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East Cowes and Silverleaves Adaptation Plan

Victoria Department of Environment Energy and Climate Action

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Contact Information	
Prepared by	**Range Consulting Pty Ltd**
ABN	97 644 088 344
Address	366A Bridge Road, Richmond VIC 3121 Australia
Phone	1300 372 477
Email	projects@fsc-range.com
Website	fsc-range.com

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1 INTRODUCTION

1.1 Project Overview

The 1970s rock revetment (Asset Number S201355) at East Cowes, located along the shoreline adjacent to Silverleaves Beach, was identified as being in poor condition and has contributed to substantial terminal erosion downstream at Silverleaves, which threatens both ecological and private assets. To address these issues, the State of Victoria Department of Energy, Environment, and Climate Action (DEECA) partnered with FSC Range to undertake a detailed risk assessment of the revetment to evaluate its structural integrity and understand its role in risk management (FSC Range 2024a). Following this, a comprehensive coastal processes study was undertaken to assess the dynamics affecting the revetment and the surrounding coastline (FSC Range 2024b). The findings of these initial assessments highlighted the need for an immediate and long-term solution. As a result, the next phase in this process—this study—focuses on developing a coastal adaptation plan to mitigate ongoing erosion and increase the resilience of the Silverleaves shoreline.

1.2 Study Area

The study area is located on the northwestern coast of Phillip Island, spanning the East Cowes 1970's revetment (asset S201355), with its western edge near Coghlan Road. The project area continues eastward along the Silverleaves shoreline, extending to the easterly end of Silverleaves Ave., which is also the Ramsar Wetland boundary. Figure 1-1 shows the project and surrounding area.

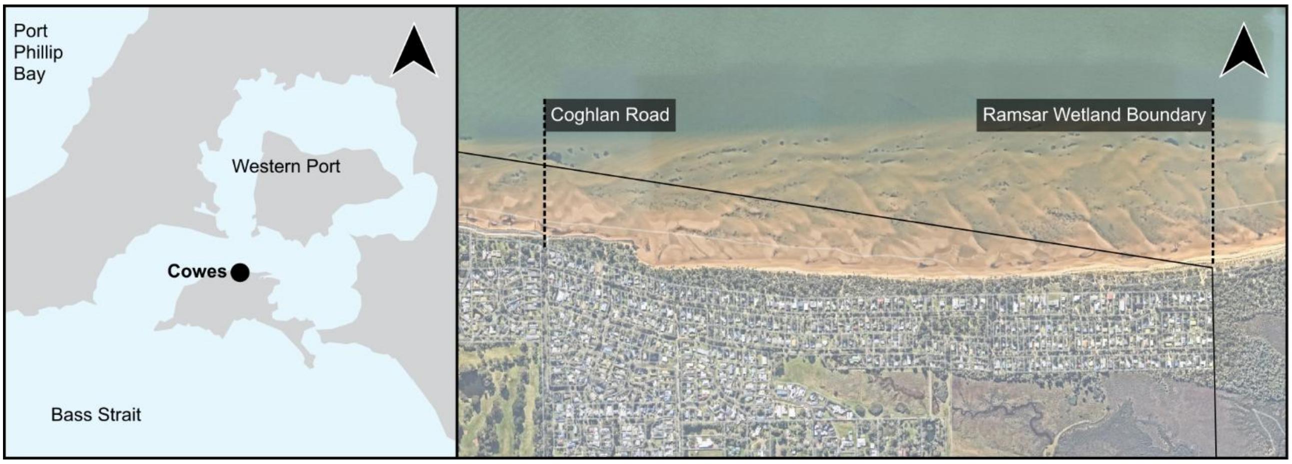

Figure 1-1: Map of locality and context
(left) The project area in relation to Melbourne. (right) An aerial view of surrounding area (Nearmap, 2023).

For the purposes of adaptation planning, the study area was divided into three sections (Figure 1-2): Section A (the existing 1970s revetment, asset S201355), Section B (approximately 850 meters shoreline at western Silverleaves), and Section C (the remainder of the Silverleaves shoreline extending to the easterly end of Silverleaves Ave.). This division allows for targeted assessment and planning tailored to the specific conditions of each section. We also discuss additional actions further west within the adaptation plan section of this report.

Figure 1-2: Shoreline Sections for Adaptation Planning

1.3 Scope of Services

FSC Range was engaged to lead the adaptation planning, in accordance with *Marine and Coastal Policy 2020* and *Victoria's Resilient Coast – Adapting for 2100+*. This Adaptation Plan will use the "Planning and Decision Pathway" for long-term coastal hazard adaptation, integrating community engagement, the Silverleaves Coastal Processes Study (FSC Range 2024b), and historical data with the goal to develop a sustainable coastal management solution. The scope can be summarised as follows:

- Step through the adaptation pathways approach outlined in *Victoria's Resilient Coast – Adapting for 2100+* (2023).
- Identify, investigate and compare adaptation options to mitigate coastal hazards.
- Make recommendations for the preferred solutions with consideration of values of the site.
- Identify residual condition and risk rating associated with implementing the preferred option.

A coastal asset risk assessment (FSC Range 2024a), and coastal processes assessment (FSC Range 2024b) were conducted to evaluate coastal processes and hazards for the broader Cowes and Silverleaves area. While these assessments are part of the broader project scope and beyond the scope of this report, their results have been used to inform the outcomes of this adaptation plan.

Interim coastal protection design (FSC Range 2024c) was also completed to evaluate and design options for urgent erosion control measures at Silverleaves. The draft Adaptation Plan was published prior to selection and construction of the interim works (commenced April 2025), which ultimately consisted of a rock bag revetment. As a result, these interim works were not reflected in the evaluation of long-term adaptation strategies. However, recommendations were made on how the rock bag revetment can be integrated into the adaptation pathway, ensuring it complements the chosen strategy and addresses both immediate and long-term coastal protection.

2 CONTEXT DESCRIPTION

2.1 Policy Context

The *Marine and Coastal Policy* and *Victoria's Resilient Coast Guidelines* set the framework for responding to coastal hazards and climate change. These guidelines advocate for an adaptive approach, prioritising solutions that enhance resilience while minimising environmental impact.

2.2 Planning Context

The planning context has been described in detail as part of previous studies (FSC Range, 2024a; 2024b; 2024c). The rock revetment and broader study area are located on a single parcel of Crown Land managed by Bass Coast Shire Council (Figure 2-1). The planning context associated with the surrounding area can be summarised as follows:

- The parcel is Crown land with State Government as underlying owner and Bass Coast Shire Council as appointed land manager. Funding of marine and coastal management is a shared responsibility of all levels of government, beneficiaries and users of the marine and coastal environment.
- The surrounding area is within the Western Port Ramsar Wetland according to the Western Port Ramsar Site Management Plan (The State of Victoria Department of Environment, Land, Water and Planning, 2017).
- The project area has the potential to contain Coastal Acid Sulphate Soils according to the Victorian Coastal Acid Sulphate Soils Strategy (The State of Victoria Department of Sustainability and Environment, 2009).
- The surrounding area has been classified as an Area of Cultural Heritage Sensitivity. The Registered Aboriginal Party is the Bunurong Land Council Aboriginal Corporation.

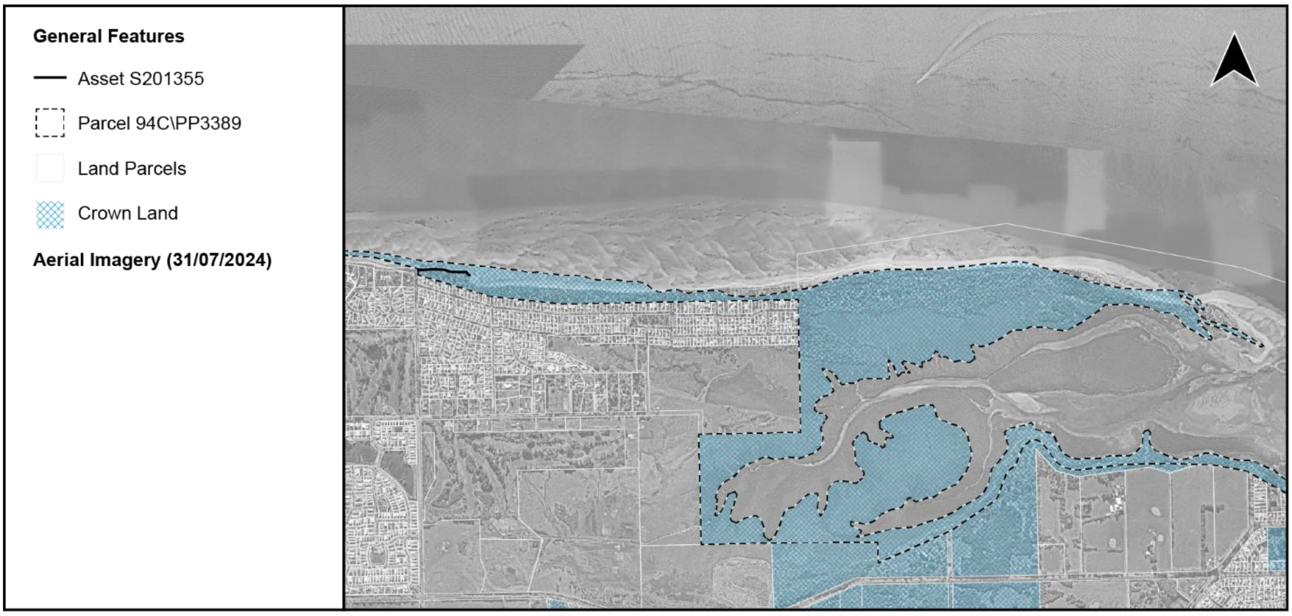

Figure 2-1: Map of land parcel and crown land
Shows land parcels and Crown Land boundaries in relation to the study area.

The rock revetment and broader study area are located on a Public Park and Recreation Planning Zone, as well as a Public Conservation and Resource Zone (Figure 2-2). The backshore area mostly comprises zoning for private residential land uses (The State of Victoria, 2024).

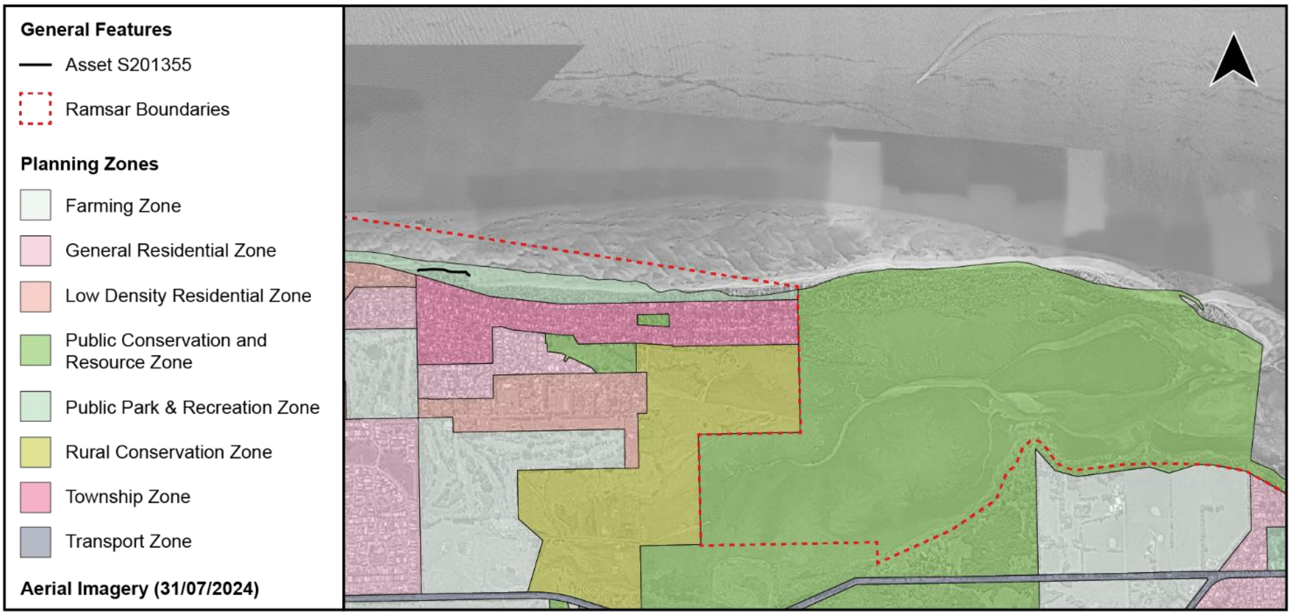

Figure 2-2: Map of planning zones
Shows planning zones and Western Port Ramsar Wetland boundaries in relation to the study area.

2.3 Site Context

The site context has been described in detail as part of previous studies (FSC Range, 2024a; 2024b; 2024c). The surrounding road, coastal, and services infrastructure in relation to the rock revetment and broader study area have been mapped below (Figure 2-3).

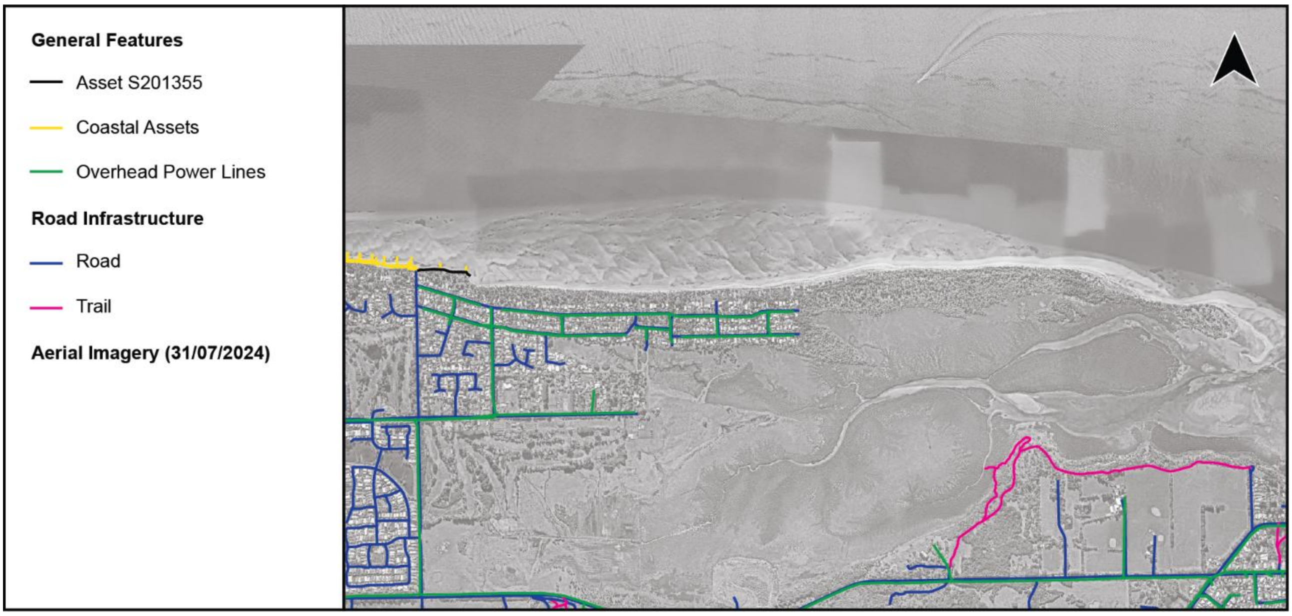

Figure 2-3: Map of site infrastructure
Shows surrounding road, coastal, and services infrastructure in relation to the study area.

