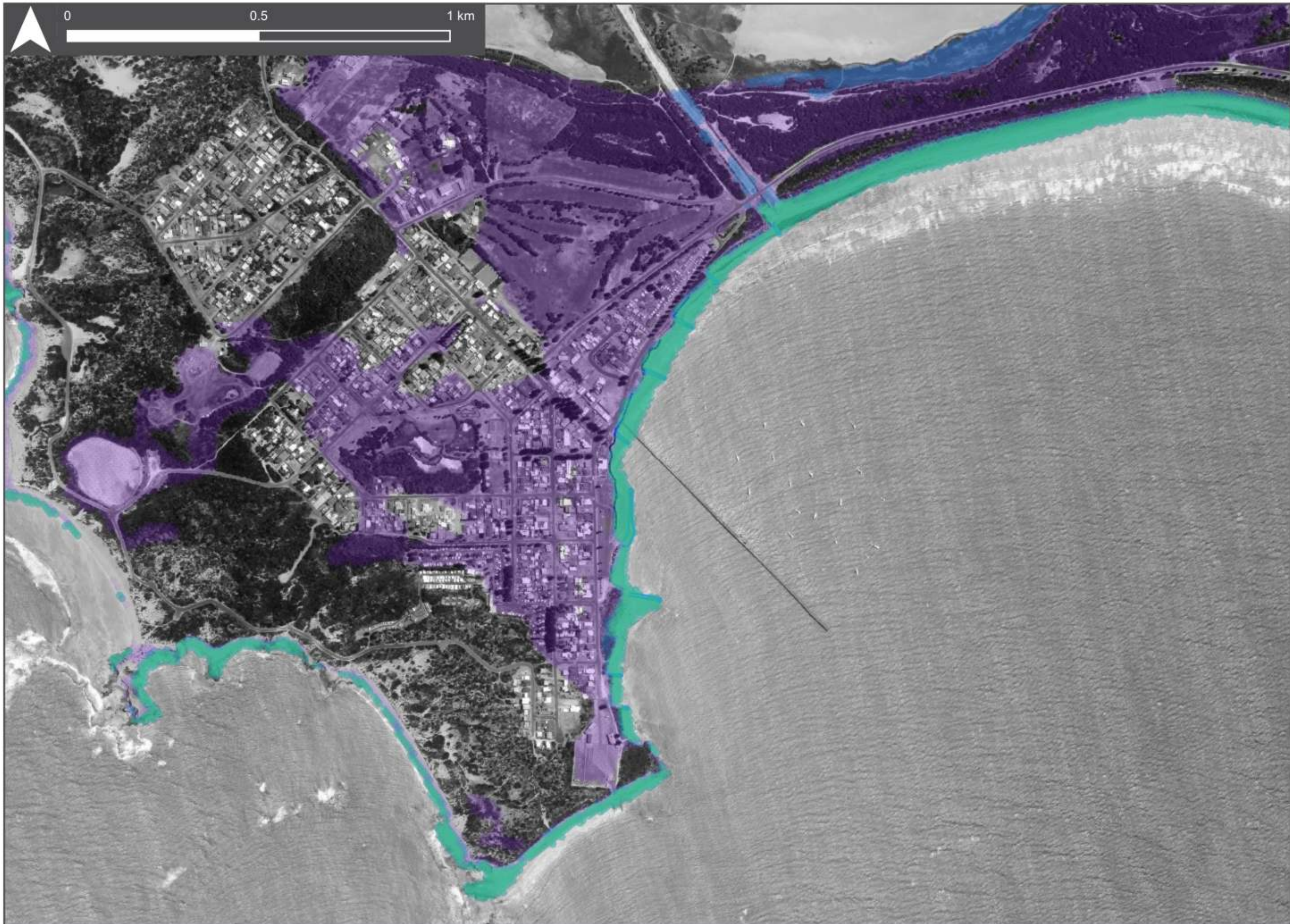

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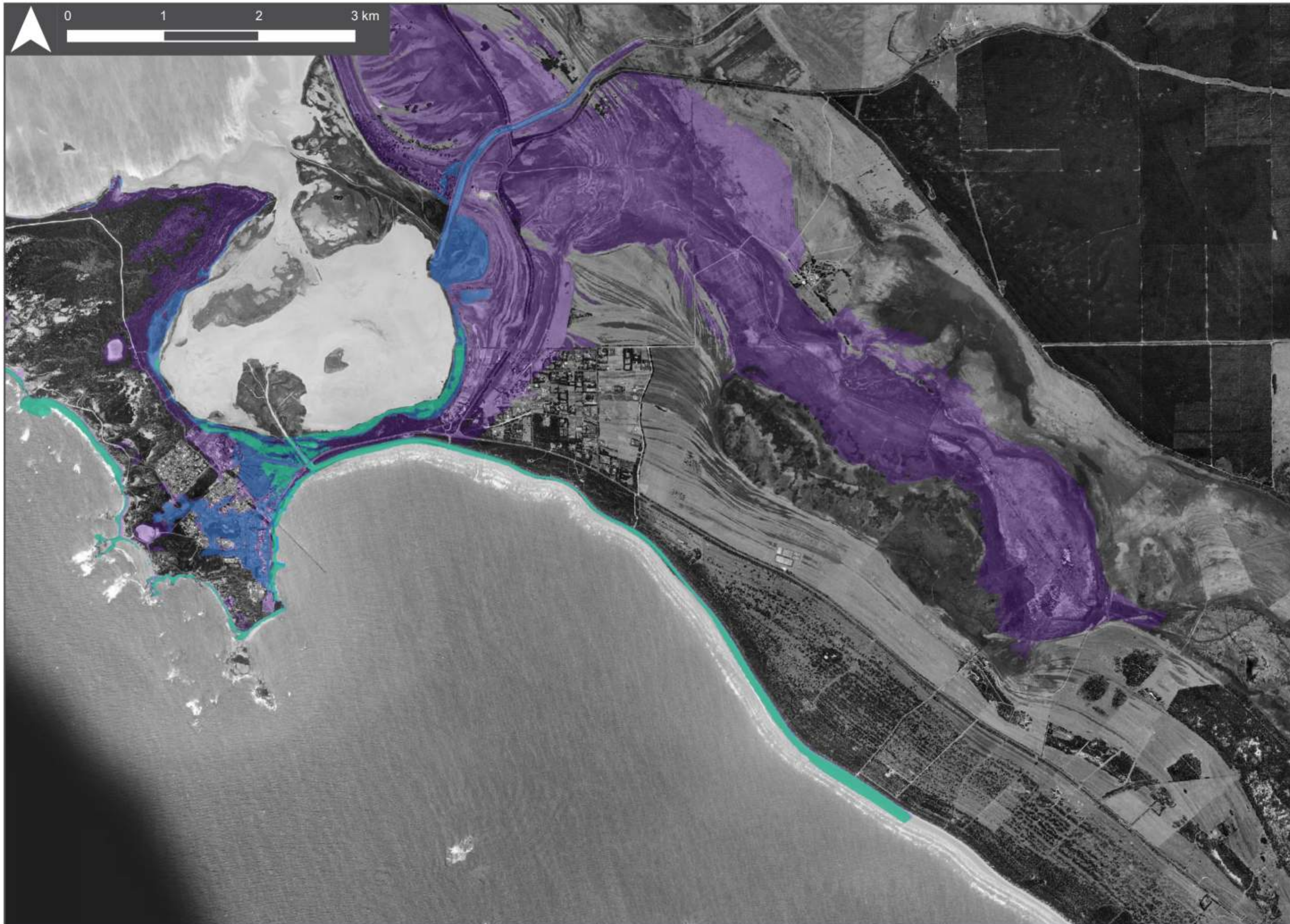

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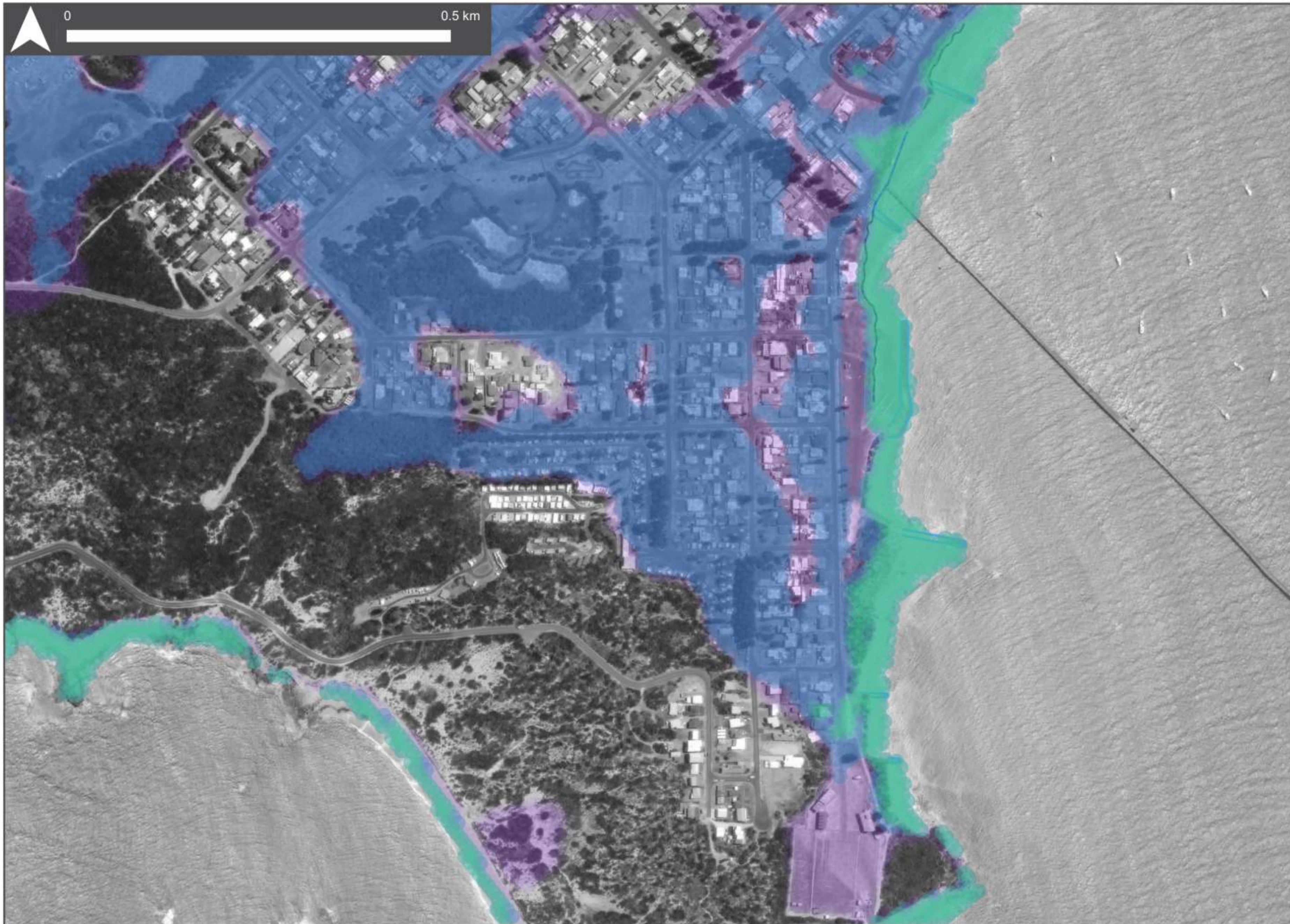
Beachport 2100 Inundation Map

Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 1 of 4
Date: 27/07/2025



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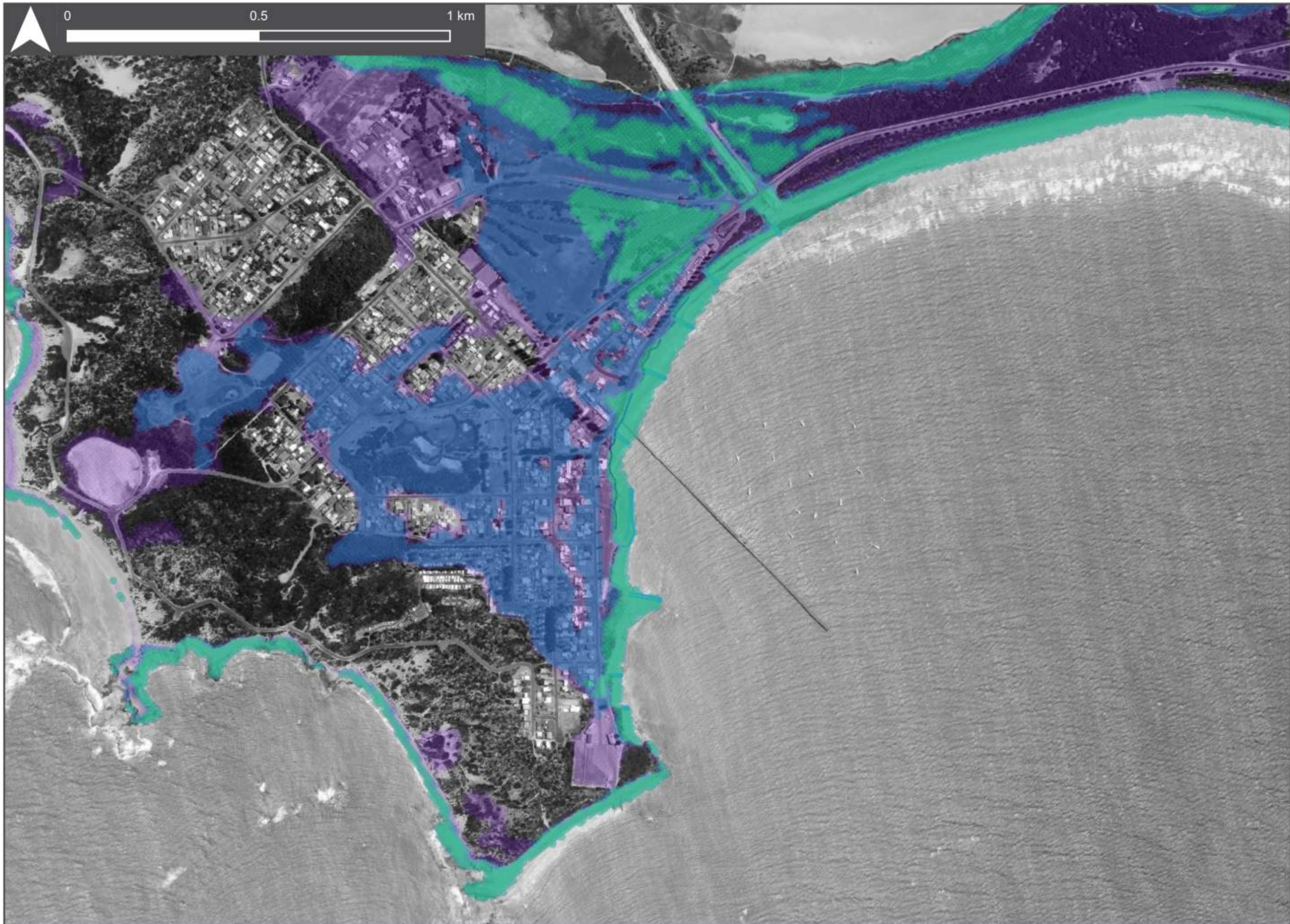

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6 COASTAL HAZARDS: EROSION

6.1 Previous Assessments

No detailed coastal hazard (erosion) assessments have been undertaken.

6.2 Assessment methodology

To define the erosion hazard zone, a probabilistic approach was adopted that combined standard and well-tested deterministic or numerical approaches to estimate various erosion components. This approach recognises that there is inherent uncertainty associated with different physical processes and indeed with the methods used to quantify these processes. The coastal erosion components were then assembled in a building block approach:

$$E = S + D + M + N \times L + SLR$$

Where:

E = erosion width (meters)

S = short term erosion for the design storm (meters)

D = dune instability component associated with short term erosion events (meters)

M = medium term shoreline position fluctuations (meters)

N = planning period (years)

L = long term rate of erosion/accretion (meters per year)

SLR = recession due to sea level rise (meters)

Probability distribution functions (pdfs) were defined for key parameters. Where a known pdf was available (i.e., in literature or could be derived from data) these pdfs were used. Otherwise, pdfs were assembled as triangular distributions and approximate a normal distribution. The minimum, maximum and modal values for each pdf is described in the following sections and summarised in Table 10. Parameter values were randomly sampled from the pdfs and the extracted values were used to define a potential coastal erosion hazard zone distance. This process was repeated 10,000 times using a Monte Carlo technique to produce a probabilistic (forecast) distribution of the resultant coastal erosion hazard zone width.

6.2.1 Short-Term Erosion (S)

Short-term erosion applies to beaches where rebuilding by wave and aeolian processes follows periods of erosion. Short-term processes include storm erosion caused by singular or clusters of events, seasonal fluctuations in wave climate, or changes in sediment supply and demand. Short-term erosion can be assessed by analysis of: (1) anecdotal evidence of past erosion distances or geomorphological signatures; (2) statistical analysis of change in shoreline position obtained from aerial photographs or beach profile analysis; (3) simple geometric models for beach response or (4) assessment of storm erosion potential using semi process-based models.

In this assessment we use the numerical model SWAN (Appendix D) to transform incident waves from offshore to the 5 m nearshore contour. We then used the numerical model XBeach (Appendix D) to predict and analyse short–term, storm-induced erosion at transects spaced at approximately 500 m intervals along the shoreline. Transects were generated from the merged bathymetry assembled for the inundation model. In the absence of suitable offshore wave data, a synthetic storm profile was assembled for each event duration / case based on field observations by FSC Range.

6.2.2 Dune Instability (D)

On non-consolidated (sandy) beaches, storm erosion results in an over-steepened scarp which must adjust to a stable angle of repose for loose dune sand. This results in an area of potential risk landward of the erosion scarp. In this analysis, we account for this instability by calculating a dune instability width, which is dependent on the height of the existing backshore (z) and the angle of repose (α) for loose dune sand.

$$D = \frac{z}{2 \tan \alpha}$$

Values for *z* were derived from LiDAR data along the coastline, and α ranged from 30-34° for beach sand and 25-30° for beach gravel.

6.2.3 Medium-Term Fluctuations (M)

Some beaches may exhibit medium-term fluctuations, which may be due fluctuations in sediment supply or climate cycles over shorter periods (i.e., 10-25 years) around a mean. In this analysis, the medium-term trends for beaches have been derived from the DEA Coastlines dataset (Bishop-Taylor, et al. 2021) or cross-shore profile data where available and included where appropriate.

6.2.4 Long-Term Trends (L)

The long-term movement of the beach profile may be driven by changes in relative mean sea level, in coastal sediment supply, by anthropogenic influences, or associated with long-term climatic cycles. This combination of processes may result in erosion, accretion or both. In this analysis, the long-term trends have been derived from the DEA Coastlines dataset (Bishop-Taylor, et al. 2021). Where cross-shore profile data was available, long-term trends were compared and judgement used to reconcile any differences.

6.2.5 Response to Sea Level Rise (SLR)

Geometric response models propose that as the sea level increases, the equilibrium profile is moved upward and landward conserving mass and original shape. The most well-known of these geometric response models is the Bruun Rule (Bruun, 1962, 1988) which proposes that with increased sea level, material is eroded from the upper beach and deposited offshore to a maximum depth, termed closure depth. The increase in seabed level is equivalent to the rise in sea level and results in landward recession of the shoreline. The model may be defined by the following equation:

$$R = \frac{L_*}{B + d_*} SLR$$

Where *R* is the landward retreat, *d** defines the depth of closure (maximum depth of sediment exchange), *L** is the horizontal distance from the shoreline to the offshore position of *d**, *B* is the height of the berm/dune crest within the eroded backshore and SLR is the relative sea level rise. The inner parts of the profile exposed to higher wave energy are likely to respond more rapidly to changes in sea level. For example, Komar (1999) proposes that the beach face slope is used to predict coastal erosion due to individual storms. Deeper definitions of closure including extreme wave height-based definitions (Hallermeier, 1983), sediment characteristics and profile adjustment records (Nicholls et al., 1998) are only affected during infrequent large-wave events and therefore may exhibit response-lag.

To account for limitations associated with this approach, uncertainty parameters were considered within the probabilistic framework for each variable.

To define parameter distributions, three different active translation slopes (L*/(B+D) component) have been derived, which include:

1. Active beach face, average dune toe position to low water mark (lower bound).
2. Inner closure slope, average dune crest to inner Hallermeier closure depth (upper value).
3. Mean of the active and inner closure slope (modal value)

The Hallermeier closure definitions are defined as follows (Nicholls et al., 1998):

$$d_i = 2.28H_{s,t} - 68.5\left(\frac{H_{s,t}^2}{gT_s^2}\right) \cong 2H_{s,t}$$

$$d_o = 1.5d_i$$

Where d_i is the inner closure depth below mean low water spring, $H_{s,t}$ is the non-breaking significant wave height exceeded for 12 hours in a defined time period, nominally 1 year, and T_s is the associated period. d_o is the outer closure depth below mean low water springs.

Table 10 Erosion Hazard Assessment Components and Distributions

The components assessed in the erosion hazard assessment are listed along with the lower, mode and upper values used to define the probability distribution function in the probabilistic assessment.