The rock revetment and broader study area comprises significant coastal ecosystems, including dune systems and coastal reserve habitat. Additionally, the surrounding foreshore and beaches serve as popular recreational spaces for both residents and visitors.

2.4 Community Values

Silverleaves Community was consulted prior to beginning the coastal processes study. This meeting was held on-site on 15 February 2024. Feedback was later collected through an Engage Victoria (EngageVic) survey conducted to inform the adaptation planning process. The survey engaged local residents, stakeholders, and community groups, gathering insights into the region's cultural, social, recreational, environmental, and infrastructure values. It also captured lessons learned from previous coastal management efforts, providing valuable input to guide future strategies that reflect community priorities and address key challenges.

Key insights regarding community values identified in the survey include:

- **Environmental Values**: The natural landscapes and ecological significance of the coastal area, including its role as a habitat for native flora and fauna, was a top priority for participants. Many respondents highlighted the need to prioritise environmentally sustainable approaches in future coastal management, emphasising the importance of preserving biodiversity and environmental integrity.
- **Infrastructure and Accessibility**: Protecting road networks, private allotments, and public amenities from erosion and flooding was identified as a key concern. Ensuring continued access to the coast while maintaining its natural integrity was frequently mentioned.

- **Recreation**: The coast is highly valued for its social and recreational opportunities, such as walking, fishing, and beach activities. Social connections fostered by these activities are seen as integral to the community's well-being.
- **Cultural heritage:** The area's culture and history hold significant meaning, with traditional owner perspectives advocating for dune restoration and preservation efforts.
- **Coastal Reserve and Foreshore**: The coastal reserve, which fronts private properties and road networks, is seen as vital for its protective, habitat and aesthetic functions. A strong emphasis was placed on the importance of the foreshore as a physical buffer, protecting both natural and built environments from coastal hazards.

Lessons learned from the survey include:

- **Erosion Concerns**: Coastal erosion is the community's primary concern, with many respondents urging immediate action to mitigate its impacts.
- **Flooding Awareness**: The community expressed significant concern about the risks of inundation, particularly in low-lying areas prone to flooding during extreme weather events and high tides. Respondents emphasised the importance of maintaining access to critical infrastructure and protecting coastal assets from potential water damage.
- **Support for Action**: There is a mixed preference for engineered solutions (e.g., rock walls, groynes), softer, nature-based approaches (e.g., sand renourishment, revegetation), and hybrid approaches, suggested to balance protection with ecological preservation.
- **Perceived Inaction**: A recurring theme was frustration over the perceived lack of urgency and action from local councils and government agencies.
- **Preparedness and Proactive Adaptation**: The community believes more planning and proactive measures are required to address long-term coastal hazards effectively. The survey underscored the importance of early intervention in coastal protection, rather than reactive measures. Participants supported strategies that address long-term risks, including future erosion and flooding hazards.
- **Holistic Management**: Respondents emphasised the need for integrated approaches that balance environmental, social, and cultural values with practical considerations for infrastructure protection.
- **Community Engagement**: Many participants felt that ongoing community involvement is crucial for successful adaptation planning. Lessons from past projects highlighted the benefits of transparent communication and collaborative decision-making.
- **Sustainability**: Lessons from previous coastal projects suggested that strategies incorporating sustainable materials and processes not only align with community values but also enhance the longevity and resilience of coastal infrastructure.

This feedback has informed the adaptation planning process, ensuring that future coastal protection measures align with community values while addressing immediate and long-term risks.

2.5 Coastal Hazard Exposure

The coastal hazard exposure has been described and mapped as part of previous studies (FSC Range, 2024a; 2024b; 2024c, Western Port Local Coastal Hazard Assessment, 2013).

2.5.1 Erosion Hazards

The coastal erosion hazard zones comprise the eastern end of the existing rock revetment and broader Silverleaves area.

Section A is exposed to significant erosion hazards at its eastern terminal end, where progressive terminal erosion undermines the stability of the existing revetment and contributes to further erosion downstream. Despite its poor condition, the revetment remains largely functional in holding the shoreline in place, protecting key values such as cultural heritage, environmental assets, informal trails, and the coastal reserve. In Section B, substantial erosion has occurred in recent years, threatening cultural, social, and environmental values as well as the coastal reserve that fronts private allotments and road networks. In contrast, the shoreline at Section C has been relatively stable to accretionary since the ‘60s, with majority of the shoreline advancing seaward. However, there are some localised areas of shoreline recession and there is significant uncertainty associated with erosion risk levels due to the unpredictable nature of shoreline response to changing coastal conditions and upstream coastal protection actions. Future erosion hazards remain possible in this area due to changing coastal dynamics, sediment supply, and climate conditions. Regular monitoring is recommended to track shoreline changes and assess potential risks over time. A periodic review of the monitoring data is essential to identify whether established triggers, such as a specific threshold of shoreline recession or sea level rise, have been realized, indicating when adaptation actions should be implemented. This proactive approach ensures timely responses to emerging hazards and supports the effective management of this dynamic coastal area.

Figure 2-4: Possible future shoreline setback extents for Silverleaves

Reproduced from FSC 2024b These projections assume no intervention. We note that there is considerable uncertainty associated with these shoreline projections.

2.5.2 Inundation Hazards

Both temporary and permanent inundation hazards are present in all three Sections. Section A has a small area of low-lying land near the shore at Coghlan Road that may be vulnerable to sea level rise (SLR) inundation beyond approximately 2070. This area is also predicted to be inundated during the 1% Annual Exceedance Probability (AEP) (100-year) event even at current sea levels. At Silverleaves, a significant portion of the land is subject to permanent inundation from SLR, even for the short term planning horizons. Inundation hazards in this area, however, are primarily driven by landside flooding originating from Rhyll Inlet rather than coastal processes. Future sea levels in Rhyll Inlet are likely to flood land with low elevations that accumulated between successive spit formations towards the contemporary spit shoreline of Silverleaves. While this assessment focuses on addressing coastal flooding through protective measures, landside flooding risks require further studies to develop effective land-based flood management strategies. These strategies fall beyond the scope of this assessment but are critical for comprehensive risk mitigation and long-term resilience planning.

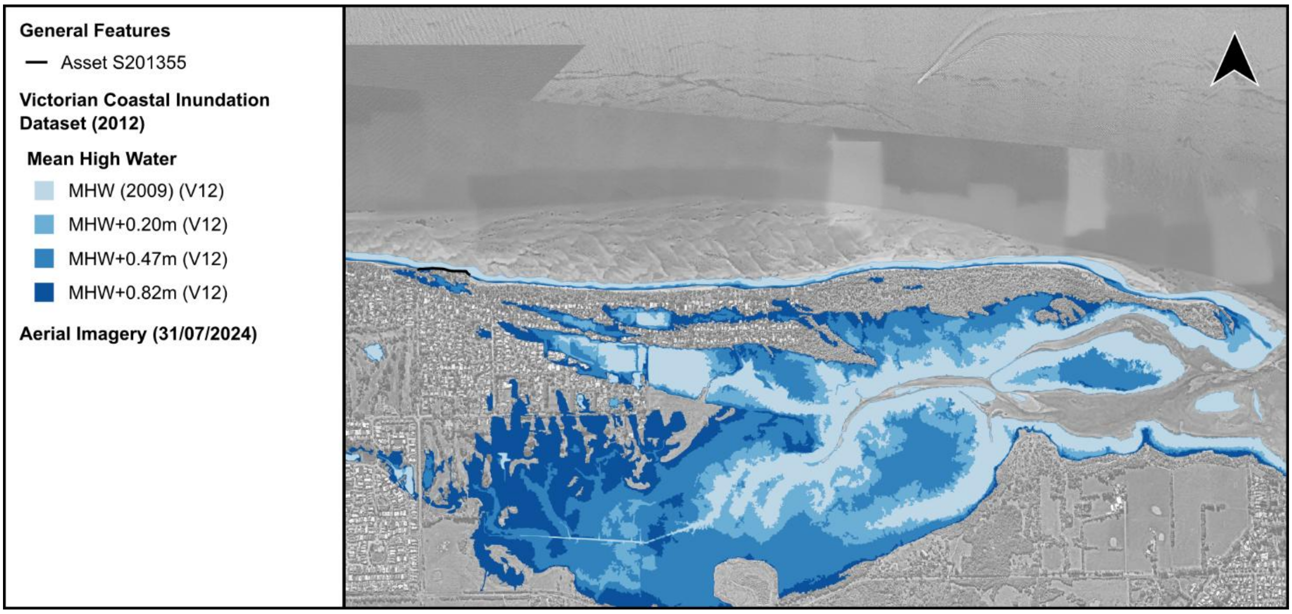

Figure 2-5: Map of projected sea level rise

Extracted from the Victorian Coastal Inundation Dataset (2009). This indicates the extent of permanent inundation due to various degrees of sea level rise.

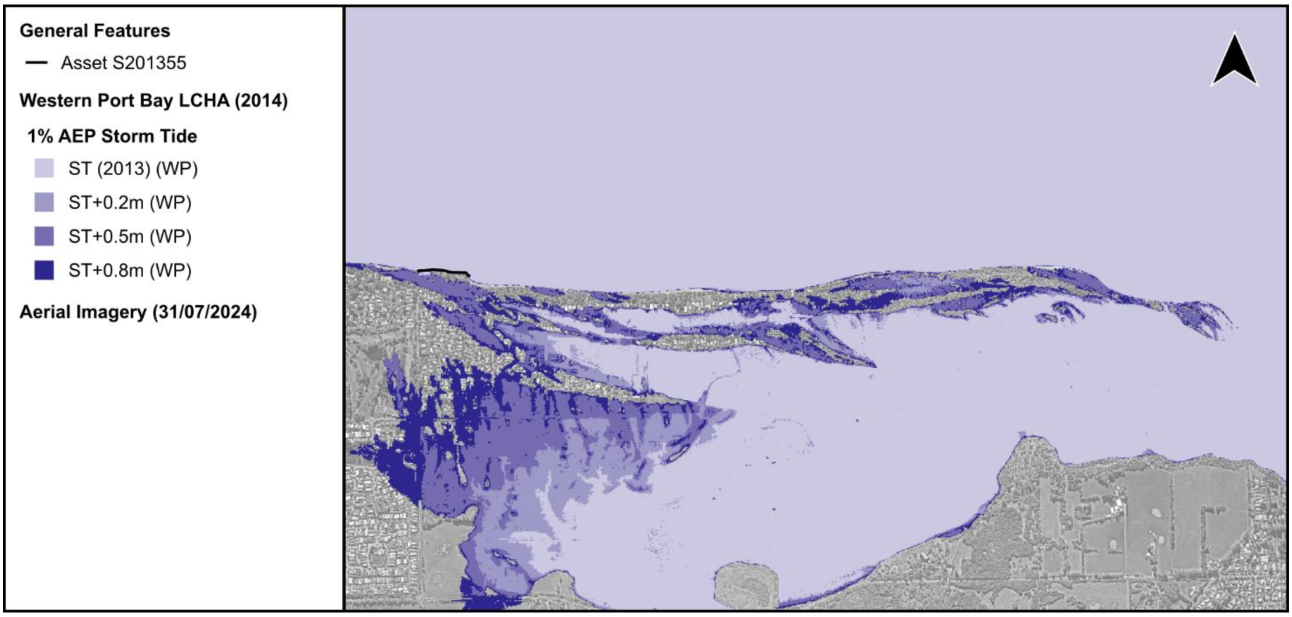

Figure 2-6: Map of storm tide – Silverleaves

Extracted from the Western Port Local Coastal Hazard Assessment (2014). Shows the extent of temporary inundation due to a 1% annual exceedance probability storm tide with various degrees of sea level rise

3 ADAPTATION PATHWAYS

3.1 Background

The pathways approach presented in the Marine and Coastal Policy (2020) is a strategic decision-making method that consists of a series of manageable steps or decision points distributed over time. This approach involves a comprehensive examination of all available options and the identification of specific thresholds or triggers (event, timing, sea level rise, other) that indicate when new decisions should be made. This forward-looking and adaptive approach acknowledges the dynamic nature of climate change impacts.

3.2 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.

3.2.1 Coastal Monitoring

Coastal monitoring is critical for managing risk, enabling timely interventions before risks escalate to unacceptable levels. The Victorian Coastal Monitoring Program (VCMP) provides valuable data for this purpose, including regular surveys of the Cowes and western Silverleaves area. These surveys generate high-resolution digital surface models with a ±0.1 m vertical uncertainty and 1 m grid resolution, including vegetation coverage (Figure 3-1).

Best practices for coastal monitoring include:

- **Trigger Points**: Establish predefined thresholds for intervention to identify when risks, such as erosion or flooding, require action. Using data from VCMP, these triggers can be calibrated to reflect local conditions accurately.
- **Regular Monitoring**: Consistently assess coastal flooding, erosion trends, and structural conditions relative to predefined triggers. Regular use of VCMP data can enable precise tracking of changes over time.
- **Erosion Markers**: Install graduated erosion markers at critical locations to detect trigger exceedance. These markers can be monitored by council staff to complement the digital data provided by VCMP.

Monitoring results should be reviewed and analysed regularly, with the timing depending on the chosen adaptation strategy and stage of implementation. In addition to routine reviews, monitoring should also occur after large storms or significant events that may impact coastal conditions. This process will be a collaborative effort between DEECA and the local council, ensuring shared responsibility for data collection, interpretation, and response. Trend analysis and proximity to identified triggers will inform adaptive management, ensuring that interventions are data-driven, timely, and proactive. Regular reviews will help ensure that the coastal management plan remains responsive to changing conditions.

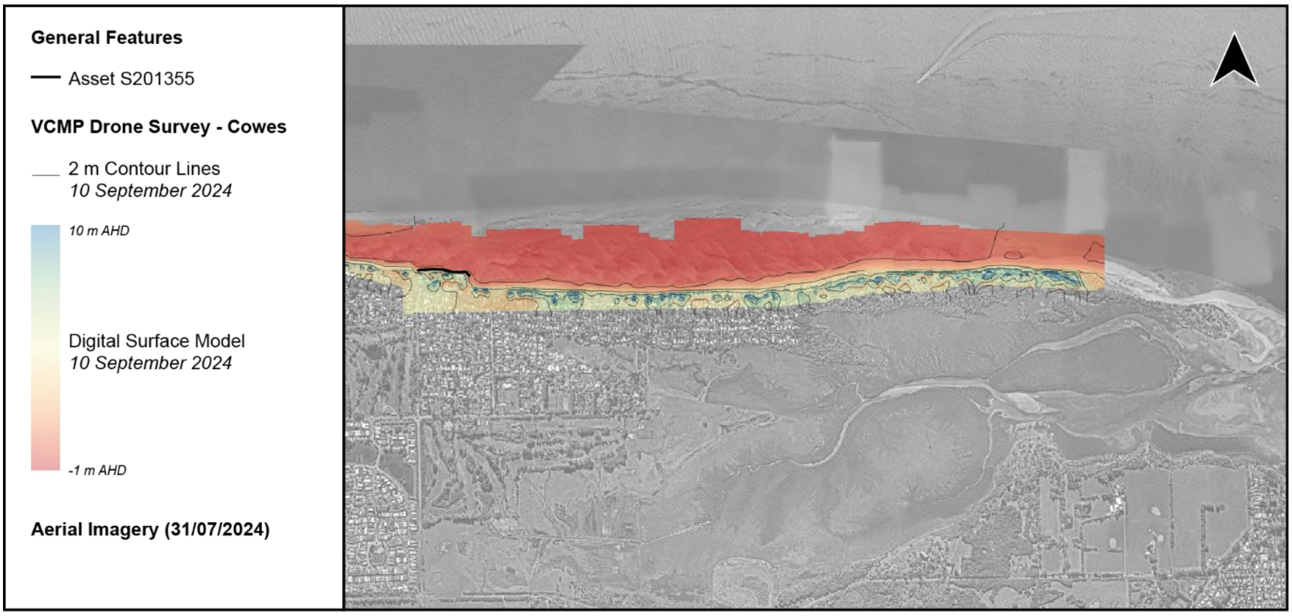

Figure 3-1: Bathymetry and topography

Shows VCMP Drone Survey at Cowes dated 10 September 2024 in relation to the rock revetment.

3.2.2 Protection of Dunes and Vegetation

Dune vegetation plays a crucial role in stabilising the dune system and reducing sand movement. To strengthen the resilience of the existing vegetation and support dune stabilisation, the following measures are recommended and can be implemented alongside any chosen adaptation option:

- **Controlled Access:** Vegetation should be safeguarded through the installation of signage, designated pathways, defined access points, and fencing to deter human impact and promote recovery.
- **Community Engagement:** Education programs and volunteer planting events can help raise awareness about the ecological and stabilisation benefits of native vegetation while fostering local stewardship.
- **Weed Control:** Implement low-impact techniques, such as manual removal and targeted herbicide application, to manage invasive species. Regular monitoring should be carried out to ensure effective control and prevent regrowth.
- **Native Planting:** Introduce dune-stabilising native species that are well-suited to local conditions and can be strategically planted in erosion-prone areas to enhance biodiversity and stability.
- **Soil and Water Management:** Organic mulches can be applied to improve soil quality, while temporary irrigation may be necessary to support the establishment of new plantings.

3.2.3 Planning Controls

As conditions change and adaptation options are implemented, planning controls, including zoning and development overlays, must be updated to ensure that hazard zones are accurately reflected. Planning and development controls should align with the type of development and potential hazards over the expected life of the development to mitigate coastal hazards and support safer, more resilient land use.

3.3 Adaptation Strategies

A range of strategic options can be used for coastal hazard risk management and adaptation. The hierarchy of Adaptation Strategies defined in the Marine and Coastal Policy (2020) and fundamental considerations for each strategy are summarised in Table 3-1. These strategies are not mutually exclusive, and employing a pathway approach is likely to involve the use of multiple strategies over time.

Table 3-1: Adaptation Strategy Order of Consideration (after Marine and Coastal Policy (2020))

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. • Triggers can be defined when additional action may commence.
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 where it would impede the movement of habitats and species or decrease their resilience to the effects of climate change.
3. Nature-Based Methods	• Creating or restoring coastal habitats to reduce coastal hazard. • Actions include dune, beach or wetland restoration, enabling landward migration of habitat, 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 (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 revetments, groynes, breakwaters, seawalls, etc) or soft (beach nourishment, dune construction, etc) measures or a combination of both. • Often expensive, with localised 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.

3.4 Adaptation Actions

A variety of adaptation actions are available to support the six adaptation strategies for managing coastal hazard risks. These actions encompass a range of tools, decisions, and interventions designed to develop effective adaptation pathways. As defined in Victoria's Resilient Coast - Adaptation Actions Compendium (VRC, 2022), adaptation actions are broadly classified into three categories:

- **Land Management, Planning and Design,**
- **Nature-Based Solutions,** and
- **Engineering**.

Each category can incorporate one or many adaptation strategies and encompass a variety of adaptation actions tailored to address specific coastal challenges (Table 3-2).

Table 3-2: Categories of Adaptation Actions (Victoria's Resilient Coast - Adaptation Actions Compendium, 2020)

Category	Description	Associated Strategies	Adaptation Actions
Land Management, Planning, and Design	Utilise policies, planning tools, guidance frameworks, effective communication, capacity-building initiatives, and strategic processes to drive change and manage coastal risks.	• Non-Intervention • Avoid • Nature-Based Methods • Accommodate • Retreat • Protect	Land Use (e.g. planning scheme amendments, planning overlays, rolling easements, controlled access, land acquisition, setbacks)
			Resilient Design/Development
Nature-Based Solutions	Implement the creation or restoration of coastal habitats to mitigate hazard risks. This can involve standalone habitat restoration (“soft” methods) or hybrid approaches that integrate natural features with engineered structures to enhance habitat resilience.	• Nature-Based Methods • Accommodate	Coastal Wetlands and Blue Carbon Ecosystems
			Beach and Dune Ecosystems
			Hybrid Approaches
Engineering Solutions	Apply engineering principles and design to construct coastal structures, reshape landforms, and modify infrastructure. These solutions encompass both “hard” and “soft” engineering approaches and can be integrated with nature-based methods for optimal outcomes.	• Protect	Beach Nourishment
			Seawalls (vertical seawalls, rock or geobag revetments)
			Groynes (rock, timber, geobag, other)
			Breakwaters
			Flood and Tidal Barriers
			Drainage systems

3.5 First Pass Assessment

A first pass assessment of all adaptation strategies was undertaken to identify which strategies and actions are viable for further investigation. This approach was taken to focus the more detailed assessment on realistic actionable adaptation options.

The first-pass assessment was principally based on the following context, values and risk profiles for each Section:

Section A: The existing revetment, constructed in the 1970s, is directly downstream of a new revetment and groyne field. The revetment remains largely functional in preventing shoreline erosion despite its poor condition. However, terminal erosion at the eastern end presents significant erosion risks in both the short and long term. Additionally, certain sections of the revetment face some level of inundation risk, which will increase with future sea level rise. Values currently afforded protection by the revetment include cultural heritage, environmental values, informal trails, and coastal reserve habitat which fronts private allotments and road networks.
Section B: This unprotected section of the coast has experienced substantial erosion in recent years, with significant erosion hazards clearly defined. While inundation hazards are present, they primarily result from landside flooding rather than coastal processes. These flooding risks therefore cannot be effectively mitigated through coastal protection structures, necessitating land-based flood management strategies to address the issue, which is out of scope of this assessment. Values relevant to this area include cultural heritage, social and recreational activities, and environmental significance. The coastal reserve, which fronts private allotments and road networks, has a critical role in preserving these values.
Section C: This unprotected section of the coast has been experiencing accretion, with the majority of the shoreline progressing seaward in recent years. However, future erosion hazards remain a possibility, particularly under changing coastal dynamics, sediment supply and climate conditions. Similar to Section B, inundation hazards in this area are primarily due to landside flooding, which cannot be addressed through coastal protection structures and requires alternative flood management strategies, which is out of scope of this assessment. Values relevant to the coast include cultural heritage, social and recreational values, and environmental significance of the area. The coastal reserve, which fronts private allotments and road networks, plays a critical role in supporting these values.

The outcomes are summarised in Table 3-3. Each option was deemed as:

Not Applicable: not relevant to the identified coastal hazard(s).
Not Appropriate: not appropriate for the coastal environment and/or processes.
Pathway: appropriate for future adaptation pathway.
Shortlist: considered a feasible option to be implemented as the first step in the adaptation pathway. A Multi Criteria Assessment (MCA) was then completed on the shortlisted actions to inform the preferred adaptation pathway.

Table 3-3: First Pass Adaptation Action Assessment

Category	Adaptation Action	Section A (Existing Revetment)	Section B (West Silverleaves)	Section C (East Silverleaves)
1. Non-Intervention	Take no action	Shortlist	Not Appropriate – The current level of risk is deemed unacceptable.	Shortlist
2. Avoid	Land management to restrict development within hazard zones	Land management (via planning policies, zone amendments, controlled access, and/or development setbacks) should be implemented and updated with changing hazard zones; however this option is Not Applicable for existing values/assets within hazard zones		
3. Nature-Based Methods	Coastal Vegetation	Not Appropriate in isolation – dynamic wave and tidal action prevent effective establishment and stabilization of vegetation.		
	Wet Sand Fencing	Not Appropriate in isolation – these structures are not suitable for areas with dynamic wave and tidal action.		
	Dune Reconstruction	Shortlist	Shortlist	Shortlist
	Supported littoral vegetation	Shortlist	Shortlist	Shortlist
4. Accommodate	Resilient design/materials	Not Applicable – While homes and road networks could be retrofitted/redesigned to accommodate temporary inundation hazard, the assets and values at risk are unable to accommodate the erosion hazard.		
5. Retreat	Relocate properties/infrastructure	Not Applicable – This action would not reduce identified risk to the coastal reserve and ecosystems. We note that private properties are not within the protection scope of this assessment.		
6. Protect	Beach Nourishment	Not Appropriate – Nourishment in front of revetment would not be sustainable without additional structures (e.g. groynes) to hold sediment in place	Shortlist	Shortlist
	Minor repair and realignment of existing revetment	Shortlist	Not Applicable	Not Applicable
	"Rich" revetment	Shortlist	Shortlist	Shortlist
	New rock revetment	Shortlist	Shortlist	Shortlist
	Geobag revetment/wall	Shortlist	Shortlist	Shortlist
	Living seawall	Shortlist	Shortlist	Shortlist
	Vertical seawall	Shortlist	Shortlist	Shortlist
	Shellfish reef breakwater	Shortlist	Shortlist	Shortlist
	Nearshore breakwater	Shortlist	Shortlist	Shortlist
	Groyne field	Shortlist	Shortlist	Shortlist
	Flood/tidal barriers	Pathway	Pathway	Pathway
	Drainage Network	Pathway	Pathway	Pathway

3.6 Shortlisted Options

The following sections describe the shortlisted adaptation options and provide an overview of their advantages, disadvantages and other considerations. Note that the applicability of each option may vary between Sections A, B and C, and these differences are considered in the Multicriteria Analysis.

Additional considerations apply to all options, including the need to design and align each option to account for and mitigate the risk of terminal erosion on adjacent beach areas. Careful attention must be given to the transitions between adjacent structures or shoreline to ensure seamless integration and avoid unintended erosion or instability at connection points.

3.6.1.1 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 3-2: 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.

For Section A, dune construction would involve burying the existing revetment. For Section B, dune reconstruction would involve the strategic placement of fill to realign the shoreline at the erosion hotspot, which is necessary to address and mitigate the existing erosive flow pattern.

Table 3-4: Evaluation of dune reconstruction

See Appendix C for detailed description of advantages, disadvantages, and considerations

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

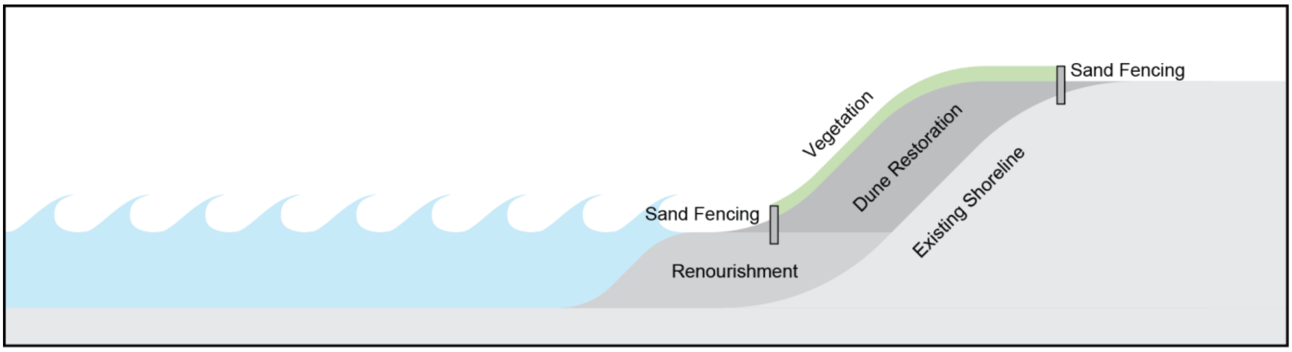

Figure 3-3: Conceptual sketch of dune reconstruction

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

3.6.1.2 Supported Littoral Vegetation

This nature-based hybrid approach involves establishing native shoreline plants, supported by low-profile rock sills, shellfish reef or rock berms. In this case, these structures would protect the plants and reduce shoreline erosion by absorbing wave energy and guiding tidal currents along the shore, mitigating erosive flow patterns. 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 3-4: 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 3-5: Evaluation of supported littoral vegetation
See Appendix C for detailed description of advantages, disadvantages, and considerations

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

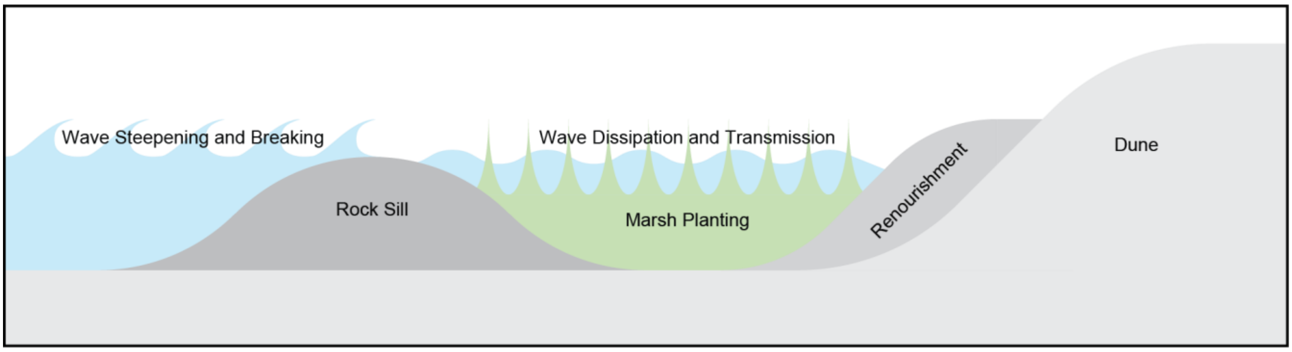

Figure 3-5: Conceptual sketch of supported littoral vegetation
Shows cross-sectional view of rock sill with planting.