Parameter	Unit	Distribution			Comment
		Lower	Mode	Upper	
Short Term (ST)	m	1% AEP (24 hours)	1% AEP (43 hours)	2x 1% AEP (86 hours)	Storm cut for various 1% AEP storm durations
Dune Stability (D)	m	z_{min}; a_{min}	z_{mean}; a_{mean}	z_{max}; a_{max}	
Medium Term (M)	m	Not included in analysis			Insufficient data resolution
Long Term (LT)	m/yr	-95% CI of smallest trend	Mean regression trend	+95% CI of largest trend	Trends from DEA Coastlines
Sea Level Rise (SLR)	m	0.3 m; 1.0 m			Prescribed by CPB
Closure Slope	-	Slope across active beach face	Inner Hallermeier closure depth	Outer Hallermeier closure depth	

6.3 Mapping Considerations

6.3.1 Mapping areas with coastal protection structures

Where structures protect the shoreline, it is assumed that these structures will remain maintained and functional. Consequently, the coastal hazard zone lines situated along the toe of these structures do not move further landward (but can move seaward). This results in coastal erosion hazard zone transitions between protected and non-protected coastlines. As coastal protection structures are typically less than 500 m long, it is not possible to refine the resulting coastal erosion hazard zone lines in an assessment at this scale. This should be undertaken later when detailed site-specific assessments are undertaken. In this assessment, the coastal erosion hazard zone lines have been generalised as far as practicable to show realistic coastal erosion hazard zone lines.

6.3.2 Smoothing and expert judgement

As a result of the mapping approach and spatial resolution of the analysis, the resulting coastal hazard zone lines would appear slightly angular and have points of discontinuity. Consequently, the mapped coastal erosion hazard lines have been modified using engineering judgement where required to make the lines more realistic or to smooth out the assessment results.

6.3.3 Probabilistic presentation

The erosion hazard results have been presented in a statistical form. The solid line indicates the most likely 1% AEP erosion extent. Dashed lines indicate the 95% exceedance value (the erosion extent that is has a 95% probability of being exceeded), as well as a 5% exceedance value (the erosion extent that has a 5% probability of being exceeded over the assessment period).

6.4 Results

The 2050 assessment indicates that the erosion is mostly contained within various reserves with limited impact on community infrastructure. Areas where coastal erosion may impact public infrastructure include:

- Millicent Road approaching from the east.
- Beach Road south of the boat ramp.
- The slipway.
- Scenic Drive to the west near the Pool of Siloam / Beachport Lake.

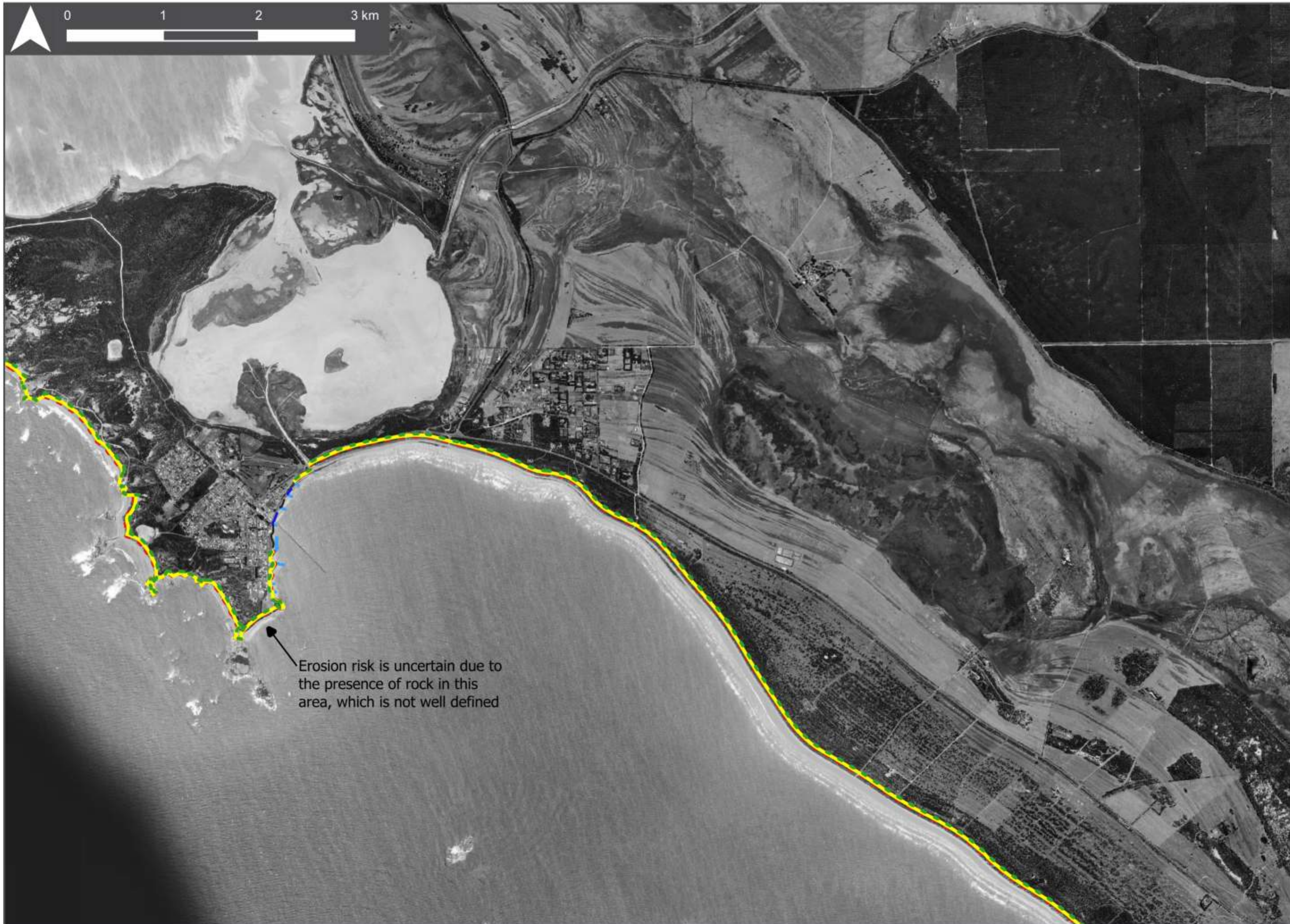
The 2100 assessment indicates that that same areas are expected to be impacted by erosion but that this erosion extent will be larger.

We note that the precise shoreline erosion extent south of the boat ramp where there is a mix of rock groynes and unprotected shoreline cannot be fully resolved at this scale of assessment. Consequently, the erosion extents are represented in the hazard maps as translated shoreline position.

6.4.1 Limitations

Several assumptions and exclusions affect this assessment:

- Tidal variations were not accounted for. Neglecting tidal variations was a deliberate choice made to adopt a conservative approach and remain within the project's defined scope. Sensitivity modelling was completed to assess the impact of this approach.
- This assessment includes data gaps, particularly in nearshore bathymetry. Detailed nearshore bathymetry data would be useful in assessing nearshore wave and sediment transport processes.
- Short term coastal erosion has been estimated using numerical models. The boundary conditions are derived from a large-scale model. Bathymetry in areas where no data were available were approximated based on aerial imagery, bathymetric charts, and the sediment grain size. The actual bathymetry may be different. This will affect the accuracy of this component. Acquisition of data at key points in the coastal zone is strongly recommended to constrain this assessment.
- The shoreline geology was inspected at 500 m intervals along the study area. It has been assumed that the shoreline geology is consistent landward of the shoreline (i.e., sandy does not overlay rocky substrata on a sandy coastline). This assumption may not always be valid and will more often result in a reduction in the hazard extent. In the absence of sufficient data, this approach is necessary.



Legend

- 5% Exceedance
- 50% Exceedance
- 95% Exceedance
- Present Shoreline
- Seawall
- Revetment
- Groyne
- Rocky Coast

This map displays the exceedance values for storm erosion during the 100-year Annual Recurrence Interval (ARI) event at the 5%, 50%, and 95% confidence levels.

The exceedance values signify the likely extent of erosion impacts and provides an indication of the uncertainty in the assessment. Land seaward of the red dashed line has a 95% likelihood of being impacted by erosion (assuming no intervention).

Features such as infrastructure, vegetation and reefs may reduce storm erosion but these effects have not been explicitly included in this assessment. The impact of existing coastal protection structures are included.

FSC RANGE

Beachport 2050 Erosion Map
Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 1 of 4
Date: 27/07/2025

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FSC RANGE

Beachport 2100 Erosion Map

Limestone Coast Coastal Adaptation Assessment

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Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 1 of 4
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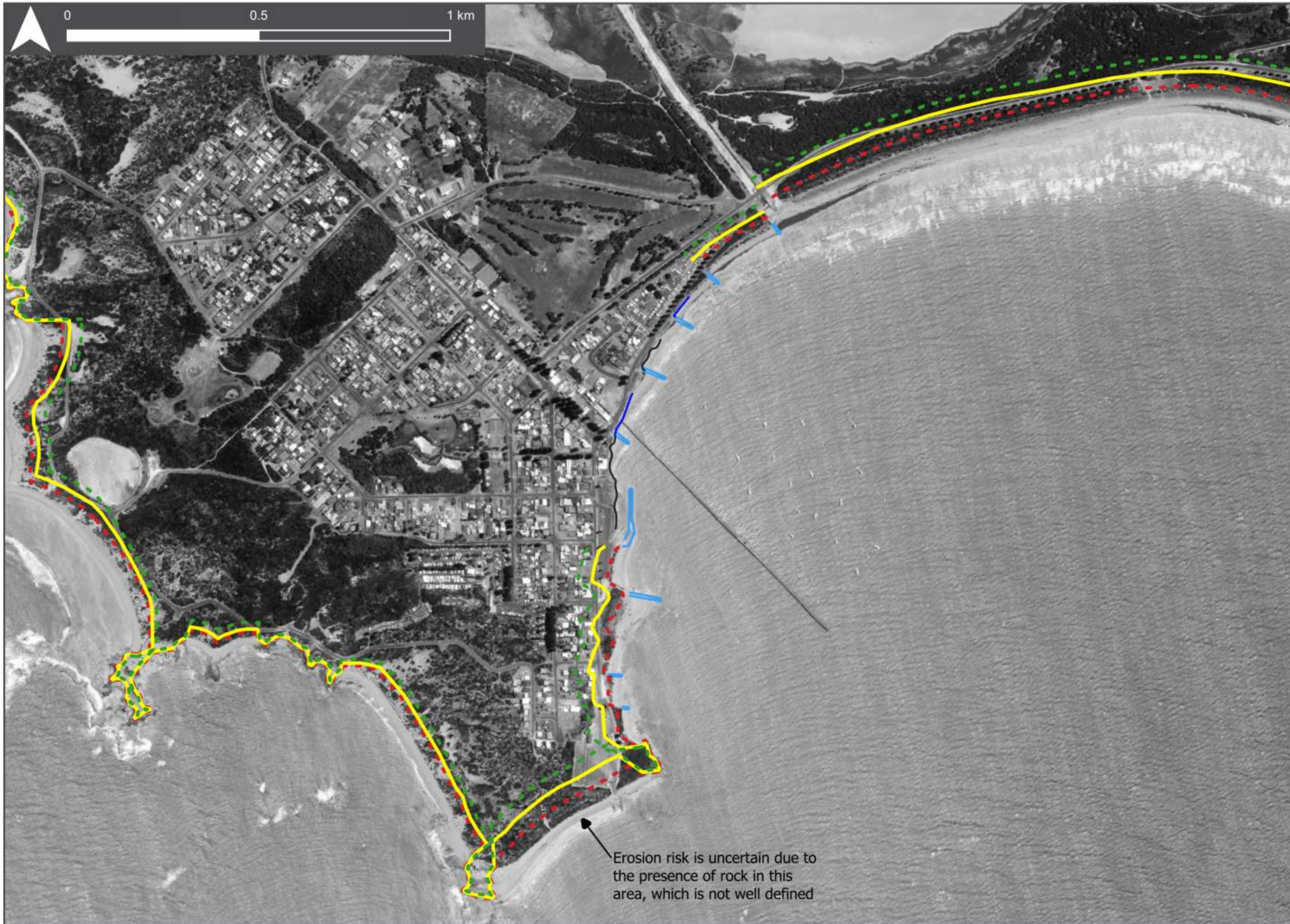

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7 RISK

7.1 Assessment Methodology

A semi-quantitative approach was used to assess the magnitude of the risk associated with the coastal hazards and is an extension on the approach used in previous assessments within the Limestone Coast Local Government Area (Wavelength, 2018).

7.1.1 Consequence Descriptors

The framework used in this assessment builds on the consequence descriptors proposed by Wainwright et al (2016). The descriptors used in this assessment are consistent with those used in other studies along this section of coast (Wavelength, 2018). We modified this approach to account for differences in land use (i.e., the consequence differs if the land is residential versus agricultural); our consequence curves are based on national and international curves for different land use. The land use types that were considered were the 17 identified by the South Australian Department for Housing and Urban Development.

We also included additional descriptors to align the framework with other frameworks commonly used in South Australia. The consequences for erosion and flooding were assessed under the assumption of no interventions.

We note that there is not a consistent approach to evaluate the consequence of erosion and especially when loss of land may occur separately from loss of assets, with varying financial implications. In this assessment, we used the approximate quantum of damage percentages to quantify the erosion consequence.

7.1.2 Likelihood

The likelihood was attributed based on the components considered in the analysis.

For inundation, the inundation extents derived from optimistic wave impacts were classified as “Likely”. Inundation extents derived from FSC Range’s estimate of wave impacts have been classified as “Possible”, and conservative estimates of wave impacts (based on CSIRO analysis) have been classified as “Rare”. We note that this is slightly different from other approaches but was chosen to align this assessment with nearby assessments in Kingston and Wattle Range.

For the erosion analysis, the likelihood was derived directly from the probabilistic assessment. Assets and land seaward of the risk probabilistic extents have been attributed the following likelihood category for the 1% AEP erosion event:

- Likely = 95% exceedance erosion
- Possible = 50% exceedance (average) erosion
- Unlikely = 5% exceedance erosion

7.1.3 Risk Rating

The resultant risk category assigned has been defined based on the likelihood / consequence matrix described by Table 11. The most conservative risk rating has been attributed at each analysis point.

Table 11: Consequence descriptors

Descriptors based on Wainwright et al (2016) and expanded by FSC Range for specific asset categories.

Descriptor	Approximate quantum of damage	Consequence Descriptions	
		Adopted in this Assessment	Additional Descriptors
Catastrophic	>100%	• Significant permanent damage and/or complete loss of the infrastructure and the infrastructure service. • Loss of infrastructure support and translocation of services to other sites. • Very significant loss to the environment. • May include localised loss of species, habitats or ecosystem. • Extensive remedial action essential to • prevent further degradation. • Restoration likely to be required	• Death or permanent disability / illness • Severe property and business loss e.g. explosion • Severe environmental damage (reportable incident to EPA) • Serious public or media outcry (International coverage) • Major breach of regulation, Major litigation and/or potential culpability / manslaughter implications • Significant Financial Loss ($500k - $1M) • Loss of Business Operation. • Multiple Financial Year Impact
Major	40 to 100%	• Extensive infrastructure damage requiring major repair. • Major loss of infrastructure service. • Major impacts on assets and property. • Significant effect on the environment and local ecosystems. • Remedial action likely to be required	• Long term illness or serious/extensive injury • Major loss of business capability for several days • Major property or environmental damage (reportable incident to EPA) • Significant adverse national/media/public attention • Serious breach of regulation with investigation or report to authority with prosecution and/or moderate fine possible • Major financial Loss ($200k - $500k). Major impact on business operation and multiple financial year impact.
Moderate	10% to 40%	• Limited infrastructure damage and loss of service. • Damage recoverable by maintenance and minor repair. • Some damage to the environment, including local ecosystems. • Some remedial action may be required	• Medical treatment or several days off work • Loss of business capability for one day • Property damage • Onsite contaminant release contained with outside assistance (reportable incident to EPA) • Attention from media and heightened concern by local community • Minor legal issues, non-compliance and breaches or regulation • Moderate Financial Loss ($50k-$200k). Moderate impact to business operations. May impact beyond current financial period.

Minor	1% to 10%	• Localised infrastructure service disruption • No permanent damage. • Some minor restoration work required. • Water depth < 0.4 m over roads. • Minimal effects on the natural environment	• First aid treatment • Negligible loss to business capability • Minor property damage • On-site contamination release immediately contained(non-reportable incident to EPA) • Minor adverse local public or media attention or complaints • Minor legal issues, non-compliance and breaches or regulation • Minor Financial Loss ($10k-$50k). • Minor financial disruption. • Minor variation to budget for financial year.
Insignificant	<1%	• No infrastructure damage, little change to service. • Water depth < 0.15 m over roads.	• No or insignificant injuries (Not requiring first aid treatment) • No or insignificant loss of business capability (less than an hour) • No or insignificant property damage (vandalism / graffiti) • No or insignificant environmental Impact (Incorrect storage chemicals • No adverse effects on natural environment • No or insignificant legal issues (legal queries under retainer) • No or less than $10K financial loss, insignificant financial interruption. • No or insignificant local media attention or complaints (request for service form)

Table 12: Likelihood / Consequence Matrix

The risk category assigned in this assessment was based on the specific combinations of likelihood and consequence.

Likelihood	Consequence				
	Catastrophic 5	Major 4	Moderate 3	Minor 2	Insignificant 1
Almost Certain 5	High	High	Significant	Significant	Medium
Likely 4	High	High	Significant	Medium	Medium
Possible 3	High	Significant	Medium	Medium	Low
Unlikely 2	Significant	Medium	Medium	Low	Low
Rare 1	Significant	Medium	Low	Low	Low

7.1.4 Mapping approach

Inundation risk has been calculated, mapped, and presented at 20 m resolution (see maps that follow). Inundation depths shown are based on Scenario 2 (see Table 9), which includes slightly more conservative estimates of wave effects than the data provided by DEW (Scenario 1) and is more realistic than the CSIRO wave setup estimates (Scenario 3). The risk rating is based on the simulated inundation depth across all scenarios and can locally vary at this resolution based upon the local topography. The results should be interpreted based on the overall trend in risk and as a general risk rating only. To better constrain the risk rating, the risk should be assessed at high-resolution where this is deemed important and should also consider the land use, duration of hazard and the value of the assets (physical, social, and environmental).

In contrast to inundation risk, standardised methods for evaluating erosion risk levels are not well defined. Consequently, erosion risk ratings were therefore not presented visually. Instead, the approach assumes an eventual complete loss of land and assets seaward of the mapped erosion hazard lines, and risk ratings were evaluated individually for each asset (or group of assets) based on this assumption.

7.2 Results

To develop the adaptation strategy, Beachport was separated into nine areas (Figure 9). These areas should not be considered to be isolated regions, they are simply areas for the purposes of communication, planning and implementation; the boundaries are artificial and for convenience. In this section the 2100 inundation extent and 50% exceedance erosion hazard lines are shown for clarity. Assets at risk were identified in recent aerial imagery of the township and in communication with project stakeholders.