The supported littoral vegetation zone will be planted with species indigenous to coastal Victoria, selected for their ability to tolerate regular tidal inundation, saline soils, and wind and wave exposure expected at the site. Suitable species for the mid-intertidal zone at Silverleaves could include Sarcocornia quinqueflora (Beaded Glasswort), Tecticornia arbuscula (Shrubby Glasswort), Suaeda australis (Austral Seablite), and Juncus kraussii (Sea Rush). These species are suited to sandy or silty substrates, full sun, and daily exposure to tidal inundation and flows, and are appropriate for low up to moderate wave energy environments. Final species selection and planting specifications will be confirmed during the concept and detailed design phases, informed by site-specific conditions and performance objectives. A figure illustrating the proposed species is included below (Figure 3-6).

Figure 3-6: Indicative species palette for supported littoral vegetation planting
(top left) Sarcocornia quinqueflora (Beaded Glasswort), (top right) Tecticornia arbuscula (Shrubby Glasswort), (bottom left) Suaeda australis (Austral Seablite), and (bottom right) Juncus kraussii (Sea Rush)

3.6.1.3 Living Seawall

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

Figure 3-7: 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 3-6: Evaluation of living seawall
See Appendix C for detailed description of advantages, disadvantages, and considerations

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

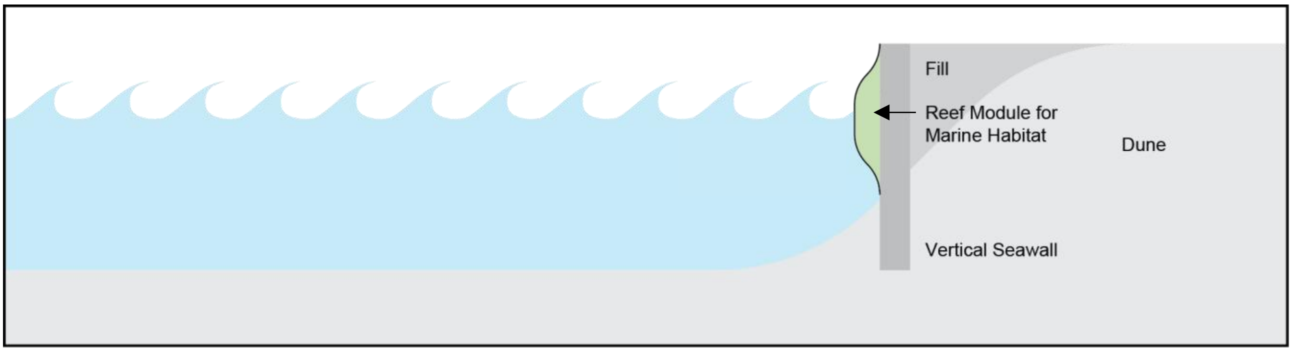

Figure 3-8: Conceptual sketch of living seawall
Shows cross-sectional view of living seawall.

3.6.1.4 "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 3-9: 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 3-7: Evaluation of "rich" revetment
See Appendix C for detailed description of advantages, disadvantages, and considerations

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

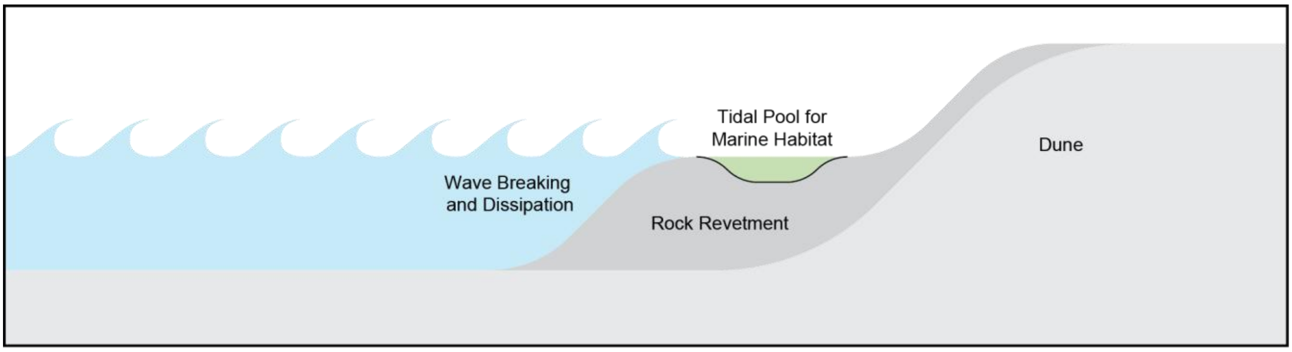

Figure 3-10: Conceptual sketch of rich revetment
Shows cross-sectional view of rock tide pool at revetment toe.

3.6.1.5 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 3-11: 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 3-8: Evaluation of rock revetment
See Appendix C for detailed description of advantages, disadvantages, and considerations

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

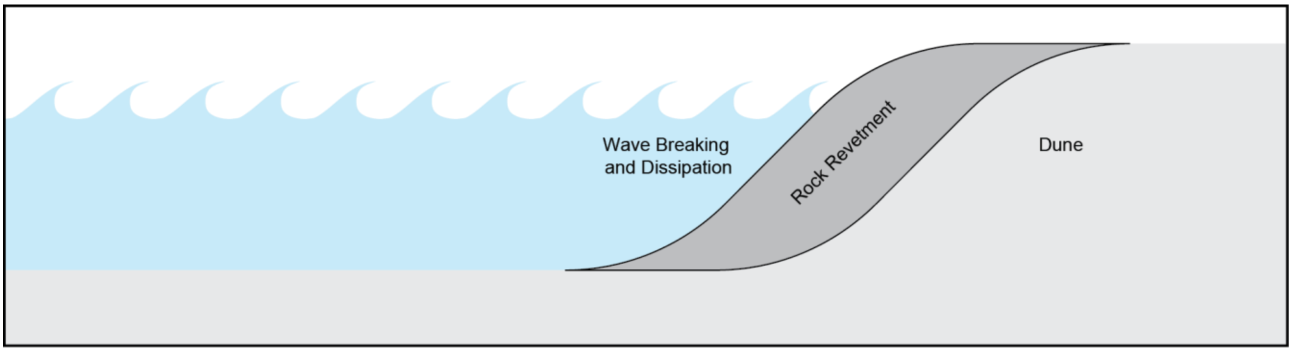

Figure 3-12: Conceptual sketch of rock revetment
Shows cross-sectional view of rock revetment.

3.6.1.6 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 3-13: 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 3-9: Evaluation of vertical seawall
See Appendix C for detailed description of advantages, disadvantages, and considerations

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

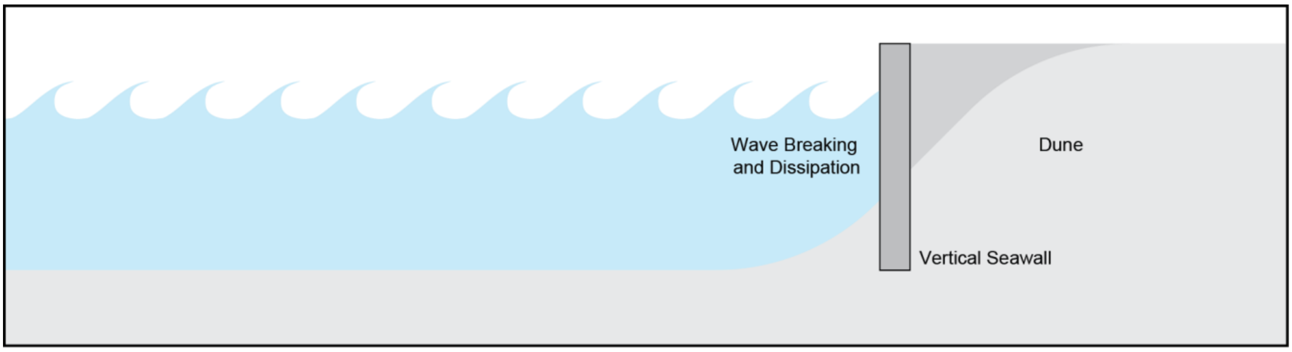

Figure 3-14: Conceptual sketch of vertical seawall
Shows cross-sectional view of rock revetment.

3.6.1.7 Nearshore Breakwater

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. At Section B, the aim would be to redirect tidal flows, mitigating the potential for localised scour. In this case, breakwaters would likely be less effective in beach amenity creation due to regular longshore tidal flow.

Table 3-10: Evaluation of offshore seawall
See Appendix C for detailed description of advantages, disadvantages, and considerations

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

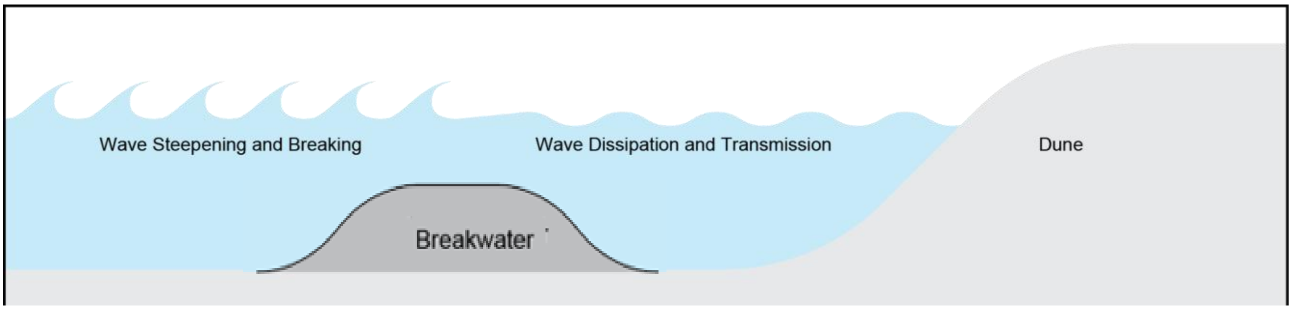

Figure 3-15: Conceptual sketch of breakwater

3.6.1.8 Groyne Field

A groyne field consists of multiple shore-normal structures, typically rock or timber, built to trap sand and reduce longshore drift. 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 3-16: 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 3-11: Evaluation of groyne field
See Appendix C for detailed description of advantages, disadvantages, and considerations

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

3.7 Adaptation Options Multicriteria Analysis (MCA)

The purpose of the 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 3-12, Figure 3-17). The weightings were informed by data collected from the Engage Victoria survey, which captured community values and priorities. This input provided critical insights into the social and environmental importance of various criteria, ensuring the weighting reflects both project objectives and stakeholder perspectives. 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 3-12.

Figure 3-17: Categories, Associated Criteria and Weightings

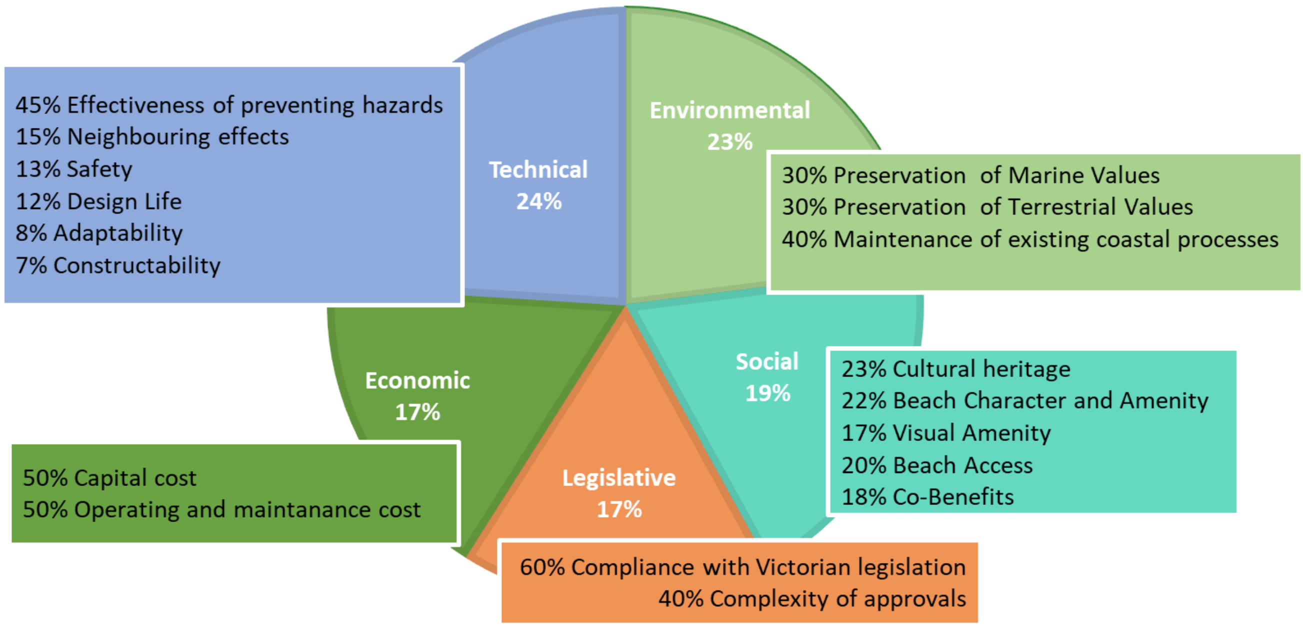

Table 3-12: MCA Scoring Breakdown

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
Legislative	Compliance with Victorian legislation and policies	In line with Victorian legislation and policies; high ranking in hierarchy of Adaptation Strategies defined in the Marine and Coastal Policy (2020) (Table 3)	Not in line with Victorian legislation or policies. Lower ranking in the hierarchy of Adaptation Strategies defined in the Marine and Coastal Policy (2020)
	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
	Beach character and amenity	Improves beach character and enhances beach amenity	Degrades beach character and reduces beach amenity
	Visual amenity	Improves visual amenity of the site	Degrades visual amenity of the site
	Beach Access	Does not impede beach access	Permanently restricts beach access
	Co-Benefits	Results in multiple benefits, in addition to its primary intended outcome (e.g. prevents erosion and improves habitat/amenity/ recreation)	No additional benefits beyond hazard reduction
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.
	Neighbouring Effects	No effect on adjacent infrastructure or coastline	Significant negative effects on adjacent infrastructure or coastline
	Safety	Presents no public safety risks	Significant safety risks; frequent hazards to public use or access.
	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

3.7.1 MCA Results

Section A (Existing 1970s Revetment)

The results of the MCA for Section A are shown in Table 3-13. Note that results and colour shading shown are skewed relative to all shortlisted adaptation options.

The MCA indicates that the most suitable adaptation option and pathway for this location involves minor repairs and realignment of the existing rock revetment. This option represents the simplest and most cost-effective solution to address current erosion challenges. Repairs will extend the life of the existing revetment, ensuring continued erosion protection of the existing coastline at Section A. Realignment of the terminal end, which interfaces with the Silverleaves beach, is designed to better integrate with the neighbouring coastline, reducing the existing erosive flow pattern and minimising downstream impacts. While this option does not contribute to habitat creation, it aligns with the principle of "holding the line," maintaining the existing shoreline position and preventing erosion. Additionally, by mitigating erosive flow patterns, it supports broader efforts to manage erosion impacts along adjacent sections of the coastline, ensuring sustainable outcomes in line with community values and responsible coastal management practices.

The MCA findings suggest that the next most favourable options for this location are either burying the revetment to construct a dune, upgrading the revetment to a rich rock revetment or a new rock revetment. All of these options also involve minor realignment at the eastern end where the revetment transitions to Silverleaves shoreline to reduce downstream effects by promoting a more streamlined flow pathway. These options can also help mitigate coastal inundation hazards if appropriately designed.

The dune construction option mitigates shoreline erosion during typical conditions and can also further reduce downstream effects by adding sediment to the system. The dune will likely require maintenance/reconstruction after major storm events, however the underlying rock revetment will hold the shoreline in place if the dune is compromised. The dune toe may require regular nourishment, however beach amenity will likely improve compared to current conditions. A groyne field and beach nourishment could be implemented in combination with the dune to further enhance amenity and improve the dune's resilience. However, groynes can interrupt natural sand transport and may lead to erosion of downstream beaches, such as at Silverleaves, if not carefully designed and supported by regular nourishment to maintain sediment bypassing.

The rich rock revetment option would provide long-term protection against erosion and coastal inundation, requiring little to no maintenance if appropriately designed. It also offers ecological benefits by creating intertidal habitat. However, it is unlikely to improve beach amenity compared to current conditions, as the revetment toe must remain within the intertidal zone to ensure regular inundation, resulting in little to no dry beach at high tide.

Alternatively, the revetment could be upgraded as a more traditional rock revetment, which would maintain a similar level of beach amenity to the existing condition but would not offer ecological enhancements. This approach could be paired with a groyne field and beach nourishment to improve beach amenity. However, groynes can alter natural sand transport and, if not carefully designed with ongoing nourishment, may reduce sediment supply to downstream areas like Silverleaves, increasing the risk of erosion.

Section B (West Silverleaves)

The results of the MCA for Section B are shown in Table 3-14. Note that results and colour shading shown are skewed relative to all shortlisted adaptation options.

The MCA indicates that the most suitable adaptation option and pathway for this location involves implementing a nature-based hybrid solution, specifically the construction of supported littoral vegetation. This option creates intertidal/marine habitat, while helping stabilise the shoreline. To complement this strategy, nourishment is recommended to enhance beach amenity and provide space for vegetation to migrate with rising sea levels. This option adds ecological and community value and is in line with the Marine and Coastal Policy (2020) hierarchy of Adaptation Strategies, which promotes nature-based solutions. To implement this strategy, it is recommended begin with a trial section of supported littoral vegetation, allowing for evaluation of its coastal protection benefits and the success of the plant species before extending the solution across the entire Section B shoreline. Dune reconstruction (scoring as the second-best option for this Section) is recommended for the remaining shoreline of Section B to address erosion in the interim during the trial period. Additional measures, such as the construction of a small number of groynes near the interface between the supported littoral vegetation and dune reconstruction areas, may also be required to mitigate terminal erosion at the downstream end of the rock sill structure.

The MCA findings suggest that the next most favourable option for Section B is dune reconstruction. Dune reconstruction at this Section would involve the strategic placement of fill to realign the shoreline at the erosion hotspot near the end of the existing revetement, which is necessary to address and mitigate the existing erosive flow pattern. This option also adds habitat and is in line with community values and the Marine and Coastal Policy (2020) hierarchy of Adaptation Strategies. Dune reconstruction would mitigate shoreline erosion during typical conditions and can help mitigate temporary coastal inundation but will likely require maintenance/reconstruction after major storm events. The dune option will also likely require regular nourishment/maintenance, however beach amenity will likely improve compared to current conditions.

The groyne field option did not score highly in the MCA and is not recommended in isolation. This is primarily because it may not effectively mitigate erosion or inundation hazards without continued beach nourishment and complementary coastal protection measures to stabilise the shoreline during major storm events. However, the littoral vegetation option could be implemented in combination with construction of a groyne field and beach nourishment to further improve beach amenity and resilience. Despite these potential benefits, groynes interrupt natural sand transport processes and, if not carefully designed, may reduce sediment supply to downstream areas such as Silverleaves—potentially increasing erosion risk. Their implementation would therefore require careful design and an ongoing commitment to nourishment to maintain sediment bypassing and avoid adverse downstream impacts.

Section C (East Silverleaves)

Results of the MCA, shown in Table 3-15, indicate that the most suitable adaptation strategy at this time is non-intervention, reflecting the lower immediate erosion risk associated with this area compared to the adjacent western Silverleaves. Despite considerable uncertainty surrounding shoreline response to future conditions, relatively recent accretionary trends suggest a reduced immediate threat of erosion. For short-term adaptation planning, regular monitoring of shoreline movement is strongly recommended to track changes and refine projections.

Key triggers for consideration of future intervention should be identified, with an initial recommendation of 2040 sea level rise or when a sustained shoreline setback of 5 m is realised, whichever occurs sooner. We note that this area is highly dynamic and that the shoreline may fluctuate in the short term (storm driven or seasonal variation). Monitoring will be critical to validate and adjust these triggers, given the inherent uncertainties in SLR projections and shoreline dynamics (see section 3.2.1 for monitoring recommendations). Dune reconstruction, supported littoral vegetation, and/or beach nourishment scheme, which ranked as the next highest in the analysis, provide additional options in the longer term, as conditions evolve. To further improve beach amenity and resilience, the dune construction and beach nourishment scheme could be implemented in combination with construction of a groyne field and beach nourishment. The groyne field would however require regular nourishment and careful design to maintain sediment bypassing and avoid adverse downstream impacts.

Table 3-13: Section A MCA Results

Category	Category Weighting	Criteria	Criteria weighting	Non-Intervention	Construct Dune	Supported Littoral Vegetation	Minor Repair and Realignment of Revetment	Rich Revetment	Upgraded Rock Revetment	Geobag Revetment	Living Seawall	Vertical Seawall	Reef Breakwater	Breakwater	Groyne Field & Nourishment
Environmental	0.23	Preservation of Marine Values	**0.30**	3	4	4	3	4	3	3	3	2	4	3	3
		Preservation of Terrestrial Values	**0.30**	3	5	3	3	3	3	3	3	3	3	3	3
		Maintenance of existing coastal processes	**0.40**	2	4	3	4	4	4	4	3	3	2	2	2
Legislative	0.17	Compliance with Victorian legislation	**0.60**	5	4	4	5	3	2	2	3	2	3	2	2
		Complexity of approvals (including costs)	**0.40**	5	4	4	5	5	5	4	4	4	4	4	4
Social	0.19	Cultural heritage	**0.23**	2	5	4	4	4	4	4	4	4	4	4	4
		Beach Character and Amenity	**0.22**	2	4	4	3	3	3	3	3	3	3	3	5
		Visual Amenity	**0.17**	3	4	4	4	3	3	3	2	2	3	3	3
		Beach Access	**0.20**	3	3	2	3	3	3	3	3	3	3	3	2
		Co-Benefits	**0.18**	2	4	4	2	3	2	2	3	2	4	3	4
Economic	0.17	Capital cost	**0.50**	5	3	3	5	2	2	3	1	1	2	2	3
		Operating and maintenance cost	**0.50**	3	2	3	4	5	5	4	4	5	4	4	3
Technical	0.24	Effectiveness of preventing hazards	**0.45**	2	4	3	3	5	5	5	5	5	1	1	2
		Neighbouring effects	**0.15**	2	5	4	3	3	3	3	3	3	2	2	2
		Safety	**0.13**	4	5	5	5	5	5	5	4	4	5	5	5
		Design Life	**0.12**	1	2	4	3	5	5	2	4	4	4	4	4
		Constructability	**0.07**	5	3	3	5	4	4	4	3	3	3	3	4
		Adaptability	**0.08**	4	4	4	4	4	4	4	2	2	4	4	4
			TOTAL SCORE:	**3.18**	**3.81**	**3.50**	**3.84**	**3.80**	**3.59**	**3.44**	**3.25**	**3.13**	**2.98**	**2.78**	**2.98**

Table 3-14: Section B MCA Results

Category	Category Weighting	Criteria	Criteria weighting	Construct Dune	Supported Littoral Vegetation	Beach Nourishment Scheme	Rich Revetment	Rock Revetment	Geobag Revetment	Living Seawall	Vertical Seawall	Reef Breakwater	Breakwater	Groyne Field & Nourishment
Environmental	0.23	Preservation of Marine Values	**0.30**	4	4	3	4	2	2	3	2	4	3	3
		Preservation of Terrestrial Values	**0.30**	5	4	4	4	4	4	4	4	3	3	3
		Maintenance of existing coastal processes	**0.40**	5	3	5	2	2	2	2	2	2	2	2
Legislative	0.17	Compliance with Victorian legislation	**0.60**	4	4	4	3	2	2	3	2	3	2	2
		Complexity of approvals (including costs)	**0.40**	4	4	4	4	4	4	4	4	4	4	4
Social	0.19	Cultural heritage	**0.23**	5	4	5	2	2	2	2	2	2	2	4
		Beach Character and Amenity	**0.22**	4	4	5	1	1	1	1	1	4	4	5
		Visual Amenity	**0.17**	4	4	4	2	2	2	2	2	2	2	3
		Beach Access	**0.20**	3	2	3	3	3	3	3	3	3	3	2
		Co-Benefits	**0.18**	5	5	4	3	2	2	3	2	4	3	4
Economic	0.17	Capital cost	**0.50**	2	3	3	1	1	1	1	1	3	3	3
		Operating and maintenance cost	**0.50**	1	3	1	4	5	4	4	5	4	4	3
Technical	0.24	Effectiveness of preventing hazards	**0.45**	3	4	1	5	5	5	5	5	1	1	2
		Neighbouring effects	**0.15**	5	3	5	2	2	2	2	2	3	3	3
		Safety	**0.13**	5	5	5	5	5	5	4	4	5	5	5
		Design Life	**0.12**	2	4	1	5	5	2	4	4	4	4	4
		Constructability	**0.07**	3	3	5	3	3	3	2	2	3	3	4
		Adaptability	**0.08**	4	4	4	4	4	4	2	2	4	4	4
			TOTAL SCORE:	**3.66**	**3.67**	**3.40**	**3.19**	**3.00**	**2.83**	**3.00**	**2.88**	**3.02**	**2.82**	**3.02**

Table 3-15: Section C MCA Results

Category	Category Weighting	Criteria	Criteria weighting	Non Intervention	Construct Dune	Supported Littoral Vegetation	Beach Nourishment Scheme	Rich Revetment	New Rock Revetment	Geobag Revetment	Living Seawall	Vertical Seawall	Reef Breakwater	Breakwater	Groyne Field & Nourishment
Environmental	0.23	Preservation of Marine Values	**0.30**	3	4	4	3	3	2	2	3	2	4	3	3
		Preservation of Terrestrial Values	**0.30**	3	5	4	4	4	4	4	4	4	3	3	3
		Maintenance of existing coastal processes	**0.40**	5	5	3	5	2	2	2	2	2	2	2	2
Legislative	0.17	Compliance with Victorian legislation	**0.60**	5	4	4	4	3	2	2	3	2	3	2	2
		Complexity of approvals (including costs)	**0.40**	5	4	4	4	4	4	4	4	4	4	4	4
Social	0.19	Cultural heritage	**0.23**	5	5	4	5	2	2	2	2	2	2	2	4
		Beach Character and Amenity	**0.22**	2	4	4	5	1	1	1	1	1	4	4	5
		Visual Amenity	**0.17**	3	4	4	4	2	2	2	2	2	2	2	3
		Beach Access	**0.20**	3	3	2	3	3	3	3	3	3	3	3	2
		Co-Benefits	**0.18**	1	5	5	4	3	2	2	3	2	4	3	4
Economic	0.17	Capital cost	**0.50**	5	3	3	4	1	1	1	1	1	3	3	3
		Operating and maintenance cost	**0.50**	5	1	3	1	4	5	4	4	5	4	4	3
Technical	0.24	Effectiveness of preventing hazards	**0.45**	1	3	4	2	5	5	5	5	5	1	1	4
		Neighbouring effects	**0.15**	5	5	4	5	2	2	2	2	2	3	3	3
		Safety	**0.13**	5	5	5	5	5	5	5	4	4	5	5	5
		Design Life	**0.12**	2	2	4	1	5	5	2	4	4	4	4	4
		Constructability	**0.07**	5	3	3	5	3	3	3	2	2	3	3	4
		Adaptability	**0.08**	5	4	4	4	4	4	4	2	2	4	4	4
			TOTAL SCORE:	**3.80**	**3.75**	**3.71**	**3.60**	**3.12**	**3.00**	**2.83**	**3.00**	**2.88**	**3.02**	**2.82**	**3.12**

4 ADAPTATION PATHWAY

The adaptation pathways outlined below provide a phased approach to shoreline management, with distinct timeframes for each Section, spanning from the present day to 2100. Note that while the adaptation pathways focus on broader strategic options for hazard mitigation, each pathway is expected to incorporate coastal management best practices (as outlined in section 3.2), even if not explicitly listed. These best practices form a core part of implementation across all options. In addition to local actions within each Section, the pathways also include upstream interventions—particularly the nourishment of existing groyne fields—to restore sediment supply to the broader system and encourage natural bypassing to downstream beaches such as Silverleaves. These system-wide considerations are essential for supporting long-term sediment dynamics and improving the resilience of adjacent shorelines.

The adaptation pathways are presented in diagram forms on the following pages to illustrate how strategies may evolve over time in response to sea level rise (SLR) and associated decision points. Each diagram features a timeline along the bottom axis, with projected SLR values plotted against it. Key points in time—such as the present, 2040, and 2070—are highlighted to indicate when certain decisions or actions may be needed in response to identified "triggers." However, it's important to note that these triggers or decision points may occur earlier or later than indicated. The data is simply the best estimate based on current projections. This variability reflects the inherent uncertainty in how shorelines will respond to SLR, as well as the unpredictable pace of SLR itself. The timing and choice of actions will ultimately depend on ongoing monitoring and assessment of real-world conditions. Within each diagram, the solid black lines represent the recommended adaptation strategies, the dotted line shows an alternative route that may be followed under different circumstances, and the white line highlights when the strategy may be less effective in preventing the coastal hazard. Other effective options are shown or noted that may be applied in combination with the preferred option to enhance resilience, however note that the diagram does not present all possible effective options. These pathways are intended to illustrate how the preferred strategies can evolve over time based on observed changes.

4.1 Section A (existing 1970s rock revetment)

The preferred initial pathway for this Section of coast involves repairs of the current rock revetment structure and realignment near the eastern end. This will help stabilize the shoreline in the short term, as part of the present-day adaptation strategy to enhance resiliency. However, as sea levels rise and coastal conditions evolve, the effectiveness of this option in managing inundation and erosion will decrease. The indicative trigger for the next phase of intervention is a sea level rise of approximately 0.5 m or around the year 2070. However, this is not a fixed threshold, as there is considerable uncertainty associated with SLR projections, therefore continued monitoring of shoreline response, storm impacts, and sea level trends will be critical to inform the timing and choice of further intervention.