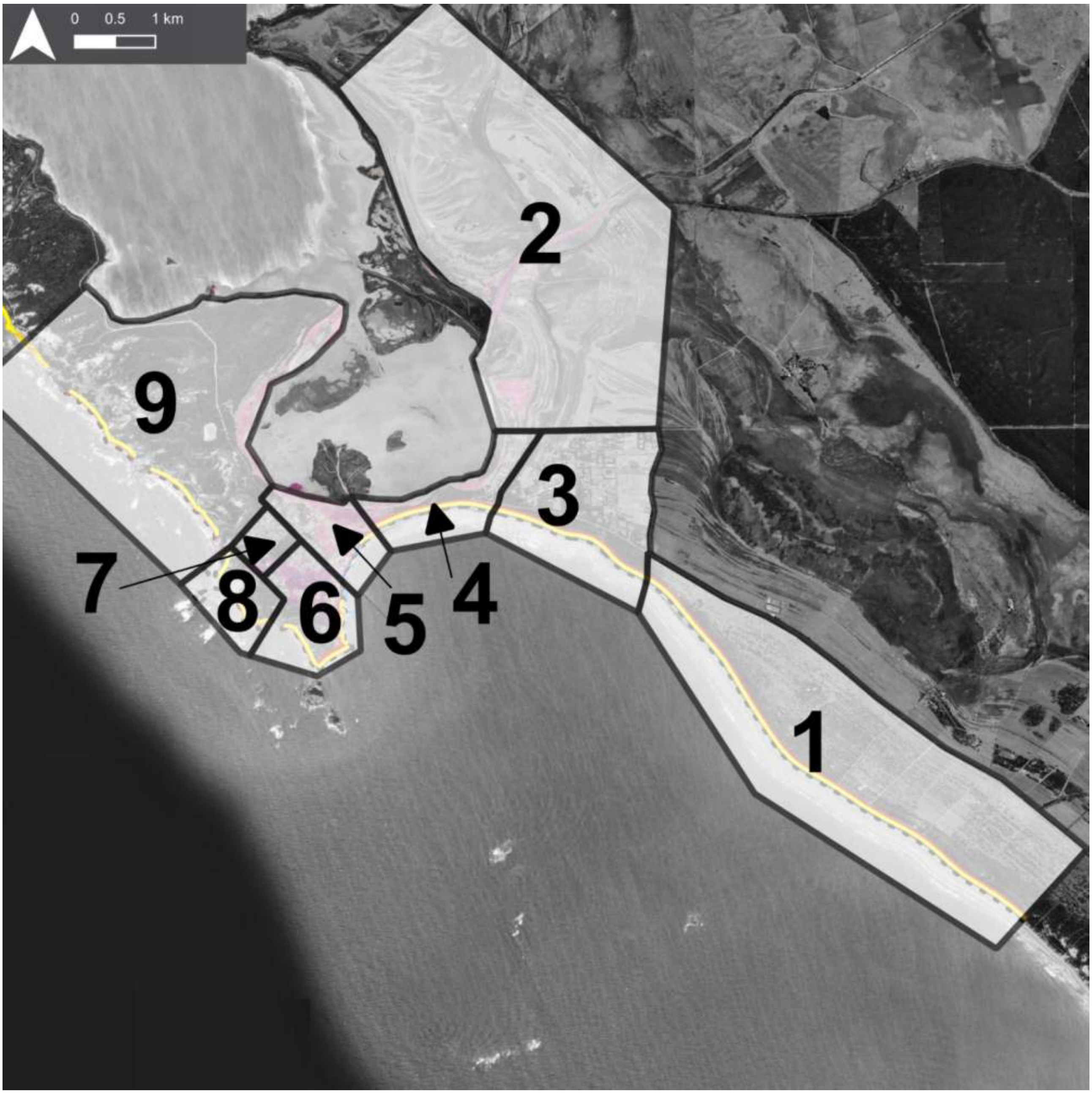


Figure 9: Coastal Area Divisions

7.2.1 Area 1 (Southeast Beachport)

Erosion Hazard
- Baseline
- By 2050
- By 2100

Inundation Hazard
- <0.25 m
- 0.25 - 0.35 m
- 0.35 - 0.65 m
- 0.65 - 1.25 m
- >1.25 m

Shoreline Features
- Groyne
- Revetment
- Rocky Coast
- Seawall

Hazard extents are prior to any adaptation actions and for a 100-year Annual Recurrence Interval (ARI) storm event.

The erosion hazard lines correspond to the 50% likelihood extent by 2100.

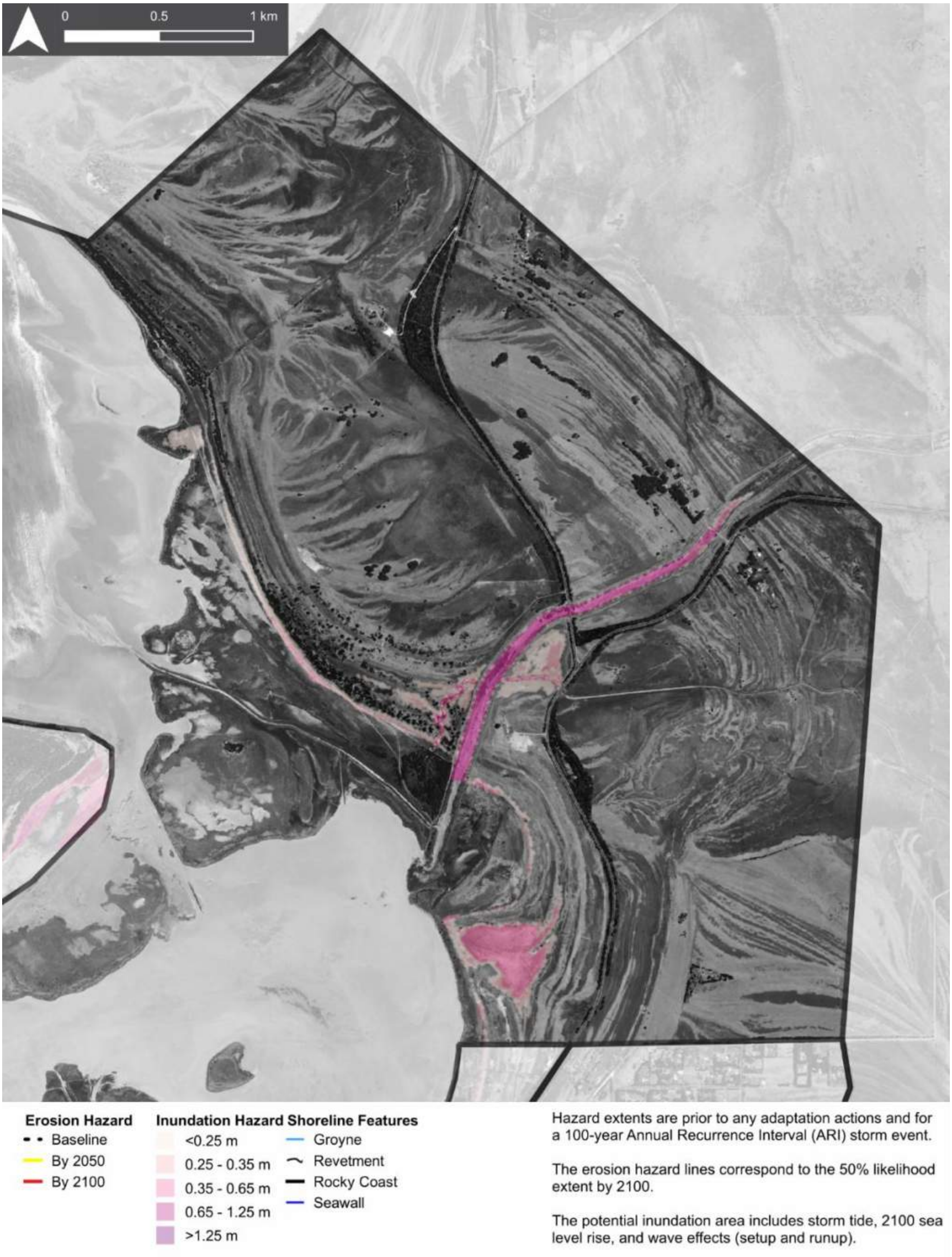
The potential inundation area includes storm tide, 2100 sea level rise, and wave effects (setup and runup).

Assets at risk

No assets were identified as being at risk in this area except for the local coastline of Rivoli Bay.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Rivoli Bay Foreshore	Public Amenity	Medium	Low	Medium	Low

7.2.2 Area 2 (Northeast Beachport)



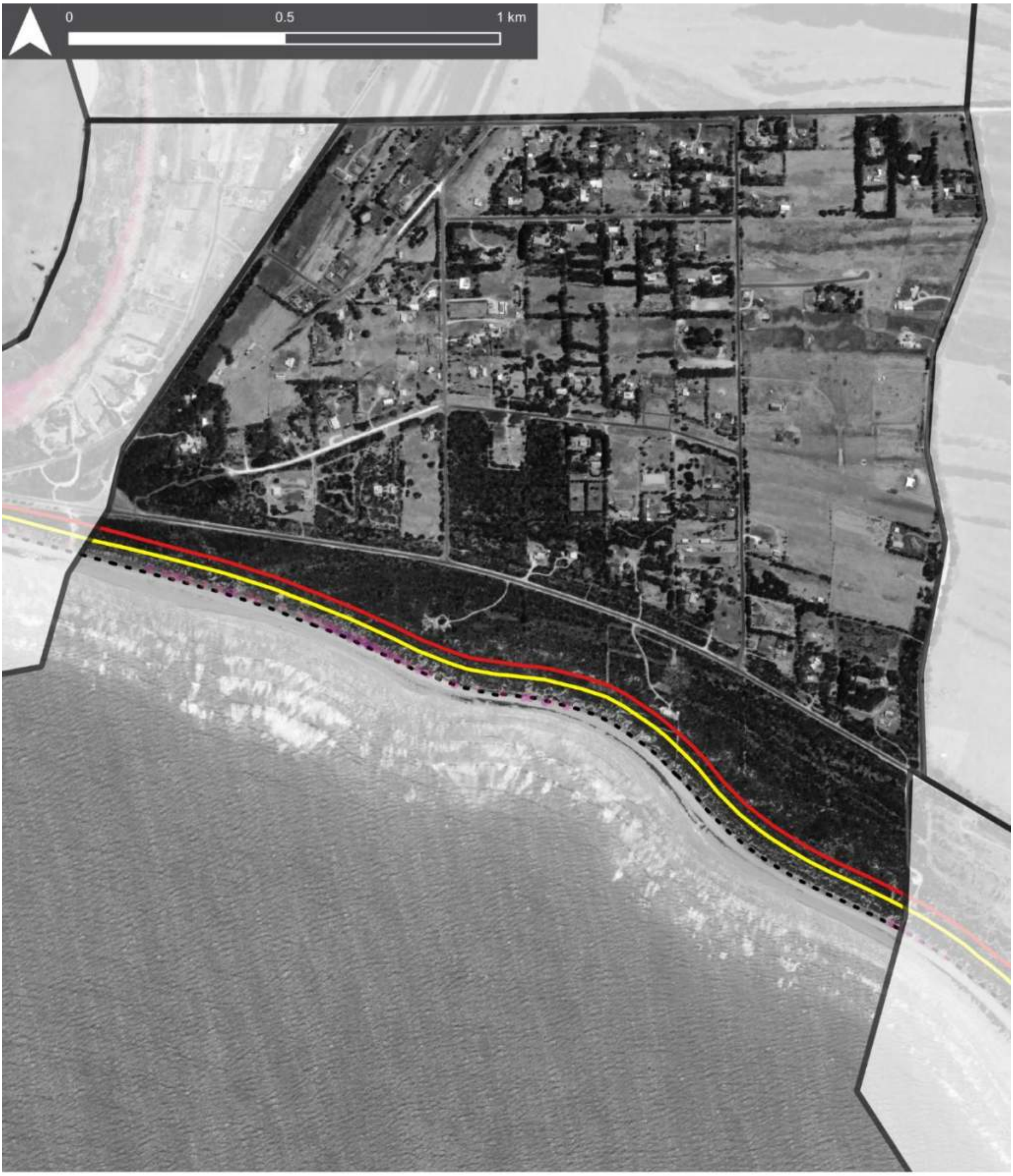
Assets at risk

The assets at risk in this area are the two main roads that pass through the area, along with agricultural lands.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Agricultural Land	Agriculture		Low		Significant*
Southern Ports Highway	Transport		Low		Low
Beachport Penola Road	Transport				Low

* Some assets within this category have a lower risk rating

7.2.3 East Beachport (Area 3)



Erosion Hazard
- Baseline
- By 2050
- By 2100

Inundation Hazard
- <0.25 m
- 0.25 - 0.35 m
- 0.35 - 0.65 m
- 0.65 - 1.25 m
- >1.25 m

Shoreline Features
- Groyne
- Revetment
- Rocky Coast
- Seawall

Hazard extents are prior to any adaptation actions and for a 100-year Annual Recurrence Interval (ARI) storm event.

The erosion hazard lines correspond to the 50% likelihood extent by 2100.

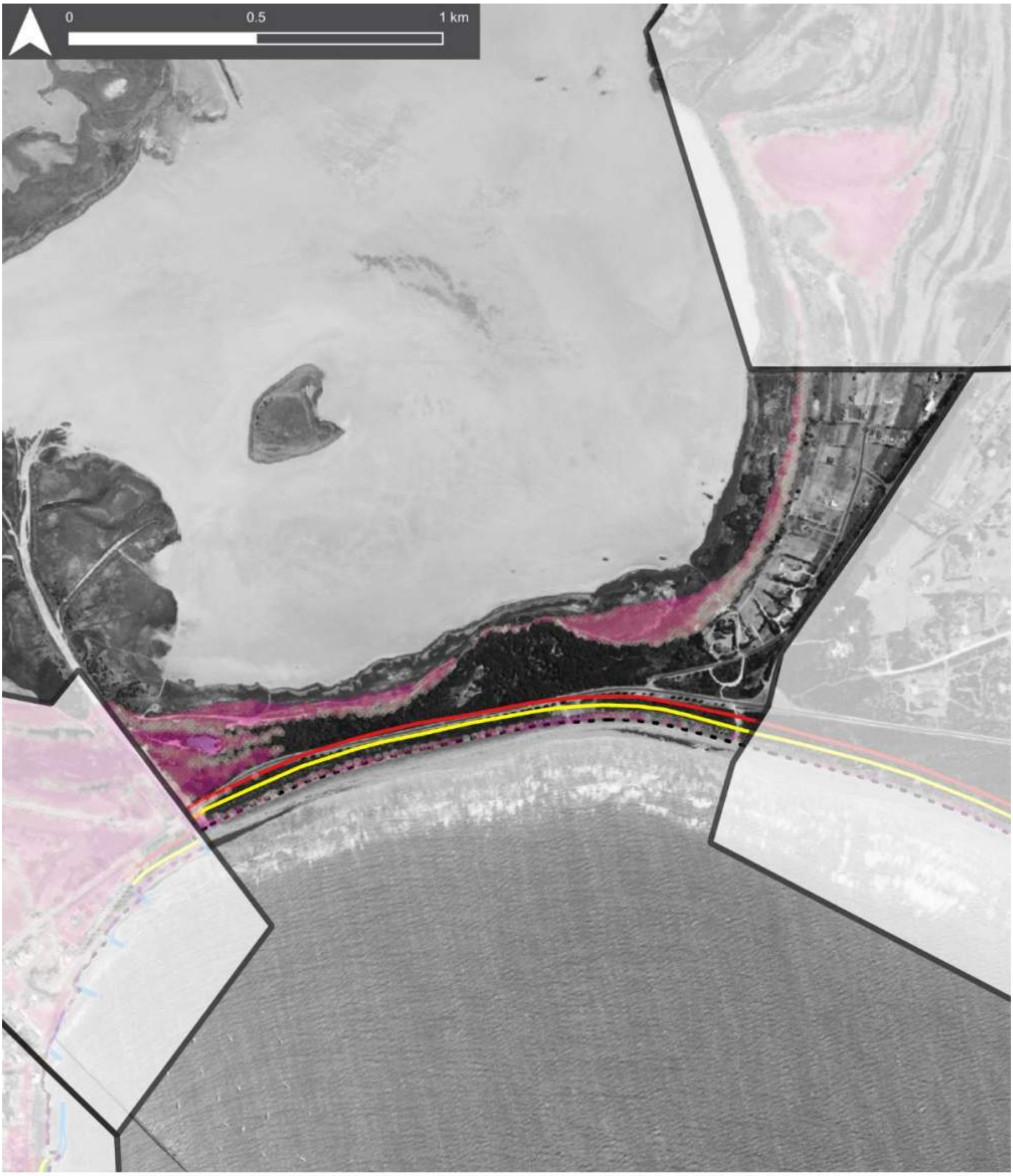
The potential inundation area includes storm tide, 2100 sea level rise, and wave effects (setup and runup).

Assets at risk

The assets at risk within this area principally consist of Southern Ports Highway, local roads and some rural residential properties. These assets are exposed to some inundation in isolated areas over the assessment horizon. The Rivoli Bay foreshore is also exposed to erosion over the assessment horizon.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Rural Residential Properties	Private Asset		Low		Low
Rivoli Bay Foreshore	Public Amenity	Medium	Low	Medium	Low
Sunderland Drive	Transport		Low		Low
McLachlan Drive	Transport		Low		Low
Southern Ports Highway	Transport			Low	

7.2.4 Area 4 (East of Lake George Outlet)



Erosion Hazard
- Baseline
- By 2050
- By 2100

Inundation Hazard
- <0.25 m
- 0.25 - 0.35 m
- 0.35 - 0.65 m
- 0.65 - 1.25 m
- >1.25 m

Shoreline Features
- Groyne
- Revetment
- Rocky Coast
- Seawall

Hazard extents are prior to any adaptation actions and for a 100-year Annual Recurrence Interval (ARI) storm event.

The erosion hazard lines correspond to the 50% likelihood extent by 2100.

The potential inundation area includes storm tide, 2100 sea level rise, and wave effects (setup and runup).

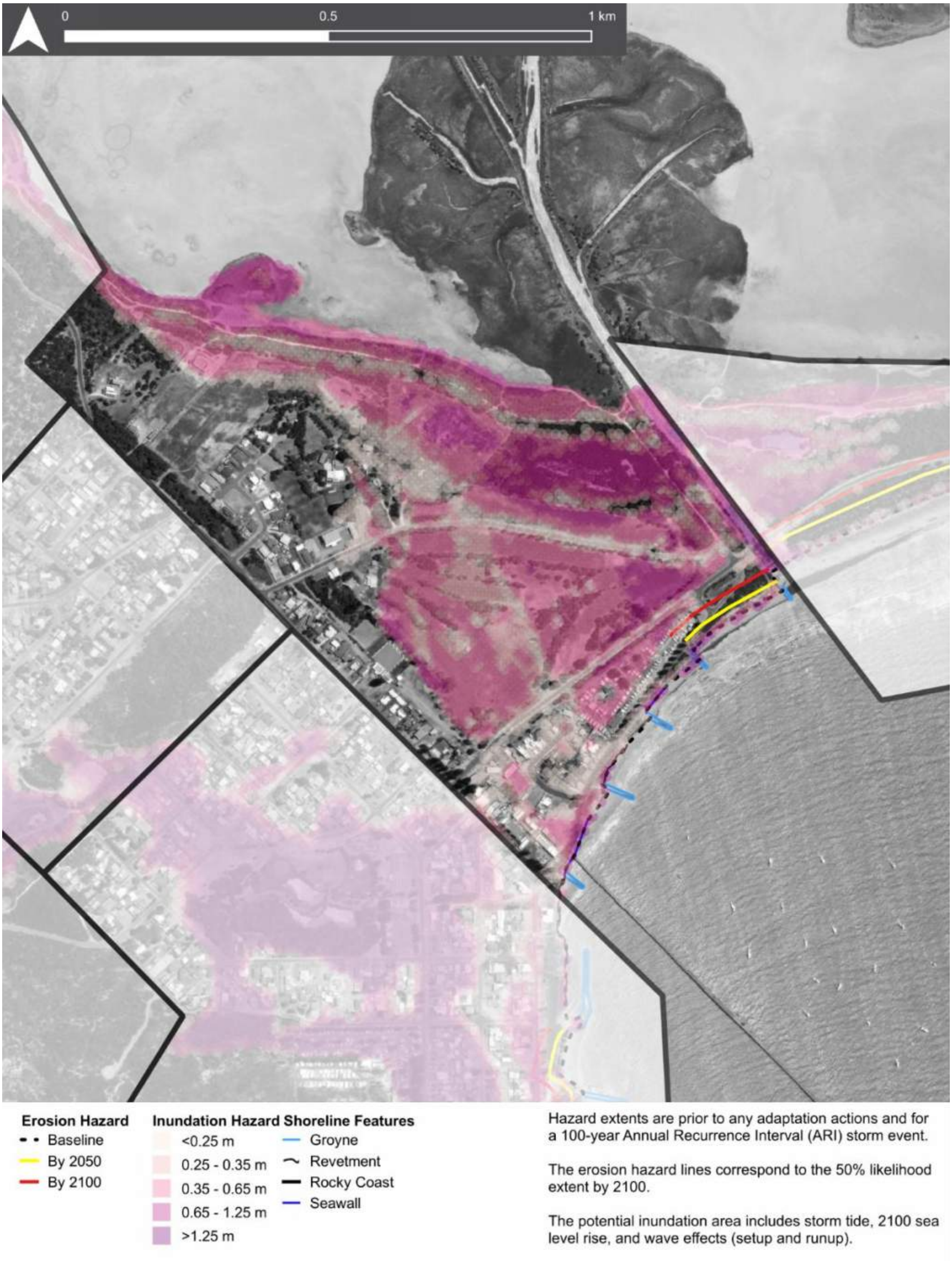
Assets at risk

The inundation that occurs in this area is due to the propagation of water from Rivoli Bay through the Lake George Outlet during large storm events. As the storm events persist in duration, inundation is expected to impact this area as well as other areas within Beachport. Some minor inundation also originates across the Rivoli Bay Foreshore. Erosion along the shoreline is also expected, which will principally impact transport infrastructure.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Carpark near Sir William Mills Drive (on Millicent Road)	Council Asset	High*	Low	High*	Low
Rural Residential Properties	Private Asset		Low		Low
Beachport Rail Trail	Public Amenity	Significant*	Low	Significant*	Low
Reserve fringing Lake George	Reserve		Low		Significant*
Rivoli Bay foreshore	Reserve	High	Low	High	Medium
Lakeside Drive	Transport		Low		Low
Millicent Road	Transport	Medium	Low	High	Low
Samuel Way Drive	Transport		Low		Low
Sir William Mills Drive	Transport		Low		Low

* Some assets within this category have a lower risk rating

7.2.5 Area 5 (West of Lake George Outlet, Inc. Golf Course and Beachport Caravan Park)



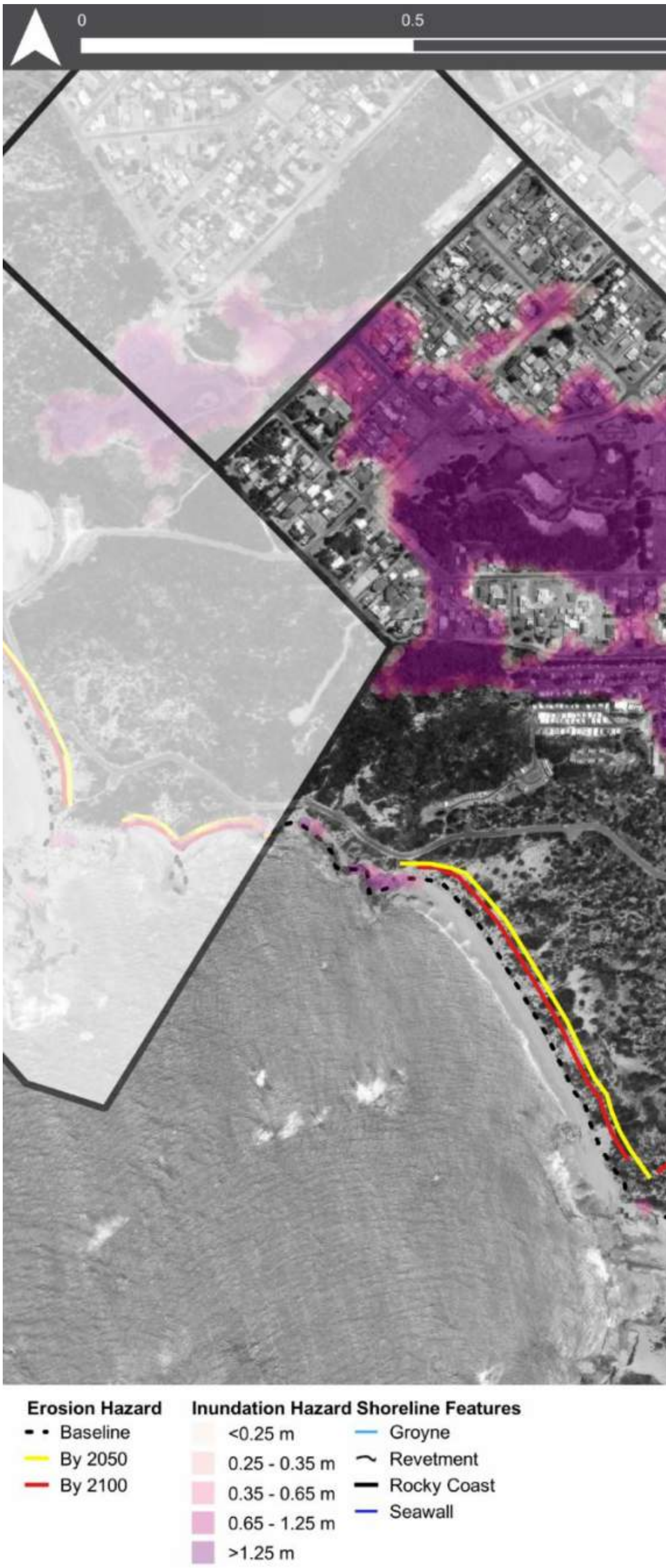
Assets at risk

The inundation that occurs in this area is predominantly due to the propagation of water from Rivoli Bay through the Lake George Outlet during large storm events. As the storm events persist in duration, inundation is expected to impact the area as well as other areas within Beachport. Some inundation also originates across the Rivoli Bay Foreshore near the end of the existing seawall. Erosion is expected to occur adjacent to The Outlet where the existing shoreline is currently unprotected. This will impact the shoreline and foreshore reserve, as well as Beach Road.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Beachport Rail Trail	Council Asset		Medium*		Significant*
Beachport Visitor Information Centre	Council Asset		Low		Medium
Millicent Road Parking	Council Asset		Low		Medium
Old Custom House	Council Asset		Low		Low
Parking along Beach Road	Council Asset		Low		Medium
Beachport Recreation Centre	Council Asset		Low		Low
Beachport Foreshore Reserve (Near Lake George Outlet)	Public Amenity	Significant	High*	High	High*
Beachport Foreshore Reserve (Other locations)	Public Amenity		High*		High*
Susan Wilson Memorial Playground	Public Amenity		Low		Low
Beachport Primary School	Public Services		Low*		Medium*
Beachport CFS Station	Public Services				
Commercial properties (Between Millicent Road and Beach Road)	Private Assets		Low*		Medium*
Residential Properties along Golf Course	Private Assets				Low
Beachport Bowling Club	Recreation				
Beachport Golf Course	Recreation		Significant*		Significant*
Alfred Court	Transport		Low		Medium*
Beach Road	Transport		Low		Medium*
Golf Course Road	Transport		Medium*		Medium*
Lakeside informal tracks	Transport		Medium*		Significant*
Lake George Road	Transport		Low		Low
Linnell Drive	Transport		Low*		Low*
Millicent Road	Transport		Low		Medium
Railway Terrace	Transport		Low*		Medium*
Beachport Caravan Park	Tourism		Medium*		Significant*

* Some assets within this category have a lower risk rating

7.2.6 Area 6 (Central Beachport)



Hazard extents are prior to any adaptation actions and for a 100-year Annual Recurrence Interval (ARI) storm event.

The erosion hazard lines correspond to the 50% likelihood extent by 2100.

The potential inundation area includes storm tide, 2100 sea level rise, and wave effects (setup and runup).

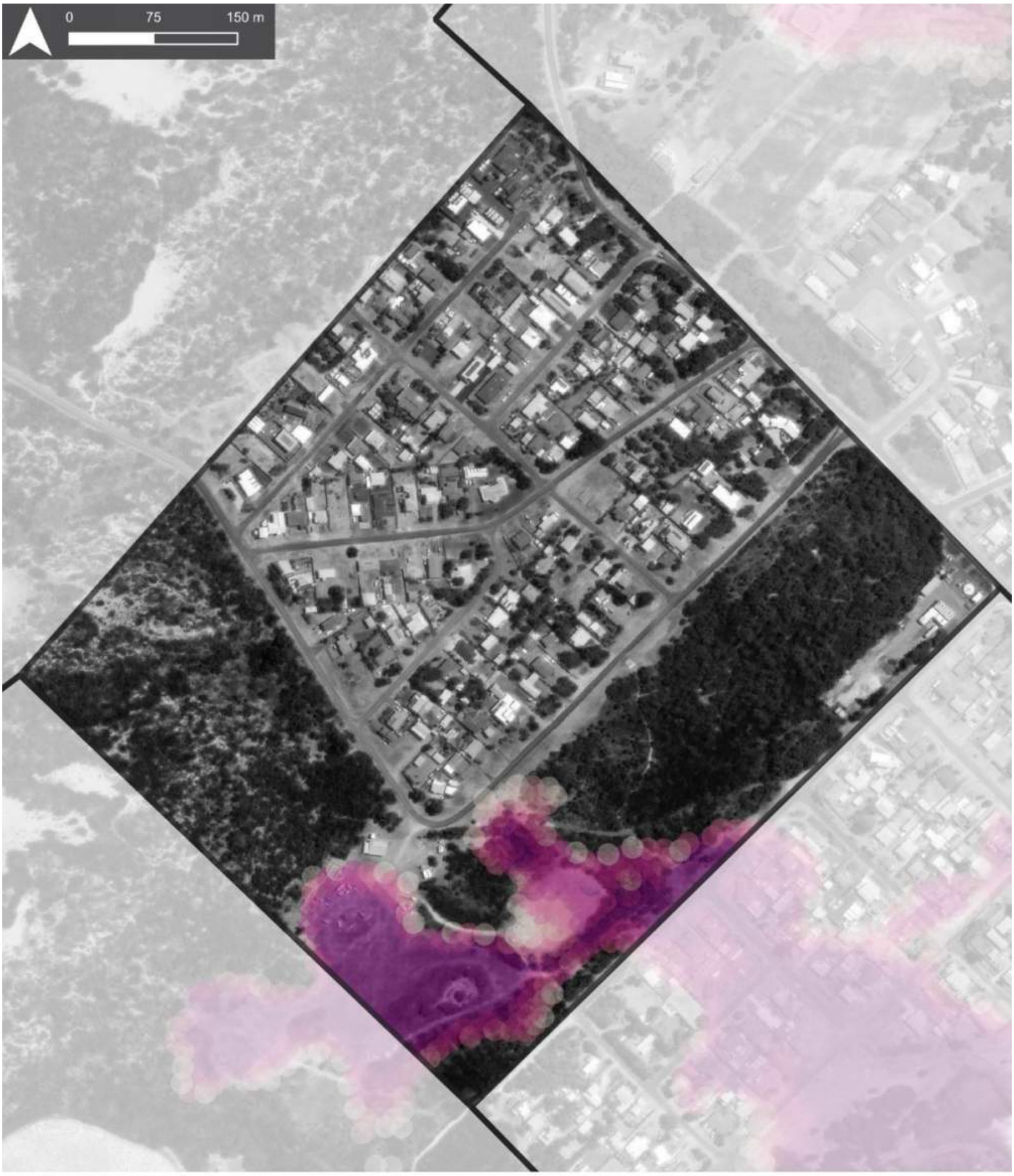
Assets at risk

The majority of assets at risk in this area are exposed to inundation that passes over Beach Road and propagates through the landscape to areas with lower elevation. Erosion along the eastern shoreline occurs south of the Beachport Harbour where the shoreline is principally protected by low dunes and sand that accumulates between groynes. This area is an area of public amenity, relatively narrow, and low in elevation. Within Cape Martin much of the erosion is observed with reserve areas where few assets are located.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Beachport Harbour Carpark	Council Asset		Low		Low
Beachport Harbour Masters Complex	Council Asset		Low		Low
Beachport Harbour Public Toilets	Council Asset		Low		Low
Beachport Foreshore Reserve / Shoreline	Public Amenity	High*		High*	
Beachport Lagoon and nearby public space	Public Amenity		Medium*		Significant
Cape Martin – South East Shoreline	Public Amenity	High		High	
Cape Martin – South West Shoreline	Public Amenity	High		High	
Centennial Park	Public Amenity		Medium*		Significant
Commercial properties along Railway Terrace	Private Asset		Low		Medium
Industrial properties within this area	Private Asset	High	Low	High	Low
Properties within this area (particularly near Beachport Lagoon)	Private Asset		Medium*		Significant*
Beachport Southern Ocean Tourist Park	Tourism		Low*		Significant*
Beachport Whaling Monument	Tourism		Low		Medium
Beach Road	Transport	High	Low	High	Significant*
Several Local Roads within area	Transport		Low		Significant*

* Some assets within this category have a lower risk rating

7.2.7 Area 7 (Central West, Bounded by Parkland and Railway Terrace)



Hazard extents are prior to any adaptation actions and for a 100-year Annual Recurrence Interval (ARI) storm event.

The erosion hazard lines correspond to the 50% likelihood extent by 2100.

The potential inundation area includes storm tide, 2100 sea level rise, and wave effects (setup and runup).

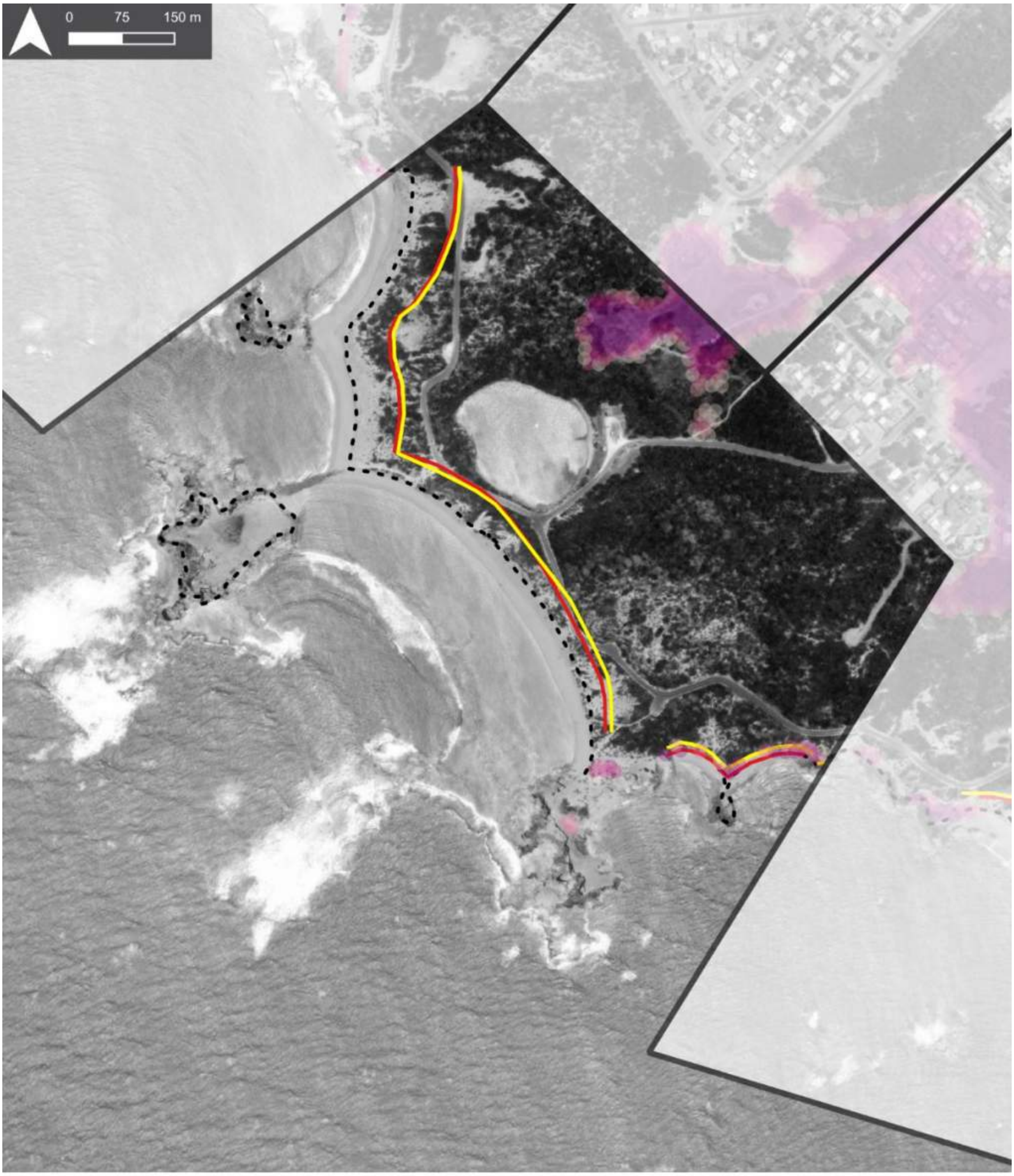
Assets at risk

Assets in this area at exposed inundation hazards that originate from Area 6. These assets are predominantly public assets and areas of reserve, except for Beachport Pony Club.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Parklands Terrace	Transport		Low*		Medium*
Beachport Pony Club	Private Asset		Medium*		Significant*
Reserve between Parklands and NW Terrace	Reserve		Medium*		Significant*

* Some assets within this category have a lower risk rating

7.2.8 Area 8 (Western Beachport, including Pool of Siloam and Scenic Drive)



Erosion Hazard
- Baseline
- By 2050
- By 2100

Inundation Hazard
- <0.25 m
- 0.25 - 0.35 m
- 0.35 - 0.65 m
- 0.65 - 1.25 m
- >1.25 m

Shoreline Features
- Groyne
- Revetment
- Rocky Coast
- Seawall

Hazard extents are prior to any adaptation actions and for a 100-year Annual Recurrence Interval (ARI) storm event.

The erosion hazard lines correspond to the 50% likelihood extent by 2100.

The potential inundation area includes storm tide, 2100 sea level rise, and wave effects (setup and runup).

Assets at risk

Assets in this area are principally exposed to erosion hazards. These assets are associated with Scenic Drive where shoreline erosion is expected to impact the road as well as parking areas. The implications for a breach in the dune is addressed in Area. Note that in this area the dune is expected to breach by 2050, which is the source of the inundation into this area.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Coastal reserve within this area	Reserve	High	Low	High	Low
Dawn's Lookout Parking Area	Council Asset	High		High	
Scenic Drive	Transport	Significant*	Low	High*	Low
Parking area off Scenic Drive opposite Pool of Siloam.	Council Asset	High		High	
Pool of Siloam Parking area and Toilet Block	Council Asset		Low		Low
McCourt Street	Transport	Low	Medium*	Low	Medium*

* Some assets within this category have a lower risk rating

7.2.9 Area 9 (North West Beachport)

Erosion Hazard
- Baseline
- By 2050
- By 2100

Inundation Hazard
- <0.25 m
- 0.25 - 0.35 m
- 0.35 - 0.65 m
- 0.65 - 1.25 m
- >1.25 m

Shoreline Features
- Groyne
- Revetment
- Rocky Coast
- Seawall

Hazard extents are prior to any adaptation actions and for a 100-year Annual Recurrence Interval (ARI) storm event.

The erosion hazard lines correspond to the 50% likelihood extent by 2100.

The potential inundation area includes storm tide, 2100 sea level rise, and wave effects (setup and runup).

Assets at risk

The key asset at risk in this area is Scenic Drive, along with some informal coastal and lakeside tracks.

ASSET	ASSET TYPE	2050		2100	
		EROSION	INUNDATION	EROSION	INUNDATION
Lake George Track / Lake George Road	Transport		Low		Low
Beachport Conservation Park	Reserve		Significant*		Significant*
Scenic Drive	Transport	Low*		Medium*	
Parking area on Scenic Drive (near Blowhole)	Council Asset				
Informal parking areas at end of Scenic Drive	Council Asset				
Parklands Terrace	Transport				
Informal lakeside tracks	Transport		Medium*		Significant*
Informal coastal tracks	Transport	Significant		High	

* Some assets within this category have a lower risk rating

8 ADAPTATION

8.1 Coastal Management Best Practices

Regardless of the specific adaptation strategy chosen, implementing coastal management best practices is essential for enhancing resilience and preparedness to coastal risks. These best practices should be integrated into the overall adaptation approach to enhance resilience and preparedness for coastal risks. These actions, detailed below, do not require significant capital or compromise, allowing flexibility for future management approaches.

8.1.1 Coastal Monitoring

In managing risks to existing assets and infrastructure, the preferred approach is to monitor key indicators and intervene before risks escalate to an intolerable level, known as the trigger point. Establishing these triggers before actual impacts occur enables proactive planning and implementation of alternative measures, especially for community-dependent infrastructure. Regular review of triggers at critical assets is essential. Additionally, monitoring results should be analysed, published, and integrated into coastal management plan reviews, covering aspects such as coastal flooding, erosion, and condition of coastal structures, at least every 5 years. Assessment should involve trend analysis and proximity to pre-defined triggers. Installation of erosion markers with graduated markings at key locations can aid in identifying trigger exceedance, monitored regularly by council.

8.1.2 Protection of Existing Vegetation

Dune vegetation plays a crucial role in stabilizing the dune system and reducing sand movement. It is imperative to protect and enhance existing vegetation through signage and, where necessary, established paths to deter human intrusion. Community education on the ecological and stabilization benefits of vegetation can further mitigate human impacts.

8.1.3 Planning Controls

Development controls should align with the type of development and potential hazards over the expected life of the development. These controls should restrict development in at-risk areas to mitigate coastal hazards.

8.2 Adaptation Strategies

The hierarchy of Adaptation Strategies and fundamental considerations for each strategy are summarised in Table 13. These strategies are not mutually exclusive, a pathway approach is likely to incorporate multiple strategies over time.

Table 13: Adaptation Strategy Order of Consideration

Adaptation Strategy	Definitions and Considerations
1. Non-Intervention	• Allowing marine and coastal processes, and the hazards they may pose, to occur. • May be an appropriate action when the hazard poses an acceptable level of risk to values or uses, when intervention would cause unacceptable negative impacts, or when intervention would be ineffective or not cost-effective. • Often applied in conjunction with coastal monitoring, with intervention considered only if predefined thresholds trigger the implementation of an alternative strategy.
2. Avoid	• Strategically placing new developments and redevelopment away from areas negatively affected or projected to be impacted by coastal hazards. • Can help natural systems adapt by avoiding development that would impede the movement of habitats and species or decrease their resilience to climate change.
3. Nature-Based Methods	• Creating or restoring coastal habitats to reduce coastal hazard. • Actions include wetland restoration, dune restoration, and hybrid nature-based and engineering approaches. • Nature-based methods tend to have more co-benefits than other adaptation actions, in that they can restore and enhance biodiversity values, improving resilience of vulnerable coastal ecosystems and often improving amenity.
4. Accommodate	• Design structures to reduce exposure to or decrease the impact of coastal hazard risk. • Actions include movable infrastructure (e.g., life-saving towers, stairs/ramps), flood-resilient building design, and the use of resilient materials.
5. Retreat	• Decommission or relocate existing structures, assets, or uses away from areas that are or will be negatively impacted by coastal hazards. • May apply locally or more broadly as part of the adaptation planning process.
6. Protect (Typically Major Engineering Works)	• Enhance existing protective measures, or construct/implement new ones, to mitigate the impact of coastal hazards. • Actions include hard (construction or enhancement of groynes, breakwaters, seawalls, etc) or soft (beach nourishment, etc) measures or a combination. • Often expensive, with localized benefits and the potential to transfer the problem to nearby areas. • Actions likely to have a significant impact on natural coastal processes. • Includes a commitment to ongoing maintenance.