Potential future interventions identified through the MCA include burying the rock revetment to construct a dune, or constructing a rich revetment or upgraded rock revetment. (See section 3.7.1 for full discussion of preferred options at this section). The traditional revetment upgrade, dune, or minor repairs option could be implemented in combination with groynes and beach nourishment to improve beach amenity and resilience. However, groynes can significantly alter natural sand movement and, if not carefully designed, may reduce sediment transport to downstream beaches such as Silverleaves, increasing the risk of erosion in those areas. Their effectiveness relies on regular nourishment and maintenance, and they can result in unintended environmental and geomorphic impacts if sediment bypassing is not maintained.

4.2 Section B (western Silverleaves)

The initial course of action for this Section involves transitioning from the rock revetment at Section A to a low crested rock structure that supports littoral vegetation, and dune reconstruction along the remaining shoreline of Section B to mitigate erosion. These actions will both involve beach nourishment (initially and as needed following monitoring) to enhance beach amenity and dune stability and provide space for littoral vegetation to migrate as sea levels rise. A small number of groynes may be required near the interface between the dune and rock sill to reduce the risk of terminal erosion at the transition zone. Beyond this, a broader groyne field could be considered as a complementary measure to further enhance beach amenity and improve dune resilience by retaining sand. The groyne field would however require regular monitoring and careful design to maintain sediment bypassing and avoid adverse downstream impacts at Silverleaves eastern beaches.

The recommended first phase of the pathway for this Section includes a section of supported littoral vegetation, spanning 100 to 200 meters across the prominent erosion hotspot at Silverleaves, and dune reconstruction along the remaining shoreline of Section B. This section aims to ensure the littoral vegetation establishes and thrives, as well as to address the immediate issue. The shoreline should be regularly monitored to assess the success of the littoral vegetation and dune reconstruction. Subject to successful implementation (i.e. the littoral vegetation establishes and successfully stabilizes the shoreline), this approach can be expanded across the remaining length of Section B as required. However, if the dunes and/or littoral vegetation are unsuccessful in establishing and/or stabilizing the shoreline, the next best recommended course of action is implementing a beach nourishment scheme or constructing a rich rock revetment. The initial decision trigger for the next intervention is 2040 SLR (0.2m SLR) or when a sustained 5-meter shoreline setback occurs, whichever occurs first. As this area is highly dynamic, affected by both storm events and seasonal changes, and there is considerable uncertainty associated with SLR projections, continued monitoring will be critical to inform the timing and choice of further intervention.

At Section B, an interim rock bag revetment was constructed during the adaptation planning process. This revetment can be integrated into the adaptation strategy as a component of the overall coastal protection approach. For areas where the supported littoral vegetation option is implemented, the revetment can either be left in place and monitored, or it can be buried to construct a dune. For areas where the dune reconstruction option is implemented, the revetment can similarly be buried within the reconstructed dune, where it would act as a last line of defence against erosion. Burying the revetment not only extends its lifespan but also enhances habitat, improves visual amenity by blending with the natural landscape, and provides additional ecological and community benefits.

4.3 Section C (eastern Silverleaves)

The initial course of action for this Section involves regular monitoring of the shoreline, with future interventions considered based on observed conditions. Monitoring should be conducted along with other coastal management best practices (see section 3.2) including controlled access and vegetation protection/revegetation to help mitigate potential erosion. The preliminary trigger for the next decision for intervention is 2040 SLR (0.2 m SLR) or when a sustained 5-meter shoreline setback occurs, whichever comes first. As this area is highly dynamic, affected by both storm events and seasonal changes, continued monitoring will be critical to inform the timing and choice of intervention.

If the supported littoral vegetation trial and dune reconstruction in Section B are successful, a similar approach using dune reconstruction and/or supported littoral vegetation can be considered for Section C in the future. A beach nourishment scheme may also prove to be an effective adaptation strategy at this Section. Nourishment may include the beaches locally and/or upstream beaches at East Cowes to fill and maintain full groyne compartments to promote sediment bypassing to the downstream beaches at Silverleaves. To further improve beach amenity and resilience, the dune or nourishment scheme options could be implemented in combination with construction of a groyne field and beach nourishment. The groyne field would however require initial and regular nourishment to remain effective, as well as careful design to maintain bypassing of sediment to downstream beaches.

4.4 Residual Risk

The defined pathways are expected to substantially reduce the identified erosion hazards. However, addressing inundation hazards—both short-term and long-term—requires a more comprehensive approach. These hazards mainly stem from landside sources and extend beyond the scope of coastal protection measures. To effectively manage these risks, it is strongly recommended that regional flood studies be undertaken. These studies will provide essential data to inform integrated adaptation strategies, ensuring that both erosion and inundation hazards are comprehensively addressed for sustainable long-term outcomes.

The residual condition and associated risk ratings for the preferred options highlight the limitations and benefits of the proposed adaptation strategies. At Section A, the preferred option of revetment repairs or realignment is effective in mitigating the erosion hazard, stabilising the shoreline and protecting adjacent values and assets. However, this option does not substantially address the longer-term inundation hazard. To reduce inundation risks, increasing the crest height through dune construction or revetment upgrades is recommended. This would provide enhanced protection for the low-lying land located landward of the revetment, reducing vulnerability to overtopping during extreme events. For Section B and C, the preferred options of supported littoral vegetation and/or dune construction offer important benefits for erosion control and shoreline stability. While these measures will not significantly reduce the inundation hazard in this area—due to the hazards originating primarily from the land side—they will protect the coastal reserve. This reserve forms a vital natural barrier, offering some degree of inundation protection and serving as a critical buffer zone. These measures support broader resilience objectives by maintaining the ecological and protective functions of the coastal landscape. Given the complexity of inundation hazards in these sections, a detailed flood study is essential to better understand the underlying risks. This study should inform the development of targeted measures to mitigate flood risks, ensuring the long-term safety and resilience of these areas.

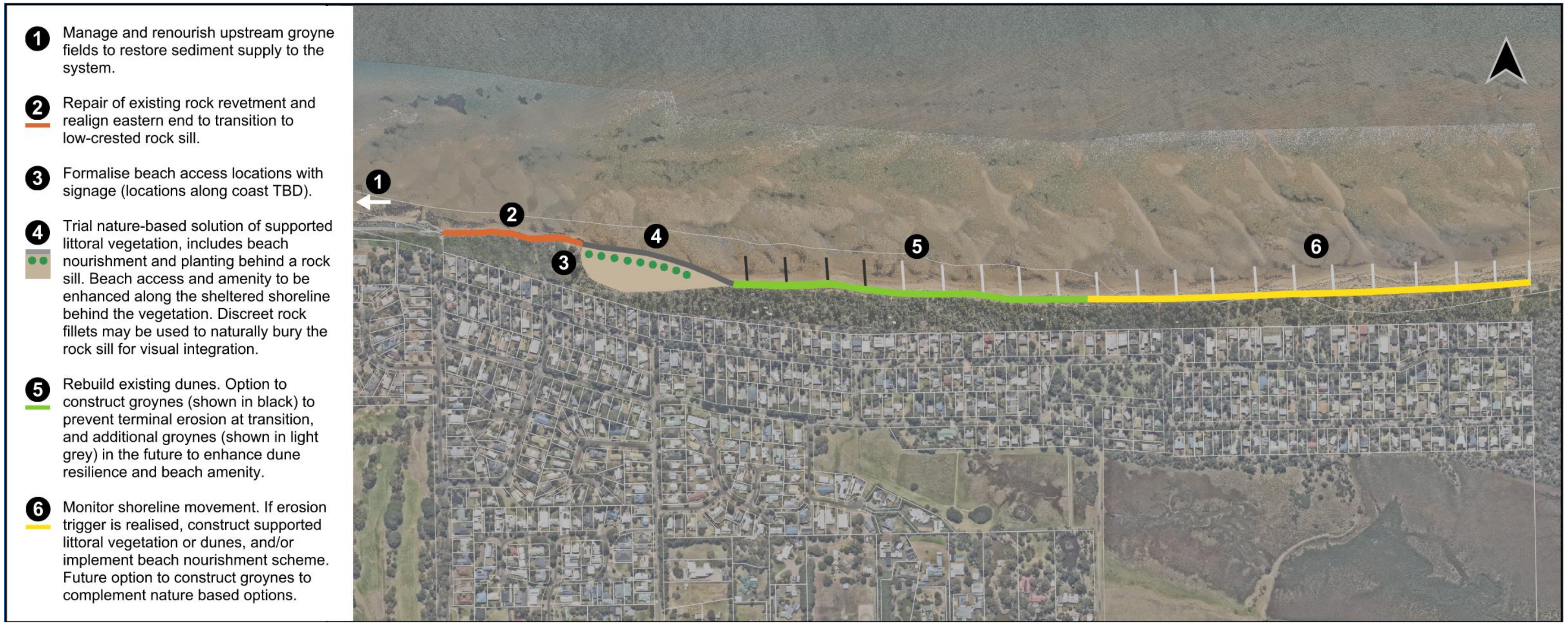

Figure 4-1: Plan view sketch of preferred initial Adaptation Pathways considered at this site

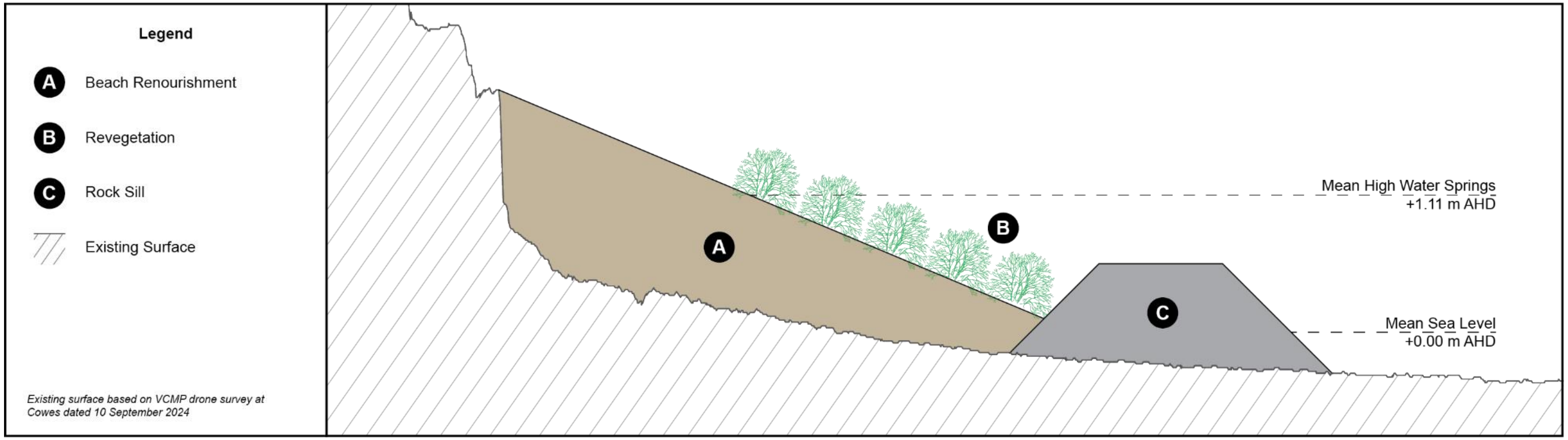

Figure 4-2: Cross section of living shoreline (supported littoral vegetation) concept

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APPENDIX A: COMMUNITY AND STAKEHOLDER ENGAGEMENT

A-1: On-Site Stakeholder Engagement

Silverleaves Community was consulted prior to beginning the coastal processes study. This meeting was held on 15 February 2024 on-site with the following attendees:

- Derek Hibbert (Bass Coast Shire Council)
- Kathleen Roberts (DEECA)
- Sarah Hendrix (DEECA)
- Andrew Pomeroy (FSC Range)
- Tessa Syvertsen (FSC Range)
- Various interested members of Silverleaves community

Comments raised about Silverleaves and Cowes are as follows:

- The new revetment built last year was an old timber seawall, waves and water often overtopped the seawall, and it did not retain the shoreline.
- Several reports were written about the coastal processes in the area, mostly focusing on Cowes
- Beach scraping has been completed over the past approx. 3 years
- The gaps under the groynes at Cowes are a concern, unsure if they are still functioning
- Beach has significantly lowered at Silverleaves, mainly on the western side
- They believe the boat ramp was the sand source for the more recent sand nourishment at Cowes main beach
- Concrete ramp at new revetment provides beach access for machines.
- Concerns of flooding during king tides, which are believed to typically occur around easter
- Significant shore recession at west Silverleaves in the past year or so, particularly near the revetment, and significant vegetation loss including large trees which pose safety hazards
- There used to be timber groynes in west Silverleaves and further east, they are now buried or were removed/lost.
- There is a steep drop at the coast which used to be much more gradual ~10 years ago.
- There was a large cut of shoreline about 2 weeks ago (estimated ~1.5m recession) during what seems like relatively calm conditions (low waves) during high tide.
- Significant concern of coastal erosion and flooding for property owners.
- There was significant concern about high tides particularly during king tides
- There's also concern about the planning policies, that it doesn't allow for residents to implement barriers at the coast, however there is a bit of confusion around this.
- The sandbank seems relatively stable, but the bar seems to be growing.
- There have been about 3 to 4 knot currents ripping in or out during the changing tides.
- There used to be a 5 metre high dune at Silverleaves
- There has been a more gradual loss of vegetation towards the West.
- A storm event last year caused the loss of several large trees which were subsequently pushed up against the shore to help prevent erosion but it seemed ineffective.
- They believe the new groynes at Cowes were not nourished after construction.

Several photographs and historical documents, including historical surveys were brought forward during and after the meeting and were recorded/photocopied by FSC Range.
FSC Range also conducted a visual assessment of the rock revetment at the conclusion of this meeting. The outcomes of this visual site assessment were used to inform the subsequent coastal process study and adaptation study.

A-2: EngageVic Survey Results

Document Information	
Date	17 October 2024
Client	State Government of Victoria, Department of Energy, Environment and Climate Action
Project	East Cowes and Silverleaves Adaptation Plan
Project Number	230689
Subject	Community Engagement Findings
File Reference	230689-CST-MEM-002[A].docx
Attachments	Data.xlsx

1. INTRODUCTION

1. Project Overview

In recent years, Silverleaves on Phillip Island has experienced significant coastal erosion leading to shoreline retreat, as well as storm tide and permanent inundation hazards. In response, the State Government of Victoria Department of Energy, Environment and Climate Action (DEECA) and Bass Coast Shire Council are implementing short-term sand renourishment works, as well as engaging FSC Range to conduct a coastal processes study and develop an adaptation pathway for the area.

2. Purpose of this Document

The purpose of this document is to summarise the 216 responses received between 29 August 2024 and 27 September 2024 from a questionnaire aimed at understanding what people value about the Silverleaves coastal environment. The feedback gathered will be used to inform the adaptation pathways planning process.