8.3 First Pass Assessment

A first pass assessment of all adaptation options was undertaken to identify which strategies are viable for further investigation for each area (Table 14). Each option was either deemed as not appropriate, or shortlisted if considered a feasible option. A Multi Criteria Assessment (MCA) will then be completed on the shortlisted options, which will consider the outcomes of stakeholder engagement in conjunction with the adaptation costs and social and environmental aspects of each viable option to inform the adaptation pathway.

Considering the constraints in erosion hazard mapping resulting from data gaps, it is strongly advised to conduct further investigations, particularly focusing on geotechnical and bathymetric mapping, to enhance the accuracy of the hazard maps prior to actioning any intervention. It is assumed that coastal management best practices, including monitoring, are a requirement of any adaptation strategy and has therefore not been assessed as standalone option but is included in the strategies for all areas. Similarly, 'Avoid' has not been assessed as standalone option, however this pathway should be prioritized for all future developments within the identified areas at risk.

Table 14: First Pass Adaptation Pathways Assessment

Area	Vulnerable Asset/Natural Feature	Non-Intervention	Nature-Based Methods	Accommodate	Retreat	Protect
1	2050: Risk of erosion of Rivoli Bay Foreshore	✓	✓	X	X	X
	2100: Risk of erosion of Rivoli Bay Foreshore	✓	✓	X	X	X
2	2050: Low temporary inundation risk to agricultural land and Southern Ports Highway.	✓	✓	X	X	X
	2100: Low risk to significant temporary inundation risk to agricultural land, Southern Ports Highway, Beachport Penola Road.	✓	✓	X	X	X
3	2050: Low temporary inundation risk to rural residential properties, Sunderland Drive, and McLachlan Drive. Risk of erosion of Rivoli Bay Foreshore.	✓	✓	X	X	X
	2100: Low temporary inundation risk to rural residential properties, Sunderland Drive, and McLachlan Drive. Risk of erosion of Rivoli Bay Foreshore and Southern Ports Highway.	✓	✓	X	X	X
4	2050: Low temporary inundation risk to the carpark near Sir William Mills Drive (on Millicent Road), Rural Residential Properties, Beachport Rail Trail, Reserve fringing Lake George, Lakeside Drive, Millicent Road, Samuel Way Drive, and Sir William Mills Drive. Risk of erosion of the carpark near Sir William Mills Drive (on Millicent Road), Beachport Rail Trail, Rivoli Bay foreshore, and Millicent Road.	✓	✓	X	✓	✓
	2100: Low to significant temporary inundation risk to the carpark near Sir William Mills Drive (on Millicent Road), Rural Residential Properties, Beachport Rail Trail, Reserve fringing Lake George, Lakeside Drive, Millicent Road, Samuel Way Drive, and Sir William Mills Drive. Risk of erosion of the carpark near Sir William Mills Drive (on Millicent Road), Beachport Rail Trail, Rivoli Bay foreshore, and Millicent Road.	✓	✓	X	✓	✓
5	2050: Low to high temporary inundation risk to Beachport Rail Trail, Beachport Visitor Information Centre, Millicent Road Parking, Old Custom House, Parking along Beach Road, Beachport Recreation Centre, Beachport Foreshore Reserve, Susan Wilson Memorial Playground, Beachport Primary School, Commercial properties (Between Millicent Road and Beach Road), Beachport Golf Course, Alfred Court, Beach Road, Golf Course Road, Lakeside informal tracks, Lake George Road, Linnell Drive, Millicent Road, Railway Terrace, and Beachport Caravan Park. Risk of erosion of the Beachport Foreshore Reserve (Near Lake George Outlet).	✓	✓	X	✓	✓

Area	Vulnerable Asset/Natural Feature	Non-Intervention	Nature-Based Methods	Accommodate	Retreat	Protect
	2100: Low to high temporary inundation risk to Beachport Rail Trail, Beachport Visitor Information Centre, Millicent Road Parking, Old Custom House, Parking along Beach Road, Beachport Recreation Centre, Beachport Foreshore Reserve , Susan Wilson Memorial Playground, Beachport Primary School, Commercial properties (Between Millicent Road and Beach Road), Residential Properties along Golf Course, Beachport Golf Course, Alfred Court, Beach Road, Golf Course Road, Lakeside informal tracks, Lake George Road, Linnell Drive, Millicent Road, Railway Terrace, Beachport Caravan Park. Risk of erosion of the Beachport Foreshore Reserve (Near Lake George Outlet).	✓	✓	X	✓	✓
6	2050: Low to medium temporary inundation risk to Beachport Harbour Carpark, Beachport Harbour Masters Complex, Beachport Harbour Public Toilets, Beachport Lagoon and nearby public space, Centennial Park, Commercial properties along Railway Terrace, Industrial properties within this area, Properties within this area (particularly near Beachport Lagoon), Beachport Southern Ocean Tourist Park, Beachport Whaling Monument, Beach Road, Several Local Roads within area. Risk of erosion to the Beachport Foreshore Reserve, Cape Martin Southeast and Southwest Shoreline, and Industrial properties near the coast.	✓	✓	X	✓	✓
	2100: Low to significant temporary inundation risk to Beachport Harbour Carpark, Beachport Harbour Masters Complex, Beachport Harbour Public Toilets, Beachport Lagoon and nearby public space, Centennial Park, Commercial properties along Railway Terrace, Industrial properties within this area, Properties within this area (particularly near Beachport Lagoon), Beachport Southern Ocean Tourist Park, Beachport Whaling Monument, Beach Road, Several Local Roads within area. Risk of erosion to the Beachport Foreshore Reserve, Cape Martin Southeast and Southwest Shoreline, and Industrial properties near the coast.	X	✓	X	✓	✓
7	2050: Low to medium temporary inundation risk to Parklands Terrace, Beachport Pony Club, and reserve between Parklands and NW Terrace.	✓	X	✓	✓	X
	2100: Medium to significant temporary inundation risk to Parklands Terrace, Beachport Pony Club, and reserve between Parklands and NW Terrace.	✓	X	✓	✓	X
8	2050: Low to medium temporary inundation risk to coastal reserve within this area, Scenic Drive, Parking area off Scenic Drive opposite Pool of Siloam, Pool of Siloam Parking area and Toilet Block, and McCourt Street. Risk of erosion to the coastal reserve within this area, Dawn's Lookout Parking Area, Scenic Drive, Parking area off Scenic Drive opposite Pool of Siloam, and McCourt Street.	✓	X	X	✓	X
	2100: Low to medium temporary inundation risk to coastal reserve within this area, Scenic Drive, Parking area off Scenic Drive opposite Pool of Siloam, Pool of Siloam Parking area and Toilet Block, and McCourt Street. Risk of erosion to the coastal reserve within this area, Dawn's Lookout Parking Area, Scenic Drive, Parking area off Scenic Drive opposite Pool of Siloam, and McCourt Street.	✓	X	X	✓	X

Area	Vulnerable Asset/Natural Feature	Non-Intervention	Nature-Based Methods	Accommodate	Retreat	Protect
9	2050: Low to significant temporary inundation risk to Lake George Track / Lake George Road, Beachport Conservation Park, and informal tracks. Risk of erosion to Scenic Drive and informal tracks.	✓	X	X	✓	X
	2100: Low to significant temporary inundation risk to Lake George Track / Lake George Road, Beachport Conservation Park, and informal tracks. Risk of erosion to Scenic Drive and informal tracks.	✓	X	X	✓	X

8.4 Multi-Criteria Assessment of Adaptation Options

The purpose of the Multi-Criteria Assessment (MCA) is to offer a clear and concise overview of various options, providing a high-level but transparent delineation of the benefits and trade-offs associated with each shortlisted option. Its goal is to facilitate the selection of preferred option(s); however, this approach recognizes that different triggers may necessitate a range of adaptation responses over time.

Criteria were categorised into five classifications: environmental, legislative, social, economic, and technical. Within each classification, assessment criteria were established and weighted based on their relative importance in achieving project objectives (Table 15, Figure 10). Weighting can be updated to reflect the importance of different criteria through additional stakeholder and/or community consultation.

Adaptation actions were scored for each criterion on a scale from 0 to 5. A higher score for each action indicates a more appropriate or desirable outcome. The MCA results are intended to guide the adaptation pathway rather than impose a rigid approach. The assessment classifications, criteria, and description of the scoring scale used in the MCA are detailed in Table 15.

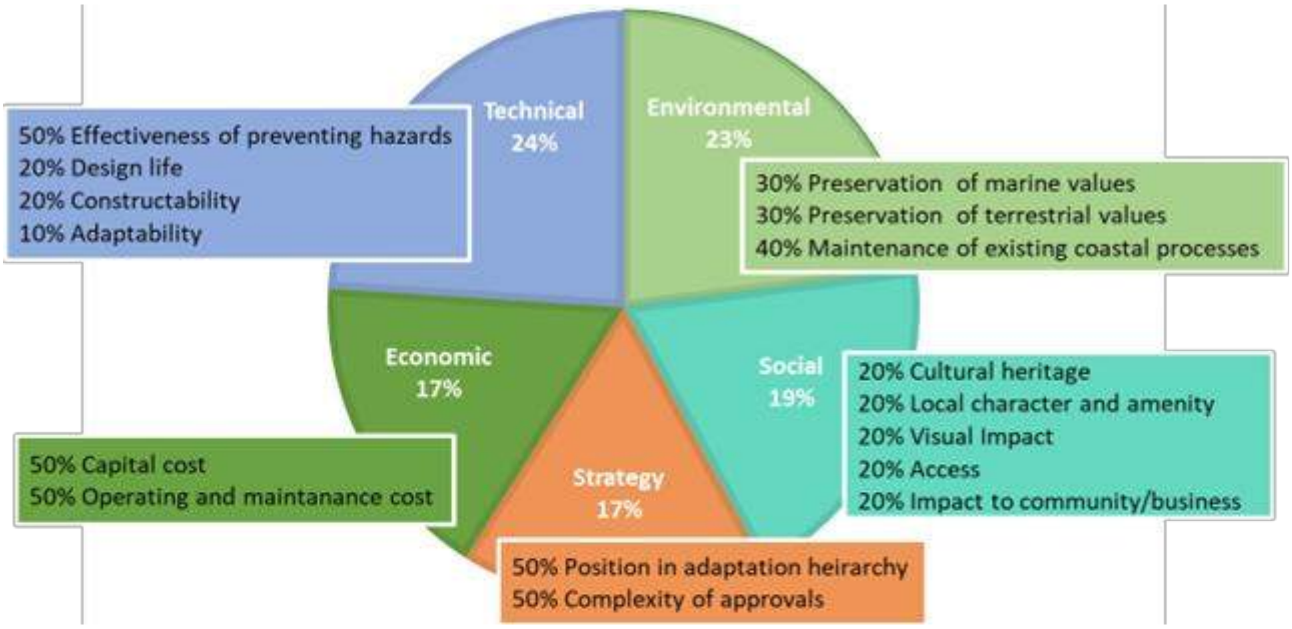


Figure 10: Categories, Associated Criteria and Weightings

Table 15: MCA Scoring Breakdown

Criteria Classification	Citeria	Success Scoring Scale	
		5	0
Environmental	**Preservation of Marine Values**	Benefits Marine Environment	Permanently negatively impacts Marine Environment
	Preservation of Terrestrial Values	Benefits Terrestrial Environment	Permanently negatively impacts Terrestrial Environment
	Maintenance of existing coastal processes	Maintains existing coastal processes	Permanently alters existing coastal processes
Strategy	**Position within adaptation hierarchy**	Highest ranking in adaptation hierarchy	Lowest ranking in adaptation hierarchy
	Complexity of approvals	Simple/straightforward approval process	Difficult/complex approval process
Social	**Cultural heritage**	Restores cultural heritage of the site	Damages cultural heritage of the site
	Local character and amenity	Improves local character and enhances beach amenity	Degrades local character and permanently reduces beach amenity
	Visual impact	Improves visual amenity of the site	Degrades visual amenity of the site
	Access	Does not impede access	Permanently restricts access
	Impact to community/business	Provides benefits to the community and local businesses	Negatively impacts the community and local businesses
Economic	**Capital cost**	The initial financial costs, including design, construction material and plant, require little to no cost (<$50k per 100 m length)	The initial financial costs are very expensive (>$1M per 100m length)
	Operating and maintenance cost	Usually not required (<$5k per annum)	Ongoing required to maintain function
Technical	**Effectiveness of hazards**	Provides a long-term solution for mitigating coastal hazards (flooding and erosion)	Does not provide a long-term solution, only effective in the short term.
	Design Life	Design life of 50+ years	Design life of <5 years
	Adaptability	Option can be easily adapted for future circumstances and would not negatively impact future generations.	Option is irreversible once implemented and limits alternative options in future.
	Constructability	No constructability concerns, no specialist contractors required	Significant constructability concerns, specialist contractors required

8.4.1 MCA Results

Area 1

A multicriteria analysis was not completed for this area as this area is relatively remote and a natural landscape. The absence of assets of substantial value warrants, over the adaptation planning horizon, allowing coastal processes to occur with only minor interventions for public safety.

Area 2

A multicriteria analysis was not completed for this area as this area is a natural / agricultural landscape. The absence of assets of substantial value at elevated risk warrants, over the adaptation planning horizon, allowing natural processes to occur. Avoiding construction of high value assets in elevated risk areas (some agricultural land) is to be avoided. While the principal adaptation approach is non-intervention, it should be noted that actions to control inundation through the Lake George Outlet will also reduce the risk in this area (see Area 4).

Area 3

A multicriteria analysis was not completed for this area as the inundation risk is low over the assessment horizon and actions to control inundation through the Lake George Outlet would further reduce the risk in this area (see Area 4). The erosion risk is confined to a natural landscape (Rivoli Bay foreshore) and no assets of substantial value are within the hazard zones over the adaptation planning horizon. The principal adaptation approach is therefore non-intervention and some monitoring in areas where risk is present.

Area 4

Options evaluates to address the inundation and erosion hazards in this area include “Retreat” of at-risk assets, for example either moving the road landward or closing this section of the road, a “Nature Based Method” of constructing a dune, hybrid methods of a constructing reinforced dune or an engineered perched beach, and various “Protect” options including a rich rock revetment, rock revetment, a living seawall and a traditional vertical seawall, reef or traditional breakwaters, or a traditional or a more natural feel ‘engineered outcrop’ style groyne field. Note that these options may be applied in localized sections rather than across the coast of this Area. The results of the MCA for this area are shown in Table 16. Note that results and colour shading shown are skewed relative to all shortlisted adaptation options.

MCA results indicate that the top four preferred potential hazard mitigation measures scored very closely, and include construction of a reinforced dune, a natural dune, an engineered perched beach or a rich rock revetment. To address the more near-term coastal hazards, dune management and/or localised retreat is proposed until the erosion extent is close to the Beachport Rail Trail and (by extension) Millicent Road, after which the construction of one of the preferred coastal protection options is proposed to protect the trail and Millicent Road. Millicent Road is a key transport route into Beachport and relocation of the road to another location was not deemed viable in the options assessment. Retreat (relocation of the carpark to the lake side of Millicent Road) was also considered but based on the options assessment undertaken this option was not progressed.

The inundation extent is predominantly confined to the edges of Lake George and was assessed to be of low risk to assets in the area. However, the Lake George Outlet was identified as a key pathway for inundation into this area as well as other areas of Beachport. Adjustments/upgrades to the Outlet were not evaluated in the MCA as these works would likely occur in combination with other coastal protection works to mitigate the erosion hazard. Given this is a key inundation pathway, a detailed assessment is proposed to assess how the outlet operates in a coastal hazards context, the suitability of its design and if it can be relied upon to manage inundation. Critical to this assessment will be to assess the impacts of compound flooding (storms + rain). Based on this assessment, change to the outlet may be required, another strategy required, or both.

Area 5

Beach erosion was identified an ongoing risk to the shoreline in this Area. Much of the shoreline is principally a public amenity asset and is popular with the local community. This Area's coast includes an existing groyne field and much of the coastline is armoured (with seawalls/revetment) and thus an extension to of this armour to The Outlet would complete this network of protection.

Options evaluated to address the coastal hazards in this area include "Nature Based Methods" of implementing a beach nourishment scheme or constructing a dune, a hybrid method of a constructing an engineered perched beach, and various "Protect" options including a rich rock revetment, rock revetment, a living seawall and a traditional vertical seawall, reef or traditional breakwaters, upgrading the existing groyne field or upgrading to a more natural feel 'engineered outcrop' style groyne field. The results of the MCA for this area are shown in Table 17Table 16. Note that results and colour shading shown are skewed relative to all shortlisted adaptation options.

MCA results indicate that the top two preferred potential hazard mitigation measures scored very closely, and include upgrading the groyne field or redesigning them as an outcrop style groyne field. While the latter has a higher initial capital cost, it offers potential ecological and aesthetic benefits in addition to improved coastal protection. Both approaches are expected to be implemented alongside beach nourishment, which is considered a critical component for effective erosion mitigation when groynes are present. The next highest scoring options included implementing a beach nourishment scheme, which would involve initial and regular beach nourishments to the existing groyne field, including nourishment after large storm events, or a construction of a dune. Either of these options could be combined with repairs or upgrades to the existing groyne field to enhance resilience and beach amenity.

Dune construction may be completed along the currently unprotected shoreline only, or could also be extended to cover (and bury) the existing seawall or revetment, effectively forming a reinforced dune structure. Although this option may involve higher initial capital and maintenance costs, it would add ecological value and enhance the coastal landscape while also helping to mitigate both erosion and coastal inundation hazards. The implementation of any of these options is expected to be triggered when erosion encroaches within 5 m of Beach Road, at which point a coastal protection option is proposed between The Outlet and nearby existing defences.

Lake George Outlet was identified as a key pathway for inundation into this Area as well as other areas of Beachport. How the outlet operates in this context, the suitability of its design and if it can be relied upon to manage inundation at Beachport requires a detailed assessment. These actions are considered in Area 4.

Further, inundation over Beach Road was identified as a potential future inundation pathway in this Area. This inundation is most likely to occur between Railway Terrace and the Caravan Park access road. Locally increasing the elevation of Beach Road and/or the foreshore reserve to close this inundation pathway was also identified as an effective strategy to mitigate the inundation hazard in this Area.

Area 6

Adaptation actions in this area include actions from Areas 4 and 5, which also impact this area. There is a focus on shoreline restoration, dune stabilisation and when required, the implementation of coastal protection options. These options may be implemented either in isolation or in combination with increasing the elevation of Beach Road, as much of the inundation in this area is caused by elevated water levels that pass over Beach Road and along the local road network to areas of lower elevation.

Options evaluated to address the coastal hazards in this area include the "Nature Based Method" of constructing a dune, hybrid methods of a constructing a reinforced dune or an engineered perched beach, and various "Protect" options including a rich rock revetment, rock revetment, a living seawall and a traditional vertical seawall, reef or traditional breakwaters, upgrading/reconfiguring the existing groyne field or upgrading to a more natural feel 'engineered outcrop' style groyne field. The results of the MCA for this area are shown in Table 17Table 16. Note that results and colour shading shown are skewed relative to all shortlisted adaptation options.

MCA results indicate that the top two preferred potential hazard mitigation measures scored very closely, and include upgrading the groyne field or redesigning them as an outcrop style groyne field. While the latter has a higher initial capital cost, it offers potential ecological and aesthetic benefits in addition to improved coastal protection. Both approaches are expected to be implemented alongside beach nourishment, which is considered a critical component for effective erosion mitigation when groynes are present. The next highest scoring options included implementing a beach nourishment scheme, which would involve initial and regular beach nourishments to the existing groyne field, including nourishment after large storm events, or a construction of a dune. Either of these options could be combined with repairs or upgrades to the existing groyne field to enhance resilience and beach amenity.

Dune construction may be completed along the currently unprotected shoreline only, or could also be extended to cover (and bury) the existing seawall or revetment, effectively forming a reinforced dune structure. Although this option may involve higher initial capital and maintenance costs, it would add ecological value and enhance the coastal landscape while also helping to mitigate both erosion and coastal inundation hazards. The implementation of any of these options is expected to be triggered when erosion encroaches within 5 m of Beach Road, at which point a coastal protection option is proposed between The Outlet and nearby existing defences.

Erosion is expected to impact Beach Road and other nearby assets south of Beachport Harbour. The initial adaptation pathway is to nourish local beaches as well as to maintain and enhance existing foreshore dunes to increase shoreline resilience. If erosion continues to progress, a coastal protection structure may need to be implemented to protect Beach Road and adjacent assets. In addition, Beach Road or other landscape elements in the area may need to be elevated to reduce inundation in the long term to this area of Beachport as well as to surrounding areas.

Within Cape Martin, erosion is confined to relatively remote natural landscape areas. Thus the most appropriate response is to allow these coastal processes to occur.

Area 7

An MCA was not conducted for this Area as actions undertaken in other areas are expected to reduce the inundation risk in this Area. After these actions are undertaken, the risk should be reassessed in this area to determine if any additional actions are required to further reduce the risk.

Adaptation actions in this area principally focus on coastal management best practices including implementing planning and development controls such as limiting construction of assets within the hazard zones.

Area 8

Erosion has been ongoing along this section of coastal for many years. Some assets such as Dawn’s Lookout Parking Area and Scenic Drive are expected to be impacted by erosion in the future. An MCA for this area was not conducted as protection of these assets was not deemed viable due to the elevation of the landscape on which they have been constructed and the length of protection that is likely to be required. The current proposed adaptation action is to monitor coastal erosion progression and to undertake dune restoration, rehabilitation and stabilisation actions. When erosion is within 5 m of compromising the asset, this strategy proposes to close or relocate these assets where it is practical to do so. Rerouting Scenic Drive to form an inland levee may provide an opportunity to protect Beachport from inundation that may occur due to breaches in the dunes along this section of coastline. We note that planning for this action has already commenced.

Area 9

Erosion and inundation in this area is confined to relatively remote natural landscape areas. Thus the most appropriate response is to allow these coastal processes to occur, with the exception of Scenic Drive, which is at risk of erosion in some locations. The adaptation pathway for this Area is to locally retreat and realign Scenic Drive. An MCA was not completed for this Area as the implementation of coastal protection structures in this Area is expected to be difficult to realise.

Table 16: Area 4 MCA Results

Category	Category Weighting	Criteria	Criteria weighting	Retreat	Dune Construction	Reinforced Dune	Engineered Perched Beach	Rich Revetment	Rock Revetment	Living Seawall	Vertical seawall	Reef breakwater	Breakwater	Groyne field	Engineered outcrops (groyne field)
Environmental	0.23	Preservation of marine values	0.3	3	3	3	3	4	2	4	2	4	2	2	4
		Preservation of terrestrial values	0.3	2	4	4	3	3	3	3	3	3	3	3	4
		Maintenance of existing coastal processes	0.4	3	3	3	3	2	2	2	2	2	2	2	2
Legislative	0.17	Position within adaptation hierarchy	0.5	3	2	2	1	2	1	2	1	2	1	1	2
		Complexity of approvals	0.5	1	3	2	2	2	2	2	2	2	2	2	2
Social	0.19	Cultural heritage	0.2	3	3	3	3	3	3	3	3	3	3	3	3
		Local character and amenity	0.2	2	5	5	5	2	2	2	2	4	4	4	5
		Visual impact	0.2	3	5	5	4	2	2	2	2	3	2	2	4
		Access	0.2	3	2	2	3	2	3	3	3	3	3	3	3
		Impact to community/business	0.2	1	4	4	4	4	4	4	4	4	4	4	4
Economic	0.17	Capital cost	0.5	1	3	1	1	1	1	1	1	1	1	3	3
		Operating and maintenance cost	0.5	4	2	2	3	4	5	4	5	2	3	2	2
Technical	0.24	Effectiveness of preventing hazards	0.5	5	3	5	5	5	5	5	5	2	3	2	2
		Design life	0.2	3	2	4	4	5	5	4	4	3	4	4	4
		Constructability	0.2	5	3	2	3	3	3	3	3	2	2	4	4
		Adaptability	0.1	2	4	4	4	4	4	3	3	3	3	3	3
			TOTAL SCORE:	**2.87**	**3.03**	**3.06**	**3.04**	**3.01**	**2.91**	**2.97**	**2.83**	**2.46**	**2.45**	**2.51**	**2.92**

Table 17: Area 5 MCA Results

Category	Category Weighting	Criteria	Criteria weighting	Beach Nourishment	Construct Dune	Engineered Perched Beach	Rich Revetment	Rock Revetment	Living Seawall	Vertical seawall	Reef breakwater	Breakwater	Redesign Groyne field	Engineered outcrops (groyne field)
Environmental	0.23	Preservation of marine values	0.3	3	3	2	3	2	3	2	3	2	3	4
		Preservation of terrestrial values	0.3	3	4	3	3	3	3	3	3	3	3	3
		Maintenance of existing coastal processes	0.4	3	3	3	2	2	2	2	2	2	3	3
Legislative	0.17	Position within adaptation hierarchy	0.5	2	2	1	2	1	2	1	2	1	1	2
		Complexity of approvals	0.5	5	3	2	2	2	2	2	2	2	3	3
Social	0.19	Cultural heritage	0.2	3	3	3	3	3	3	3	3	3	3	3
		Local character and amenity	0.2	4	5	5	2	2	2	2	4	4	5	5
		Visual impact	0.2	3	5	4	2	2	2	2	3	2	4	5
		Access	0.2	3	2	3	2	3	3	3	3	3	3	3
		Impact to community/business	0.2	4	4	4	4	4	4	4	4	4	4	4
Economic	0.17	Capital cost	0.5	4	3	1	1	1	1	1	1	1	4	3
		Operating and maintenance cost	0.5	3	2	3	4	5	4	5	2	3	3	3
Technical	0.24	Effectiveness of preventing hazards	0.5	1	3	5	5	5	5	5	2	2	2	2
		Design life	0.2	1	2	4	5	5	4	4	3	4	4	4
		Constructability	0.2	5	3	3	4	4	3	3	2	2	5	4
		Adaptability	0.1	5	4	4	4	4	3	3	3	3	4	3
			TOTAL SCORE:	**3.05**	**3.03**	**2.97**	**2.99**	**2.95**	**2.90**	**2.83**	**2.39**	**2.33**	**3.12**	**3.15**

Table 18: Area 6 MCA Results

Category	Category Weighting	Criteria	Criteria weighting	Construct Dune	Reinforced Dune	Engineered Perched Beach	Rich Revetment	Rock Revetment	Living Seawall	Vertical seawall	Reef breakwater	Breakwater	Redesign Groyne field	Engineered outcrops (groyne field)
Environmental	0.23	Preservation of marine values	0.3	3	3	2	3	2	3	2	3	2	3	4
		Preservation of terrestrial values	0.3	4	4	3	3	3	3	3	3	3	3	3
		Maintenance of existing coastal processes	0.4	3	3	3	2	2	2	2	2	2	3	3
Legislative	0.17	Position within adaptation hierarchy	0.5	2	2	1	2	1	2	1	2	1	1	2
		Complexity of approvals	0.5	3	3	2	2	2	2	2	2	2	3	3
Social	0.19	Cultural heritage	0.2	3	3	3	3	3	3	3	3	3	3	3
		Local character and amenity	0.2	5	5	5	2	2	2	2	4	4	5	5
		Visual impact	0.2	5	5	4	2	2	2	2	3	2	4	5
		Access	0.2	2	2	3	3	3	3	3	3	3	3	3
		Impact to community/business	0.2	4	4	4	4	4	4	4	4	4	4	4
Economic	0.17	Capital cost	0.5	3	1	1	1	1	1	1	1	1	4	3
		Operating and maintenance cost	0.5	2	2	3	4	5	4	5	2	3	3	3
Technical	0.24	Effectiveness of preventing hazards	0.5	3	5	5	5	5	5	5	2	2	2	2
		Design life	0.2	2	4	4	5	5	4	4	3	4	4	4
		Constructability	0.2	3	3	3	4	4	3	3	2	2	5	4
		Adaptability	0.1	4	4	4	4	4	3	3	3	3	4	3
			TOTAL SCORE:	**3.03**	**3.19**	**2.97**	**3.02**	**2.95**	**2.90**	**2.83**	**2.39**	**2.33**	**3.12**	**3.15**

8.5 Recommended Adaptation Pathways

The adaptation pathways approach is a strategic decision-making method consisting of a series of manageable steps or decision points distributed over time. Our approach aligns with the LGASA Guidelines (2020) and generally with the current Draft Guidelines (2024). We note that some methods applied in this assessment differ from those in the Draft Guidelines (2024) as this study commenced prior to these guidelines and also so that this assessment aligns with nearby studies at Kingston and Southend. This forward-looking and adaptive approach acknowledges the dynamic nature of climate change impacts and includes identification of specific thresholds or triggers (event, timing, SLR, other) that indicate when new decisions should be made.

The adaptation pathways are presented in separate document:

> *FSC Range (2025). Limestone Coast Adaptation Strategies – Adaptation Strategy for Wattle Range District Council.*

REFERENCES

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Government of South Australia. (2023). *Government Towns.* https://data.sa.gov.au/data/dataset/government-towns

Wainwright, D., and Verdon-Kidd, D., 2016: A local government framework for coastal risk assessment in Australia. National Climate Change Adaptation Research Facility, Gold Coast.

Worley & Parsons. (2015). *Rivoli Bay Study.* Wattle Range Council

APPENDIX A: SUMMARY OF PAST WORK

Table 19 Documents Reviewed

The following documents were provided and have been reviewed as part of this assessment. A summary comment is provided.

Document Name	Classification	Comment
Rivoli Bay Data Collection and Modelling Summary Report	Modelling Data Collection	Report contains extensive metocean data collected, literature review, modelling outputs and recommendations (2021)
Rivoli Bay Summary Report	Asset Management Plans	Coastal processes and management options for Beachport derived from Baird Data Collection Report (2021)
Status & Management Options for Salmon Hole/ Post Office Rock	Erosion Study Shoreline Management	Deep erosion analysis on Post Office Rock Beach with management plan and at-risk assets identified (2018)
Sand Management Plan for Beachport Town Beaches	Shoreline Management	Document identifies Beachport Town beaches with sand stores and deficits, as well as planned actions (2017)
Beachport Boat Ramp - Review of Maintenance Requirements	Technical Context	Report provides sufficient technical insight into coastal processes surrounding the Beachport Boat Ramp (2017)
Rivoli Bay Study	Modelling	Study provides Beachport foreshore groyne assessment and modelling of wave runup and overtopping outputs (2015)
Rivoli Bay - Appendix 1 - Assessment of Existing Coastal Structures	Coastal Structures Assessment	Assessment of Beachport Groynes (2015)
Lake George Study	Planning Context	Study focuses on lake management and ecology but outlines issues caused from lake outlet in Rivoli Bay, Beachport (2015)
Lake George - Appendix 1 - Tidal Inlet analysis	Modelling	Analysis provides technical context into the Lake George Outlet stability based on coastal data (2015)
Lake George - Appendix 2 - Groyne Extension Concept Design	Modelling	Document contains Beachport simulated local wave data and modelling outputs (2015)
Beachport Boat Ramp Fact Sheet	Modelling	Fact sheet summarises Baird coastal consultants modelling outputs and suggested management option for siltation at Beachport Boat Ramp
Coastal Processes Rivoli Bay Fact Sheet	Technical Context	Fact sheet summarises coastal processes across Rivoli Bay
Beachport Foreshore Fact Sheet	Planning Context	Fact sheet identifies Beachport Foreshore Groyne inefficiency, suggesting a range of upgrade options

APPENDIX B: MODEL CONFIGURATIONS

Table 20 SFINCS Model Settings

Settings specified in the application of SFINCS in this assessment.

Parameter	Value
Domain	
Spatial extent	Figure 8
Grid type	Rectangular
Δx	10 m
Δy	10 m
Processes	
River flow	No
Roughness	Constant
Infiltration	No

Parameter	Value
Boundaries	
Offshore boundary	-2 m
Outflow boundaries	East and West
Boundary Conditions	
Sea level rise	Table 9
Tide	Table 9
Surge	Table 9
Waves	Not within project scope
Rainfall	Not within project scope
River discharge	Not within project scope

Table 21 SWAN Model Settings

Settings specified in the application of SWAN in this assessment.

Parameter	Value
General	
OnlyInputVerify	false
SimMode	stationary
DirConvention	nautical
WindSpeed	0
WindDir	0
Output	
TestOutputLevel	0
TraceCalls	False
UseHotFile	False
WriteCOM	False
Domain	
DirSpace	Circle
Ndir	72
StartDir	0
EndDir	0
FreqMin	5.0e+-002
FreqMax	1.0
NFreq	24
Output	True
Boundary	
Definition	Orientation
SpectrumSpec	Parametric
SpShapeType	Jonswap
PeriodType	Peak
DirSpreadType	Power
PeakEnhanceFac	3.3
GaussSpread	9.999e-003

Parameter	Value
Processes	
GenModePhys	3
Breaking	True
BreakAlpha	1
BreakGamma	7.3e-0.001
Triads	False
TraidsAlpha	1.00e-001
TraidsBeta	2.2
WaveSetup	False
BedFriction	jonswap
BedFricCoef	6.7e-002
Diffraction	True
DiffracCoef	2.00e-001
DiffracSteps	5
DiffracProp	True
WindGrowth	False
WhiteCapping	Komen
Quadruplets	fase
Refraction	true
FreqShift	True
WaveForces	dissipation3d
Numerics	
DirSpaceCDD	5.0e-001
FreqSpaceCSS	5.0e-001
RChHsTm01	2.0e-002
RChMeanHs	2.0e-002
RChMeanTm01	2.0e-002
PercWet	9.8e+001
MaxIter	100

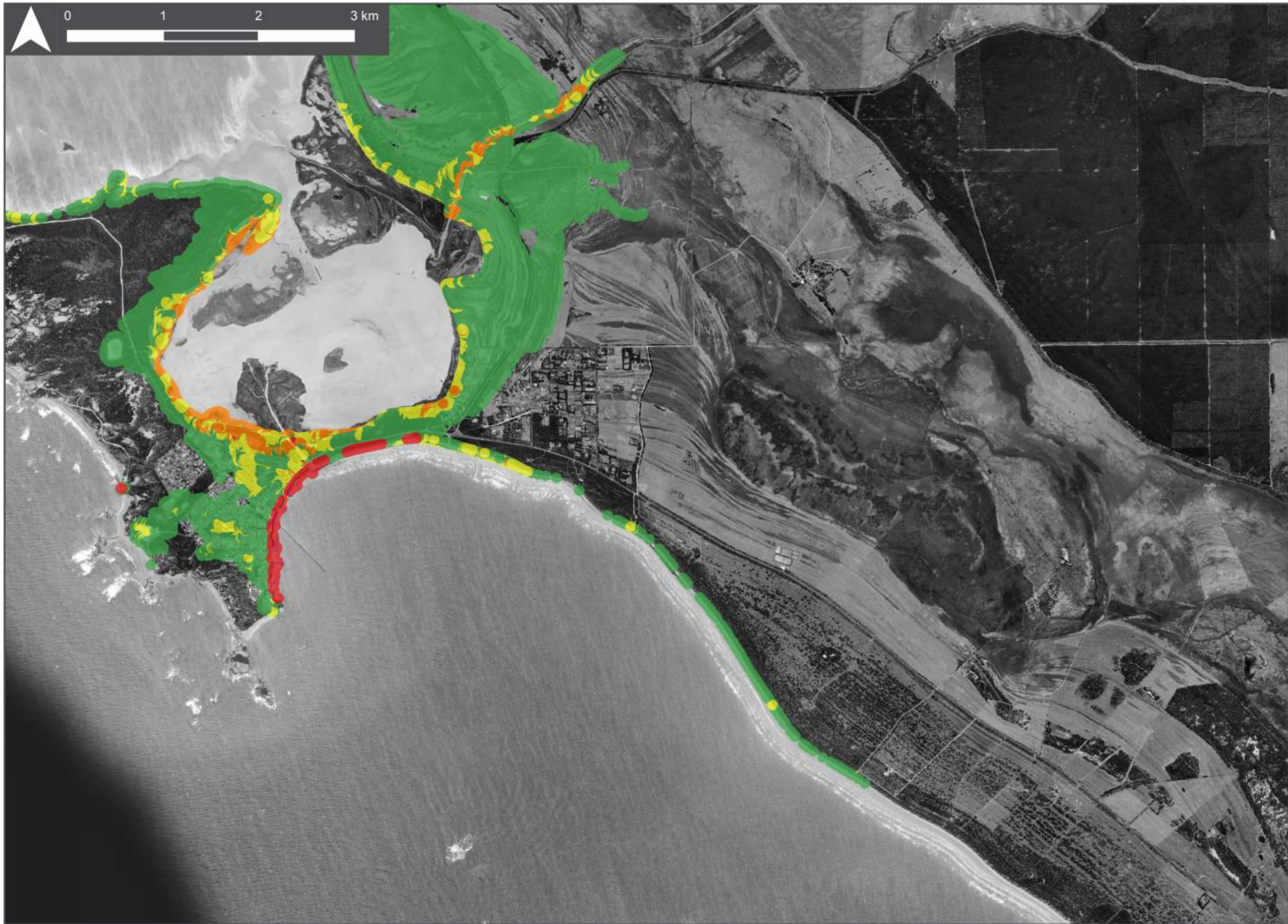
Table 22 XBeach Model Settings

Settings that differ from the default values specified in XBeach.

Parameter	Value
Flow Boundary Conditions	
front	Abs_1d
left	Wall
right	Wall
back	Wall
Flow	
bedfriction	Manning
Grid Parameters	
Thetamin	90
Thetamax	-90
Dtheta	180
thetanaut	0
Model Time	
tstop	Varies
Tide Boundary Conditions	
tideloc	1
Wave boundary conditions	
instat	Jons
Processes Simulated	
swave	true
lwave	true
flow	true
sedtrans	true
morphology	true
avalanching	true

Parameter	Value
Output Variables	
Outputformat	Netcdf
rugdepth	0.02
tintm	400
tintp	N/A
tintg	20
tstart	0
tstop	varies
Output Options	
nglobalvar	7
	zb
	zs
	H
	ue
	ve
	sedero
	hh
nmeanvar	5
	zs
	H
	ue
	ve
	hh

APPENDIX C: RISK MAPS



Legend

- Low
- Moderate
- Significant
- High

This map illustrates the inundation risk for the 100-year Annual Recurrence Interval (ARI) storm event, incorporating both the likelihood of flooding (as indicated on the inundation map) and the consequence of the inundation.