2. QUESTIONNAIRE RESULTS

1. Question 1 and 2 – Connection

The respondents were asked to indicate their connection to the Silverleaves shoreline, with the majority being residents within 1 km of Silverleaves. (Figure A-1).

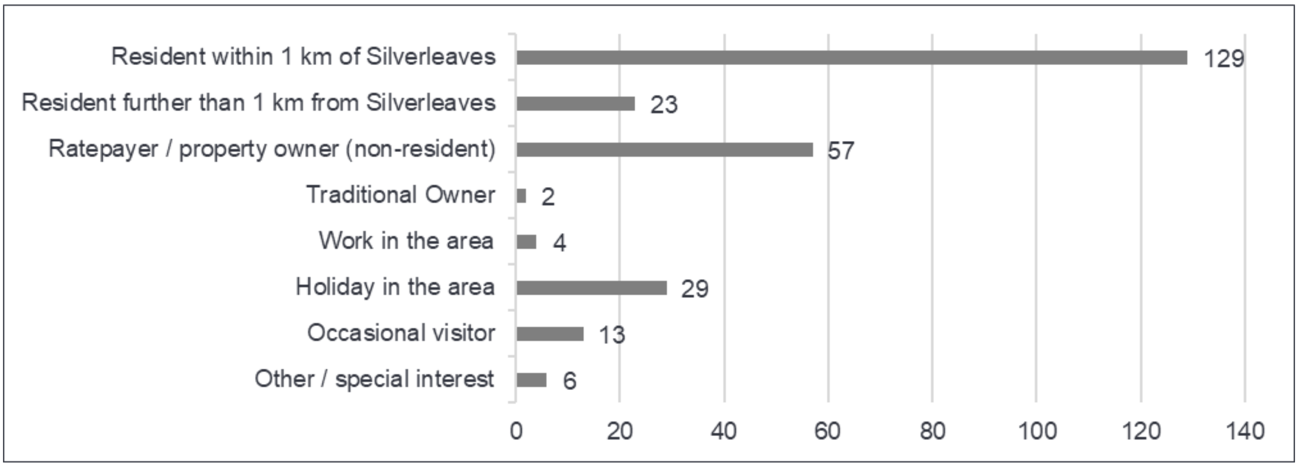

Figure A-1: Question 1 – How would you describe your connection to the Silverleaves shoreline?
Shows the number of responses received for each option, whereby respondents were allowed to select multiple options.

The respondents who selected "Other / special interest" included a coastal geomorphologist, a member of the Silverleaves Conservation Association Committee, former residents, and wildlife workers (Table A-1).

Table A-1: Question 2 - Other responses to Question 1
List of responses from respondents who selected "Other / special interest" to Question 1.

Response
I'm a coastal geomorphologist interested in the impacts of climate change.
lived several decades on the north shore beaches of p-i
Member of Silverleaves Conservation Association Committee
Previous resident.
We undertake a quarterly bird survey of a section of the Westernport Ramsar site for BirdLife Australia and are aware of the Val ue of the eastern end of Silverleaves for bird species
Wildlife rescue

2. Question 3 – Visits

The respondents were asked to indicate how often they typically visit the foreshore area, with the majority visiting the foreshore area daily (Figure A-2).

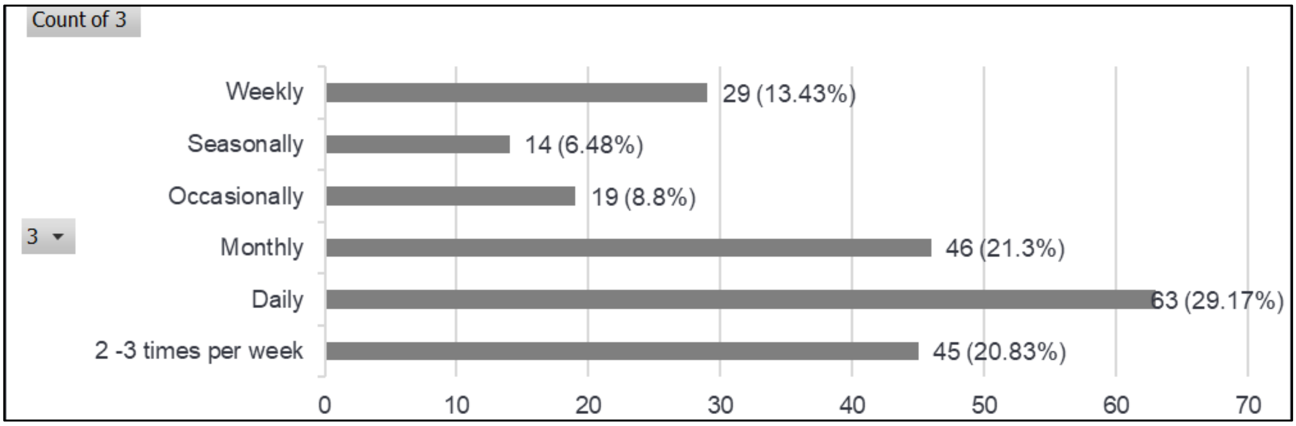

Figure A-2: Question 3 – On average, how often do you visit the foreshore area?
Shows the number of responses received for each option, whereby respondents were only allowed to select one option.

3. Question 4 and 5 – Values

The respondents were asked to indicate what they value most about the Silverleaves foreshore, with the majority valuing natural landscapes plants, animals and habitats (Figure A-3).

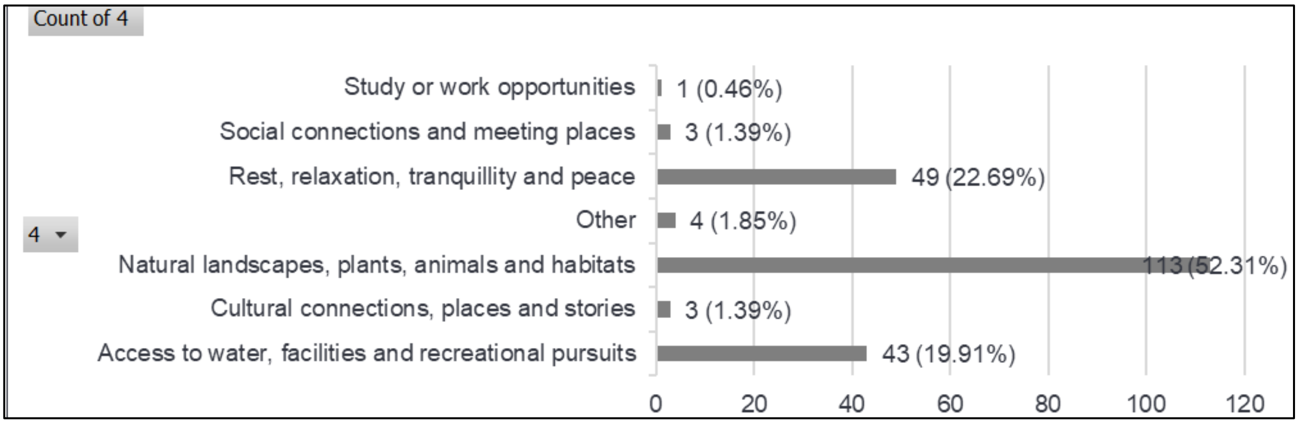

Figure A-3: Question 4 – On average, how often do you visit the foreshore area?
Shows the number of responses received for each option, whereby respondents were only allowed to select one option.

The respondents who selected "Other" have either miscategorised their response, indicated multiple options (which was not permitted for this question), or used the opportunity to express broader concerns (Table A-2).

Table A-2: Question 5 - Other responses to Question 4
List of responses from respondents who selected "Other" to Question 4.

Response
2 3 & 4
All of the above, the "value" is also the lifechanging investment we have made as homeowners and the very real risk of no return on investment due to the inept action of council and Government.
Lack of everything that was there before you altered nature
Walk the dog

4. Question 6 and 7 – Activities

The respondents were asked to indicate what activities they do when visiting Silverleaves foreshore, with the majority either walking, swimming, relaxing, and/or socialising with friends and family (Figure A-4).

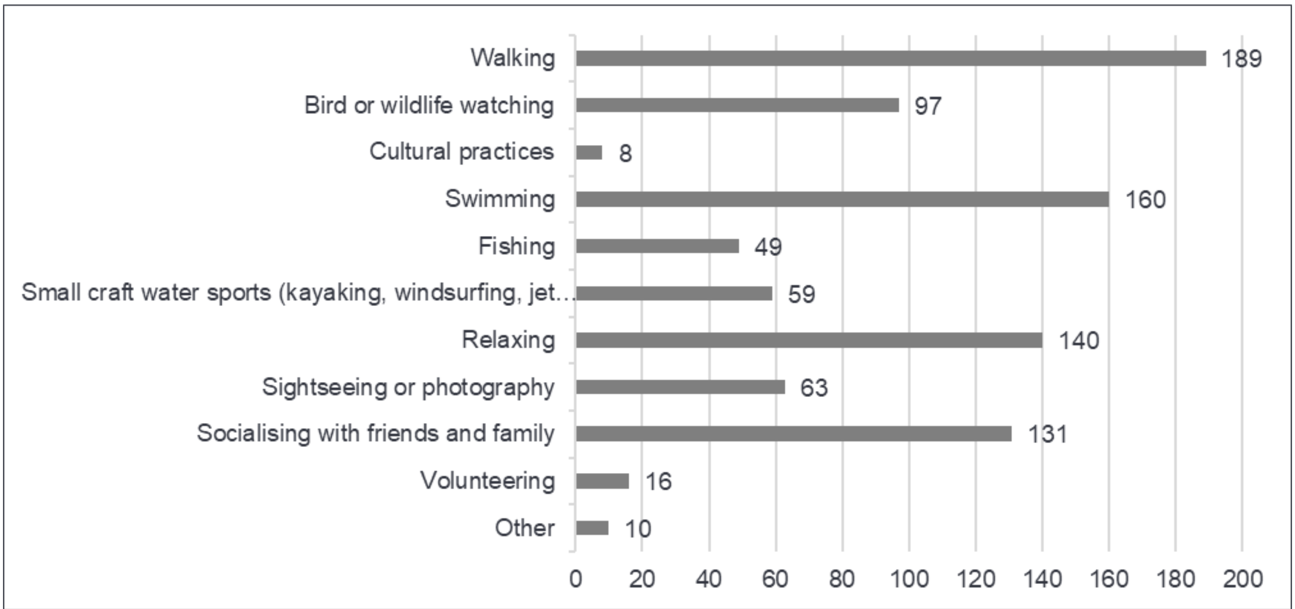

Figure A-4: Question 6 – What activities do you do when visiting Silverleaves foreshore?
Shows the number of responses received for each option, whereby respondents were allowed to select multiple options.

The respondents who selected "Other" have either miscategorised their response, indicated multiple options (which was permitted for this question), or used this opportunity to express broader concerns (Table A-3).

Table A-3: Question 7 - Other responses to Question 6
List of responses from respondents who selected "Other" to Question 6.

Response
All of the above
Clearing rubbish washed up
Cold water imersion all year round
Examine the shoreline for evidence of change in response to sea level rise.
Picking up the seemingly endless pieces of plastic, cigarette butts, wire and other pollution that sadly is on the beach and in the wYer.
Playing with grandkids
Resident
Try and walk on a rock wall that has taken a beautiful brach away
Walking, birdwatching, swimming and small water sports eg off the beach sailing and row boat for fishing.
wildlife homes and rescue

Several respondents have also raised valid concerns about cleaning up rubbish and pollution along the foreshore, including washed-up debris, plastic, cigarette butts, and other waste.

5. Question 8 – Functions

The respondents were asked to indicate the most important functions of Silverleaves foreshore area (Figure A-5). The majority were evenly split among four key functions: providing a physical buffer to protect the natural and built environment, providing habitat for flora and fauna, providing a place for people to spend leisure time, and providing a place where people can experience nature.

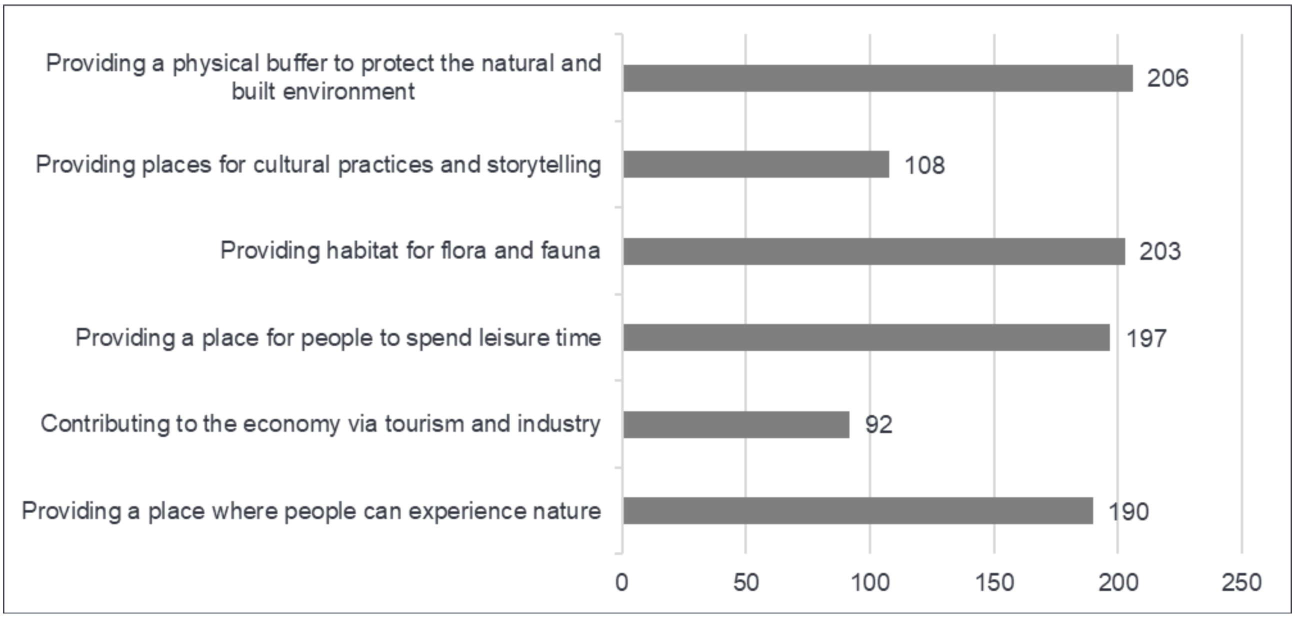

Figure A-5: Question 8 – What do you think are the most important functions of Silverleaves foreshore area?
Shows the number of responses received for each option, whereby respondents were allowed to select multiple options.

6. Question 10 – Awareness

The respondents were asked to indicate whether they were aware that a coastal processes study was recently completed, with the majority being aware of this study (Figure A-6).