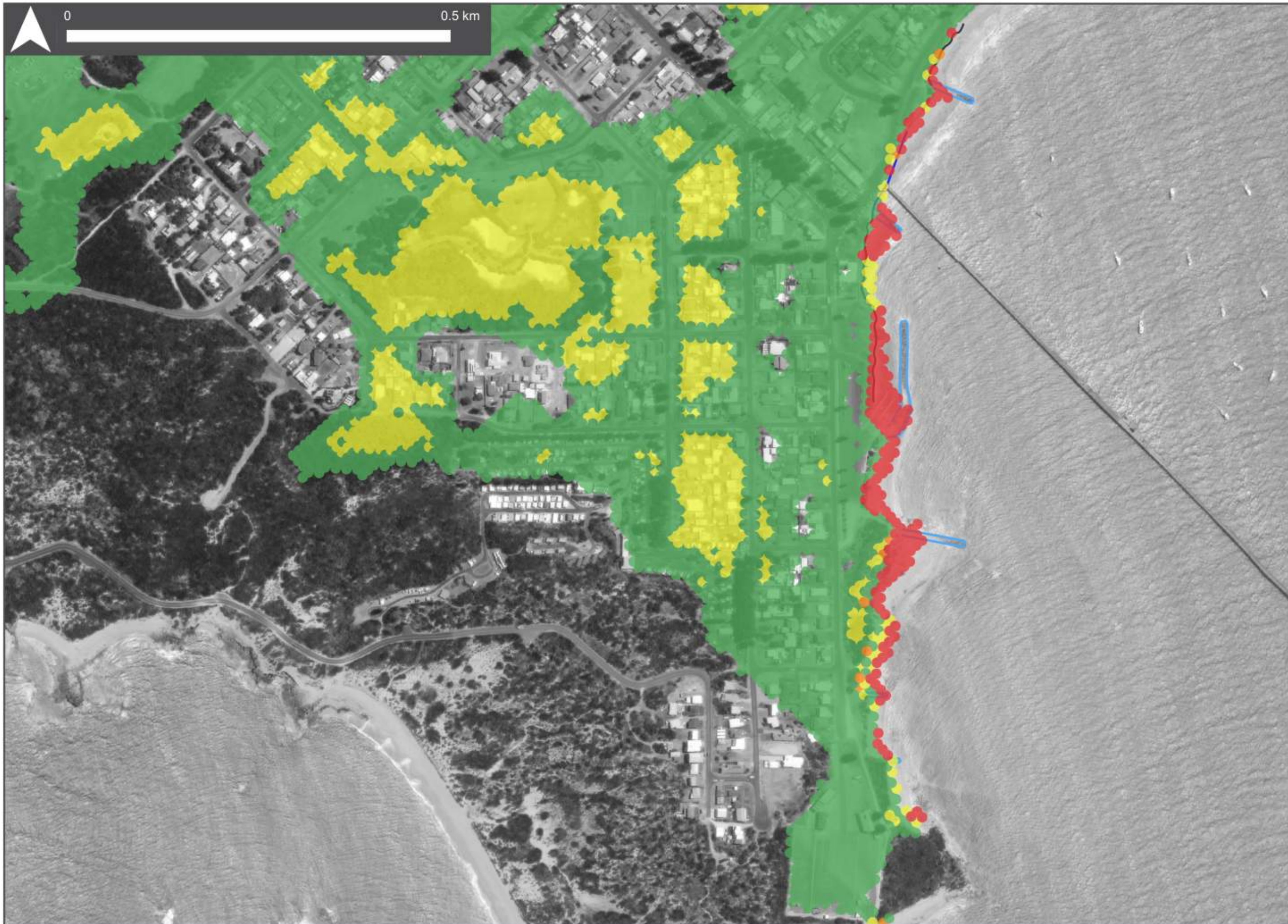
FSC RANGE

Beachport 2050 Inundation Risk

Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 1 of 4
Date: 27/07/2025



Legend

- Low
- Moderate
- Significant
- High

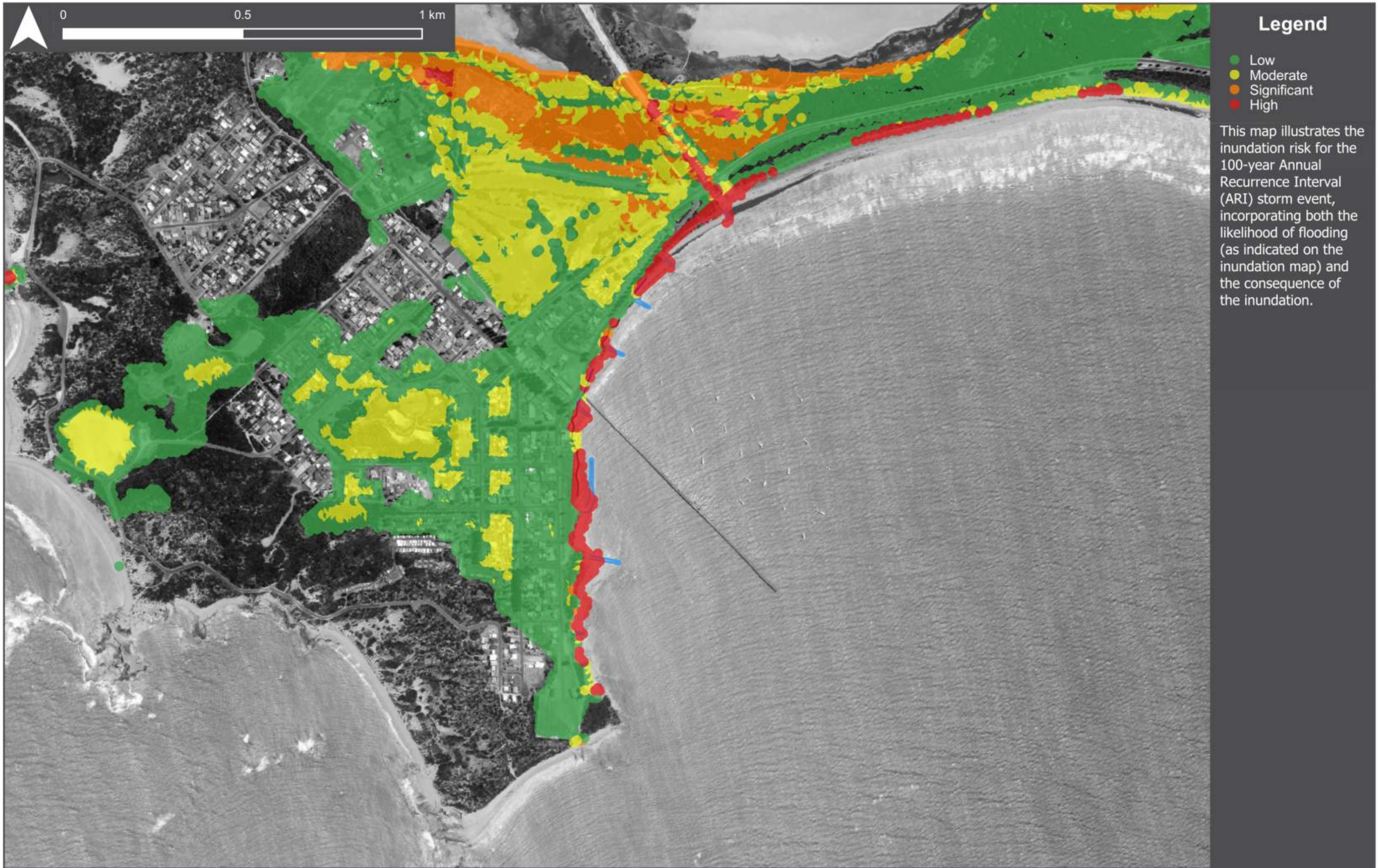
This map illustrates the inundation risk for the 100-year Annual Recurrence Interval (ARI) storm event, incorporating both the likelihood of flooding (as indicated on the inundation map) and the consequence of the inundation.

FSC RANGE

Beachport 2050 Inundation Risk
Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 2 of 4
Date: 27/07/2025



FSC RANGE

Beachport 2050 Inundation Risk
Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 3 of 4
Date: 27/07/2025

FSC RANGE

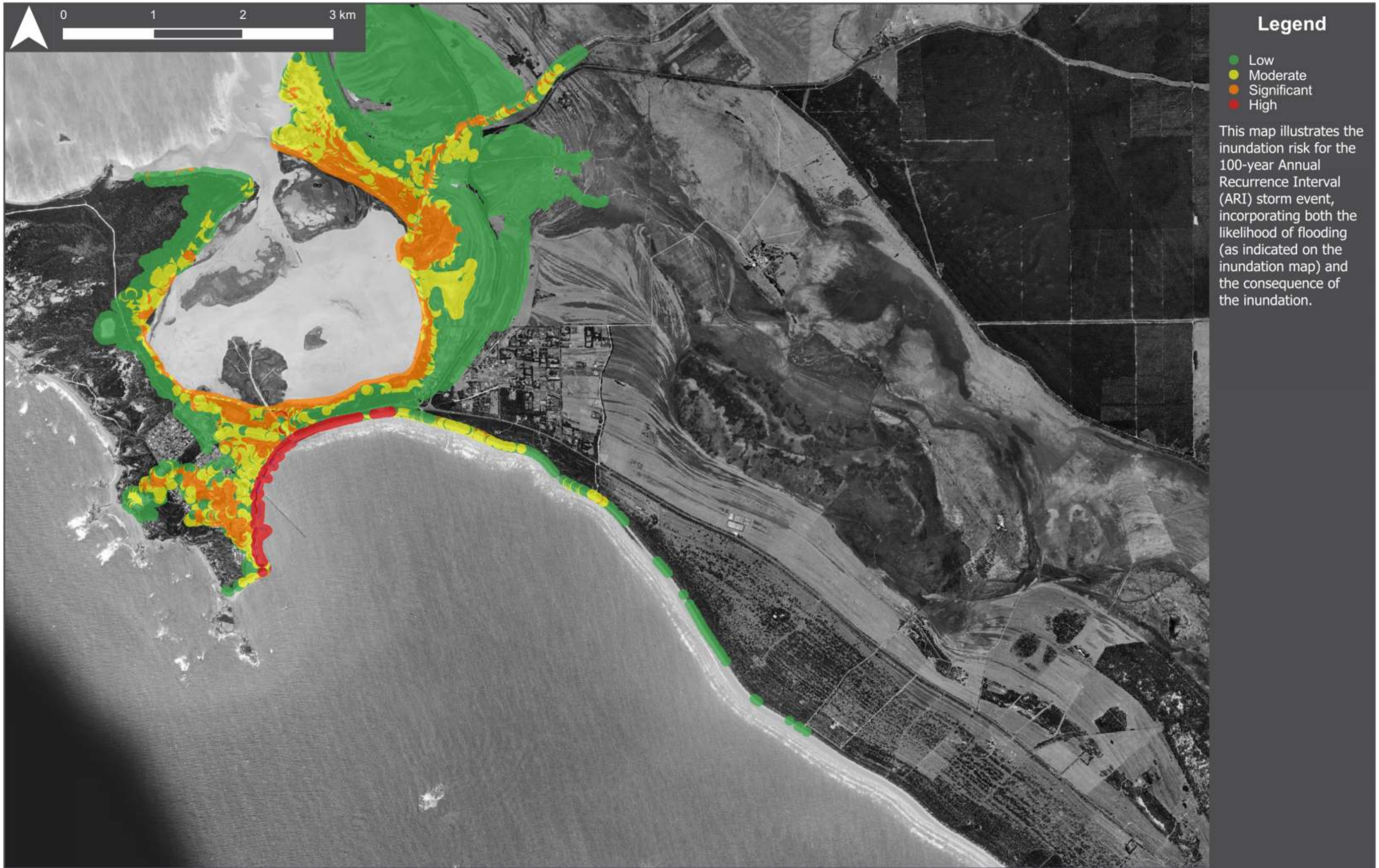
Beachport 2050 Inundation Risk

Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy

Date: 27/07/2025

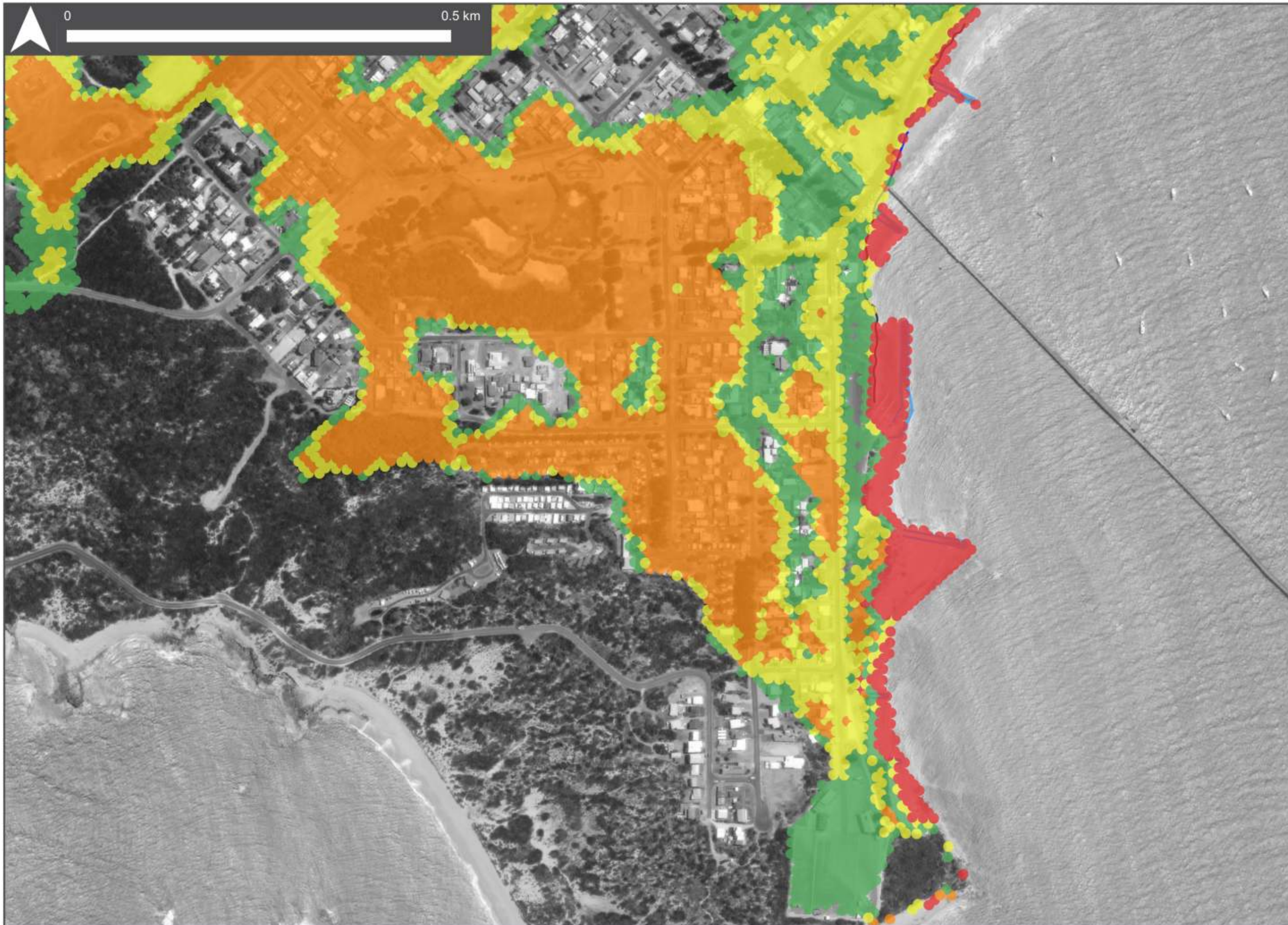


FSC RANGE

Beachport 2100 Inundation Risk
Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 1 of 4
Date: 27/07/2025



Legend

- Low
- Moderate
- Significant
- High

This map illustrates the inundation risk for the 100-year Annual Recurrence Interval (ARI) storm event, incorporating both the likelihood of flooding (as indicated on the inundation map) and the consequence of the inundation.

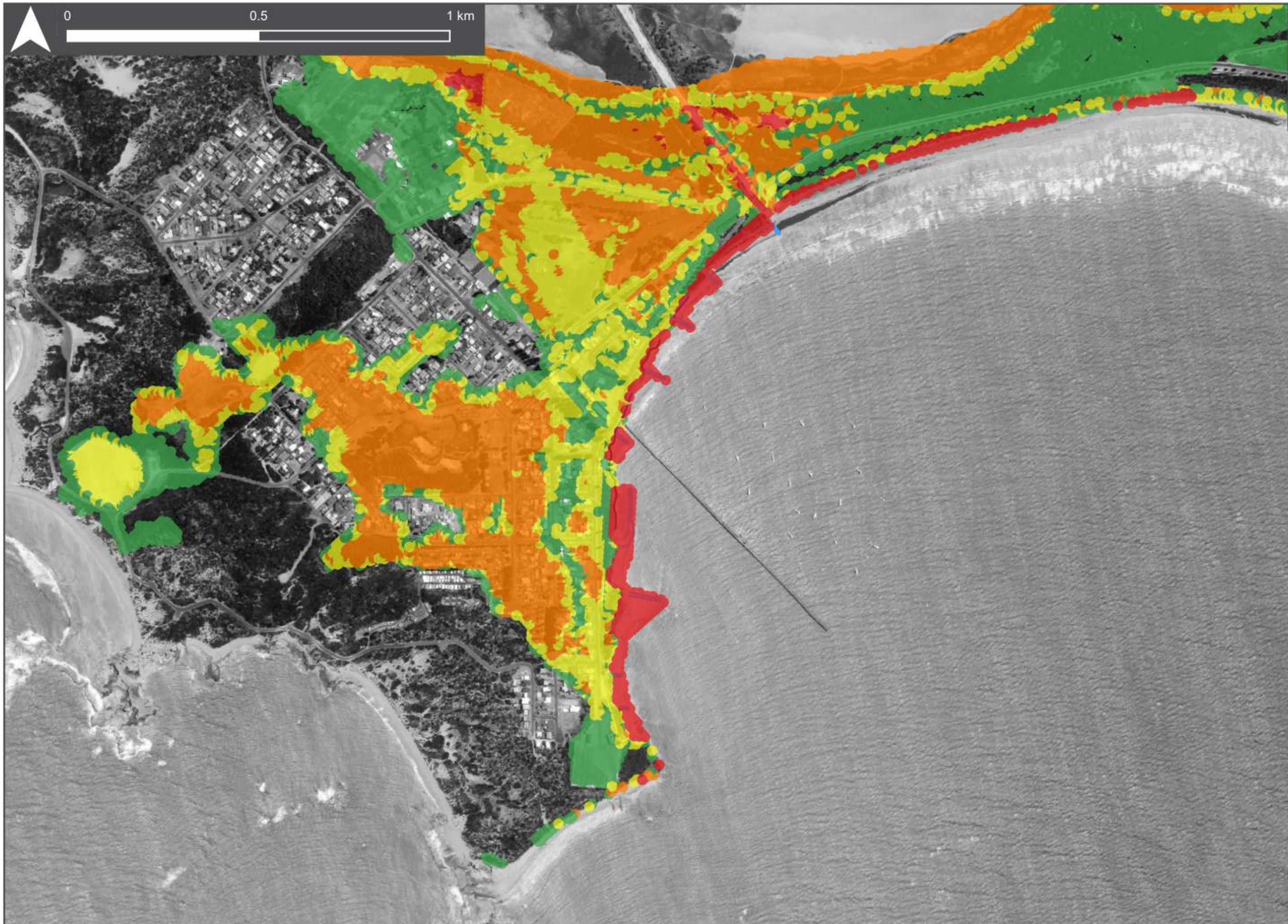
FSC RANGE

Beachport 2100 Inundation Risk

Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 2 of 4
Date: 27/07/2025



Legend

- Low
- Moderate
- Significant
- High

This map illustrates the inundation risk for the 100-year Annual Recurrence Interval (ARI) storm event, incorporating both the likelihood of flooding (as indicated on the inundation map) and the consequence of the inundation.

FSC RANGE

Beachport 2100 Inundation Risk
Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 3 of 4
Date: 27/07/2025

Legend

- Low
- Moderate
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FSC RANGE

Beachport 2100 Inundation Risk
Limestone Coast Coastal Adaptation Assessment

Project: 210205
CRS: GDA2020 / MGA zone 54
Scale: 1:55144 @ A4

Drawn: Andrew Pomeroy
Sheet: 4 of 4
Date: 27/07/2025

APPENDIX D: ADAPTATION APPROACHES

1 DUNE RECONSTRUCTION

Dune reconstruction is a nature-based or hybrid approach that involves reshaping and stabilising degraded dunes to restore their natural form and function. The reconstructed dune provides a first line of defence against coastal erosion, can help reduce wave overtopping, and supports habitat restoration. This technique involves planting native dune vegetation to stabilise sediments. This option can be enhanced by incorporating measures such as beach nourishment to protect the dune toe while providing beach amenity, and temporary sand fencing or biodegradable erosion-control mats to promote stability during establishment.

Figure 1-1: Photographs of dune reconstruction

(left) Restored dune system with native vegetation and fencing in Cape Cod, USA. (right) Dune reconstruction using fencing at Northen Beaches, Sydney, Australia. Photographs from National Oceanic and Atmospheric Administration (NOAA) and Stainless Steel Wire & Mesh.

Table 1-1: Evaluation of dune reconstruction

Advantages	Disadvantages	Considerations
▪ Coastal Protection ▪ Natural Shoreline Growth ▪ Habitat Creation and Biodiversity ▪ Water Quality and Carbon Sequestration ▪ Aesthetic and Community Value ▪ Adaptability ▪ Beach Nourishment Options	▪ Slow Establishment ▪ Site-Dependent ▪ Maintenance ▪ Post-storm repairs	▪ Access Restrictions ▪ Maintenance/Repairs Cost Factors ▪ Nature-Based Approach

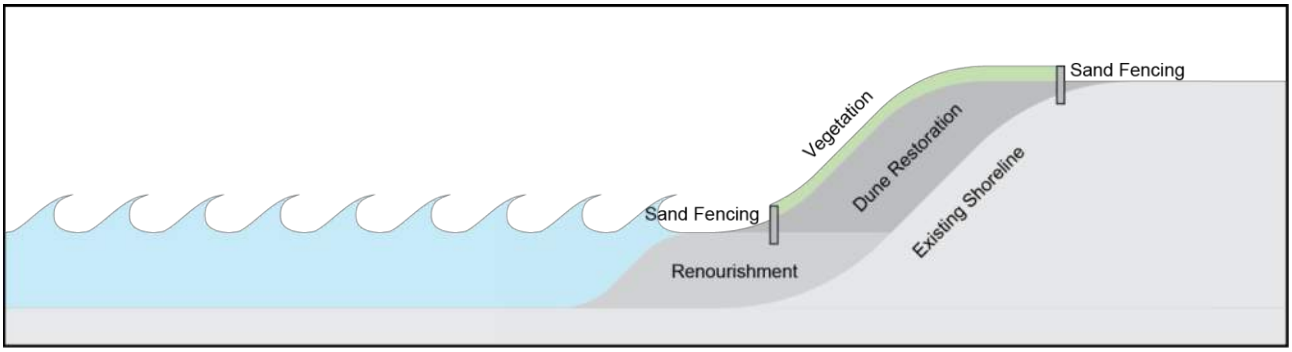


Figure 1-2: Conceptual sketch of dune reconstruction

Cross-sectional view illustrating reshaped dune with native vegetation and sand fencing for stabilisation.

2 SUPPORTED LITTORAL VEGETATION

This nature-based hybrid approach involves establishing native shoreline plants, supported by low-profile rock sills, shellfish reef or rock berms. Beach nourishment is usually also undertaken to create beach amenity and access as well as space for the vegetation to migrate with future sea levels.

Figure 2-1: Photographs of supported littoral vegetation

(left) Shows coastal saltmarsh and grasses growing behind low crested rock sill in Raymond Island, Gippsland Lakes. (middle) Shows mangroves planted behind a low rock fillet on an estuary bank in northern NSW. Source: Rebecca Morris (Morris et al., 2021). (right) Shows rock sill with planting for shoreline stabilisation at Pahurehure Inlet in Aukland, New Zealand. Photographs from Virginia Institute of Marine Science (n.d.).

Table 2-1: Evaluation of supported littoral vegetation

Advantages	Disadvantages	Considerations
▪ Coastal Protection ▪ Natural Shoreline Growth ▪ Habitat Creation and Biodiversity ▪ Water Quality and Carbon Sequestration ▪ Aesthetic and Community Value ▪ Adaptability ▪ Beach Nourishment Options	▪ Slow Establishment ▪ Site-Dependent ▪ Maintenance	▪ Trial Section ▪ Access Restrictions ▪ Modelling Needs ▪ Cost Factors ▪ 50+ Year Design Life ▪ Hybrid approach

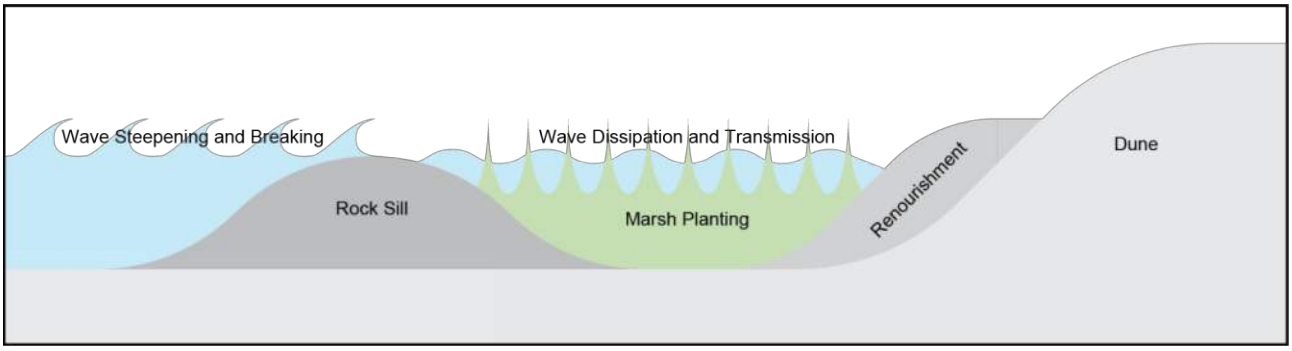


Figure 2-2: Conceptual sketch of supported littoral vegetation

Shows cross-sectional view of rock sill with planting.

3 LIVING SEAWALL

A living seawall integrates habitat features with traditional seawall structures, providing erosion protection and enhancing biodiversity.

Figure 3-1: Photographs of living seawall

(left) Shows living seawall without marine growth at Sawmillers Reserve in Sydney, Australia. (right) Shows living seawall with marine growth at Sutton Harbour in Plymouth, Wales. Photographs from Living Seawalls (2024).

Table 3-1: Evaluation of living seawall

Advantages	Disadvantages	Considerations
▪ Coastal Protection ▪ Biodiversity ▪ Aesthetic Value	▪ High Initial Cost ▪ Maintenance ▪ Scour and Beach Lowering ▪ Adaptability	▪ Capital Costs ▪ 50-Year Design Life

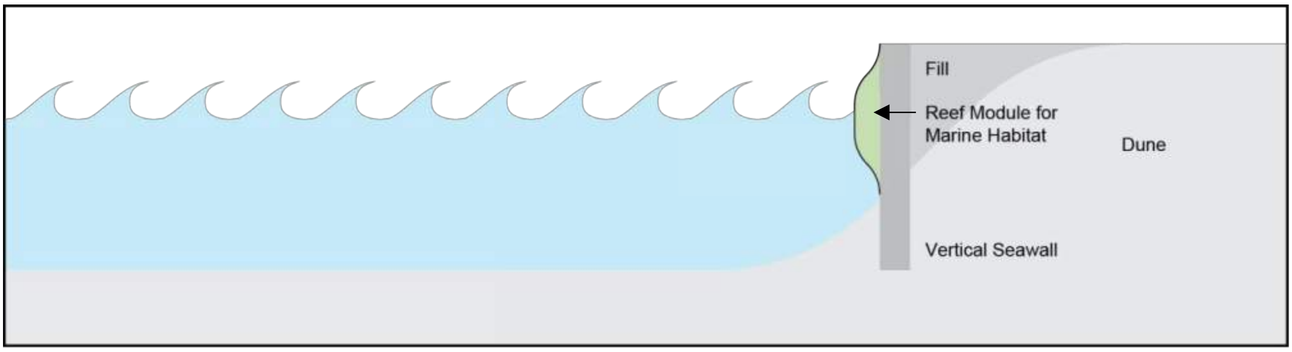


Figure 3-2: Conceptual sketch of living seawall

Shows cross-sectional view of living seawall.

4 "RICH" REVETMENT

This option is a sloped rock or block seawall that incorporates either additional rock or engineered concrete units at its toe, designed to create intertidal habitat while providing erosion protection.

Figure 4-1: Photographs of "rich" revetment

(left) Shows rock tide pool at rock revetment toe. (right) Shows engineered concrete reef unit. Photographs from EcoShape (2024) and Sella et al. (2022).

Table 4-1: Evaluation of "rich" revetment

Advantages	Disadvantages	Considerations
▪ Coastal Protection ▪ Biodiversity ▪ Aesthetic and Community Value	▪ Maintenance ▪ Cost ▪ Adaptability	▪ Capital Costs ▪ 50+ Year Design Life

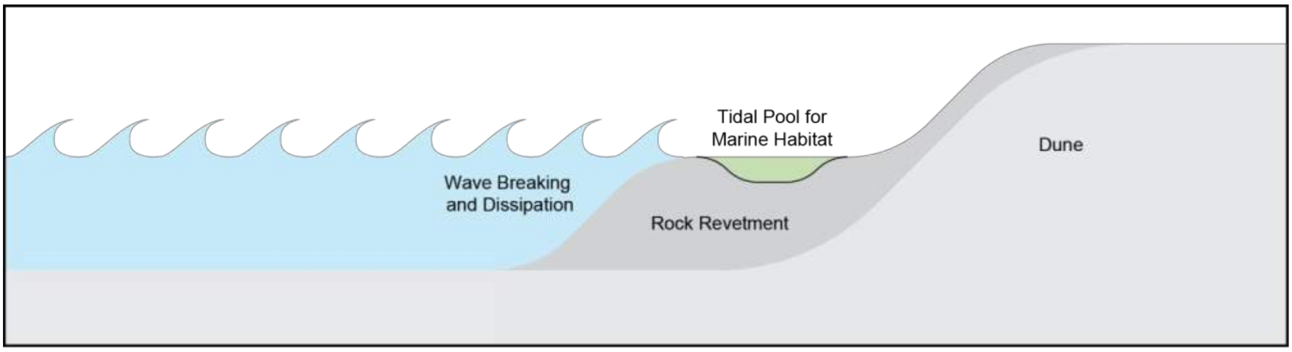


Figure 4-2: Conceptual sketch of rich revetment

Shows cross-sectional view of rock tide pool at revetment toe.

5 REVETMENT

This approach involves construction of a sloped revetment to prevent shoreline erosion. Such structures might be constructed from rock or geobags (rock or sand filled geotextile bags).

Figure 5-1: Photographs of rock revetment

(left) Shows rock revetment at Craigie Beach in Victoria, Australia. (right) Shows rock revetment at Portsea in Victoria, Australia. Photographs from AW Maritime (n.d.).

Table 5-1: Evaluation of rock revetment

Advantages	Disadvantages	Considerations
▪ Coastal Protection ▪ Long Lifespan	▪ Aesthetic Impact ▪ Scour and Beach Lowering ▪ Adaptability	▪ Capital Costs ▪ 50+ Year Design Life

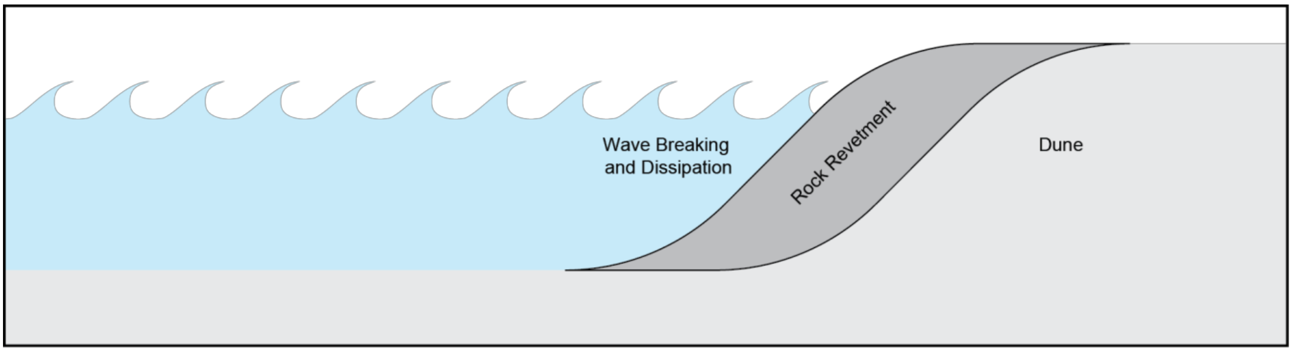


Figure 5-2: Conceptual sketch of rock revetment

Shows cross-sectional view of rock revetment.

6 VERTICAL SEAWALL

A vertical seawall, e.g. masonry block wall, sheet pile wall, etc, is a traditional hard engineering solution designed to prevent shoreline erosion.

Figure 6-1: Photographs of vertical seawall

(left) Shows vertical seawall at Black Rock in Victoria, Australia. (right) Shows vertical seawall at Brighton in Victoria, Australia. Photographs from State Government of Victoria (2024).

Table 6-1: Evaluation of vertical seawall

Advantages	Disadvantages	Considerations
▪ Coastal Protection ▪ Long Lifespan	▪ High Initial Cost ▪ Environmental Impact ▪ Limited Adaptability ▪ Scour and Beach Lowering	▪ Capital Costs ▪ 50+ Year Design Life

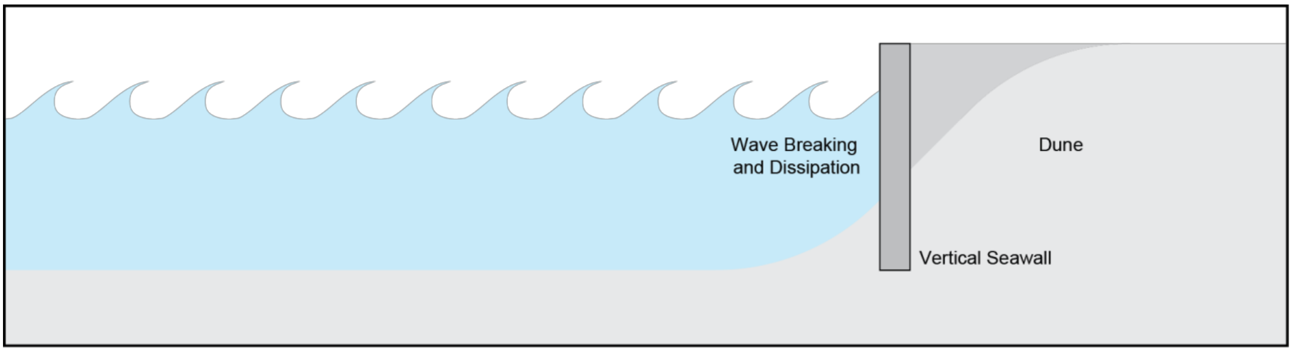


Figure 6-2: Conceptual sketch of vertical seawall

Shows cross-sectional view of rock revetment.

7 PERCHED BEACH

A perched beach is an artificial or modified beach built above the natural shoreline, typically using submerged structures like groynes, sills, or breakwaters to trap and retain sand. These offshore features reduce wave energy and stabilize the beach, creating an elevated and stable profile even in areas with limited natural sediment supply. Perched beaches are commonly used for erosion control or to provide recreational space along narrow or eroding coastlines.

Table 7-1: Evaluation of offshore seawall

Advantages	Disadvantages	Considerations
▪ Softer coastal protection and wave energy dissipation ▪ Enhances recreational beach area in narrow or eroding coastlines ▪ Stabilises sediment in areas with limited natural supply ▪ Can improve local aesthetics and amenity	▪ Requires some maintenance and potential re-nourishment ▪ Initial construction cost can be higher than other options. ▪ May alter local sediment transport and nearby shorelines ▪ Structures may pose navigational or ecological impacts if not well-designed	▪ Site-specific wave climate, sediment supply, and bathymetry must be understood ▪ Modelling for Effective Design. ▪ Capital Costs ▪ 50+ Year Design Life may be able to be achieved.

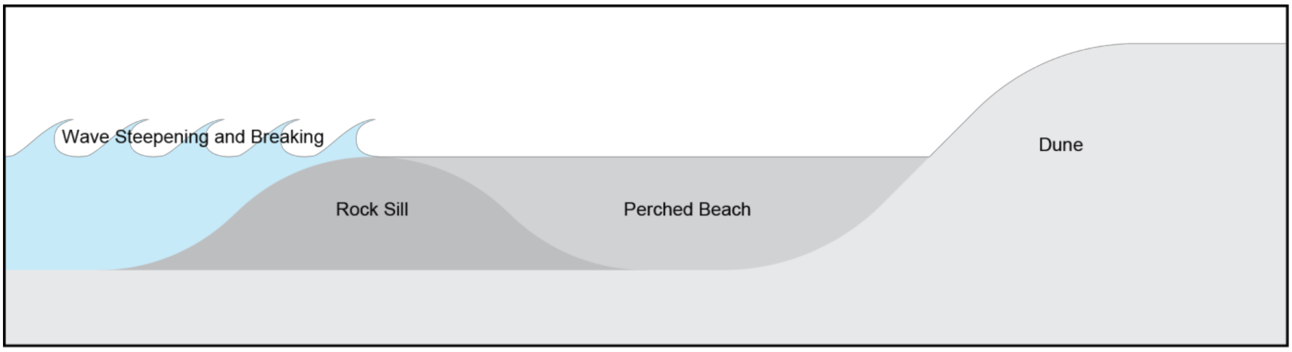


Figure 7-1: Conceptual sketch of a perched beach

8 BREAKWATERS

A breakwater is a structure built to reduce wave energy before it reaches the shoreline, protecting the coast from erosion. These may be rock or artificial reef structures.

Table 8-1: Evaluation of offshore seawall

Advantages	Disadvantages	Considerations
▪ Coastal Protection ▪ Sediment Accumulation	▪ High Construction Costs ▪ Sediment Redistribution (Interrupts littoral drift)	▪ Modelling for Effective Design ▪ Capital Costs ▪ 50+ Year Design Life

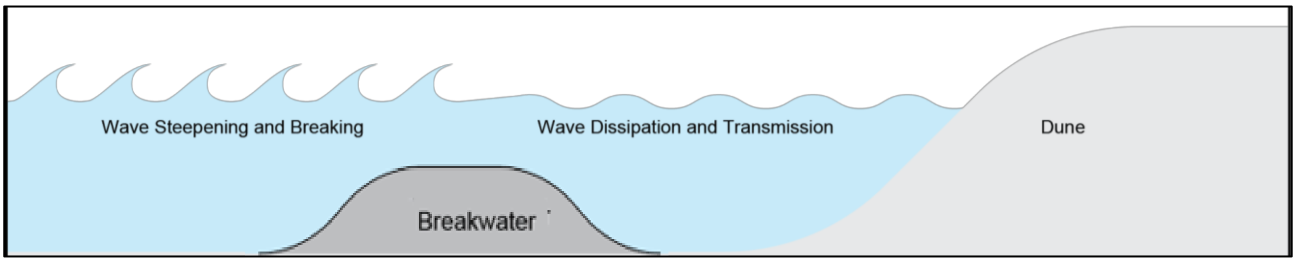


Figure 8-1: Conceptual sketch of breakwater

9 GROYNE FIELD

A groyne field consists of multiple shore-normal structures, typically rock or timber, built to trap sand and reduce longshore drift. These structures can also be designed with a more natural appearance, such as engineered outcrops, to better integrate with the surrounding coastal landscape and support ecological values. When combined with beach nourishment, groynes can enhance beach amenity and resilience by retaining sediment locally. However, they can disrupt natural sand movement and may cause downstream erosion if not carefully designed and maintained. Their effectiveness relies on regular nourishment and sediment bypassing to avoid unintended environmental and geomorphic impacts.

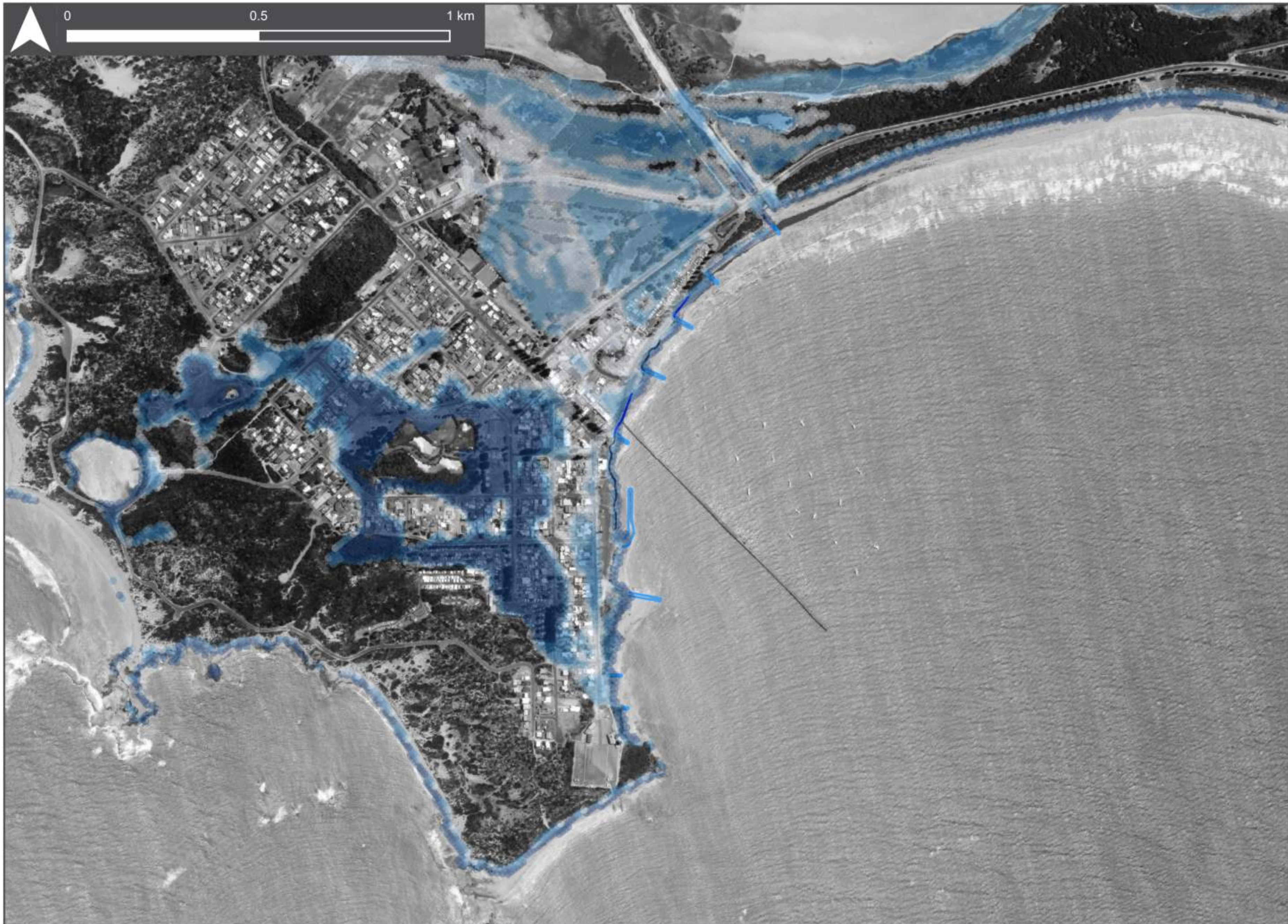
Figure 9-1: Photographs of groyne field

(left) Shows timber groyne field at Cowes East Foreshore in Victoria, Australia. (right) Shows rock groyne at Williamstown Beach in Victoria, Australia. Photographs from Engage Bass Coast (2024) and Visit Hobsons Bay (2024).

Table 9-1: Evaluation of groyne field

Advantages	Disadvantages	Considerations
▪ Sediment Management	▪ Sediment Redistribution (interrupts littoral drift) ▪ Maintenance	▪ Spacing and Length ▪ Capital Costs ▪ 50 Year Design Life

APPENDIX E: DUNE BREACH CASE



This map illustrates potential inundation areas for the 100-year Annual Recurrence Interval (ARI) storm event, considering storm tide, 2100 SLR, and wave effects (setup and runup levels).

The colours indicate the estimated water depth that is possible to occur during the event. Water depths may be higher or lower than these values, depending on the actual event that occurs.

FSC RANGE

Beachport 2100 + Dune Breach Inundation Map

Limestone Coast Coastal Adaptation Asessment

Sheet: 1 of 2
CRS:
Scale: 1: @ A4

FSC RANGE

Beachport 2100 + Dune Breach Inundation Map
Limestone Coast Coastal Adaptation Asessment

Sheet: 2 of 2
CRS:
Scale: 1: @ A4

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