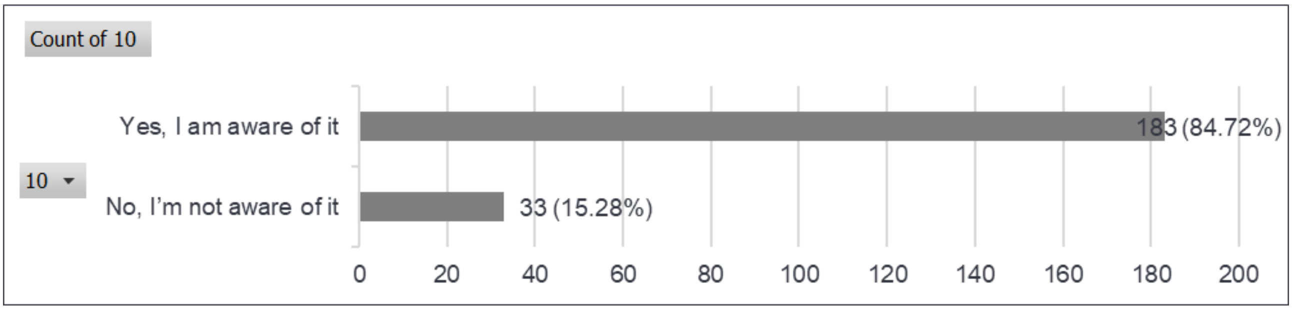

Figure A-6: Queston 10 – Are you aware that a coastal processes study was recently completed?
Shows the number of responses received for each option, whereby respondents were only allowed to select one option.

7. Question 11 – Reading

The respondents were asked to indicate whether they have read or looked through the coastal processes study or the summary document, with the majority indicating they had read or looked through one or both documents (Figure A-7).

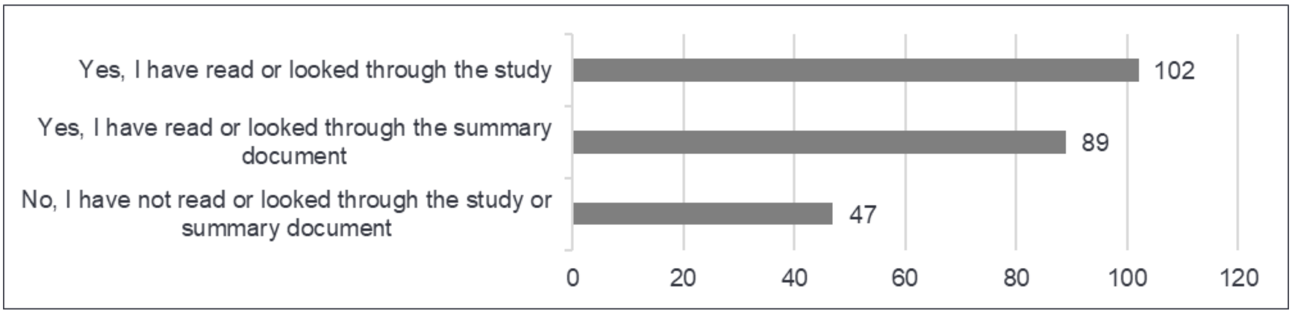

Figure A-7: Question 11 – Have you read or looked through the coastal processes study or the summary document?
Shows the number of responses received for each option, whereby respondents were allowed to select multiple options.

8. Question 12 – Understanding

The respondents were asked to rate their current understanding of the potential for coastal hazards in the Silverleaves area, with the majority indicating they have a general awareness, good understanding, or very good understanding (Figure A-8).

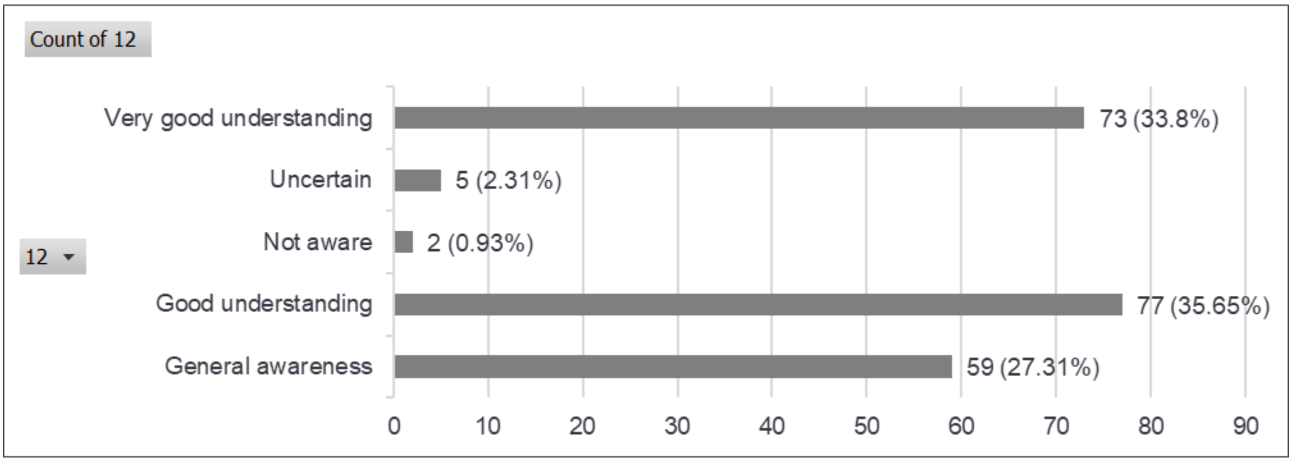

Figure A-8: Queston 12 – How would you rate your current understanding of the potential for coastal hazards in the area?
Shows the number of responses received for each option, whereby respondents were only allowed to select one option.

9. Question 13 – Erosion

The respondents were asked to indicate the likelihood that they think the foreshore area will be affected by coastal erosion in the future, with the majority indicating that they think this would be very likely (Figure A-9).

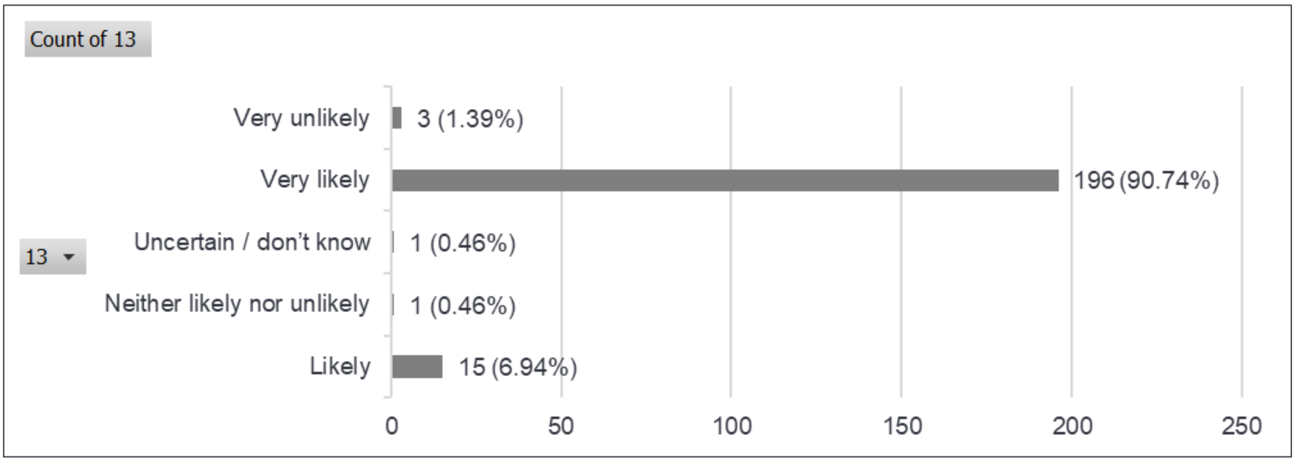

Figure A-9: Queston 13 – How likely do you think it is that the foreshore area will be affected by coastal erosion in the future?
Shows the number of responses received for each option, whereby respondents were only allowed to select one option.

10. Question 14 – Flooding

The respondents were asked to indicate the likelihood they think that the foreshore area will be affected by coastal flooding in the future, with the majority indicating that they think this would be very likely (Figure A-10).

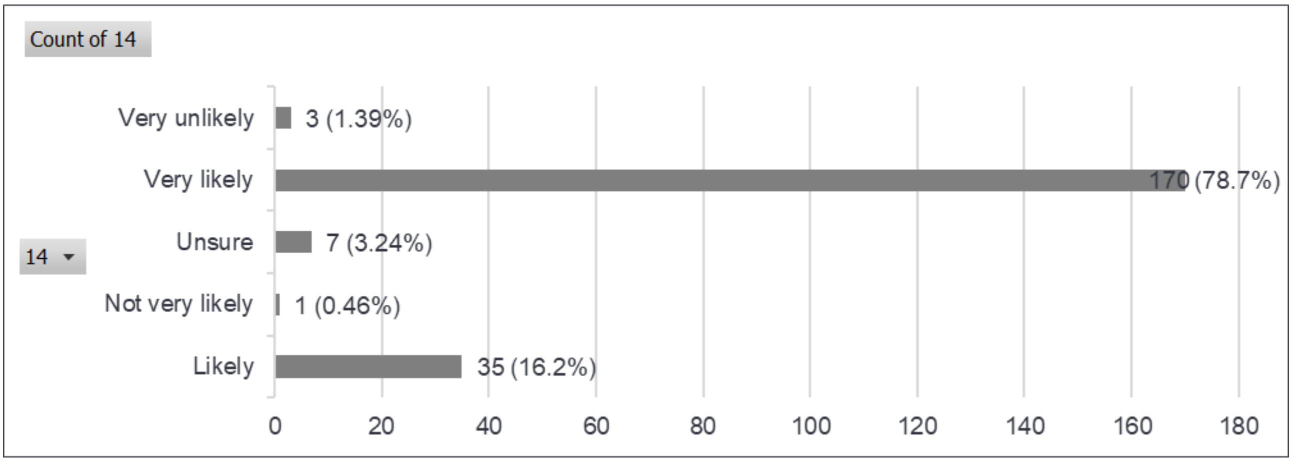

Figure A-10: Queston 14 –How likely do you think it is that the foreshore area will be affected by flooding in the future
Shows the number of responses received for each option, whereby respondents were only allowed to select one option.

11. Question 15 and 16 – Coastal Hazards

The respondents were asked to indicate which coastal hazards they were most concerned about in the future, with the majority indicating their concern about coastal erosion (Figure A-11).

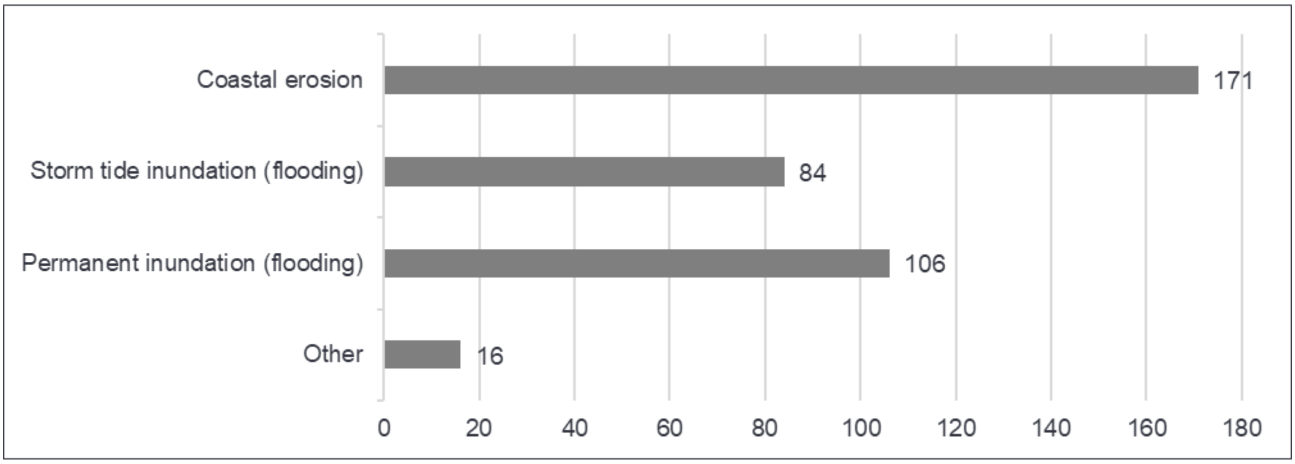

Figure A-11: Question 15 – Which of these coastal hazards are you most concerned about in the future?
Shows the number of responses received for each option, whereby respondents were allowed to select multiple options.

The respondents who selected "Other" have used this opportunity to reiterate certain coastal hazards (erosion or inundation), indicate multiple options (which was permitted for this question), or express broader concerns that are not related to coastal hazards (Table A-4).

Table A-4: Question 16 - Other responses to Question 15
List of responses from respondents who selected "Other" to Question 15.

Response
All
All of the above
Complete and permanent inundation and destruction of the whole Silverleaves and Woodland Ave region(which is several kilometres) is imminent within months. It is extremely serious and extremely urgent and is almost certainly due to the recent man made wall built west of the region which has changed the sea flow. Trees and bush covered sand dunes are eroding up to a metre per week and hundreds of homes will be lost within months if urgent engineering is not undertaken
Concerned about the current inaction and speed of process to do any action
Concerned about the increased rate of coastal erosion at Silverleaves over the last 2 years, compared to the rate of erosion previously as set out in the coastal processes study.
Hazard is you have overlooked nature and not taken advice
Hazardous is the repeat history of built interference with a natural littoral zone
Human lack of care with leaving rubbish and fishing everywhere animal entanglement & destruction of wildlife homes and removal of their food source
I objected to last year's rates on the basis that, taking into account satellite data on elevation and online data on predicted sea level rise that our property might be flooded via the Rhyll inlet in 17 years. This was not dependent on the particular sea level rise model used (at that point in time).
Inaction or wrong action by unqualified organisations eg the wall and groynes
It's not a matter of my 'concern' its a matter of management. They're all important.
Loss of biodiversity and foreshore environmental values
Loss of vegetation and mature trees along the foreshore creating greater wind impact in the rest of Silverleaves. Also concerned that the levee banks on private land adjacent to the south side of Silverleaves are protected.
The leadership have no idea how to lead. They are ideologues. Very dangerous for a leader or people in leadership to be pushed and pulled by ideology instead of facts.
The other hazard is the lack of action of Council and Government, the report indicates the foreshore has lost 16sq meters in the last 24 months. this is not at a rate of 8mt per year as the loss was nearer to 4 mt in the first year and 12mt in the 2nd thus the current rate for the next 12 months would be near 30mt lost
These are natural processes

Several respondents also raised valid concerns about additional hazards impacting the coastal environment, including rubbish and pollution along the foreshore, biodiversity loss, and vegetation degradation.

12. Question 18 – Preparedness

The respondents were asked to indicate how prepared they think the Silverleaves area is to withstand and recover from potential coastal erosion or flooding in the future, with the majority indicating that they think theire is a lot more planning and preparation required (Figure A-12).

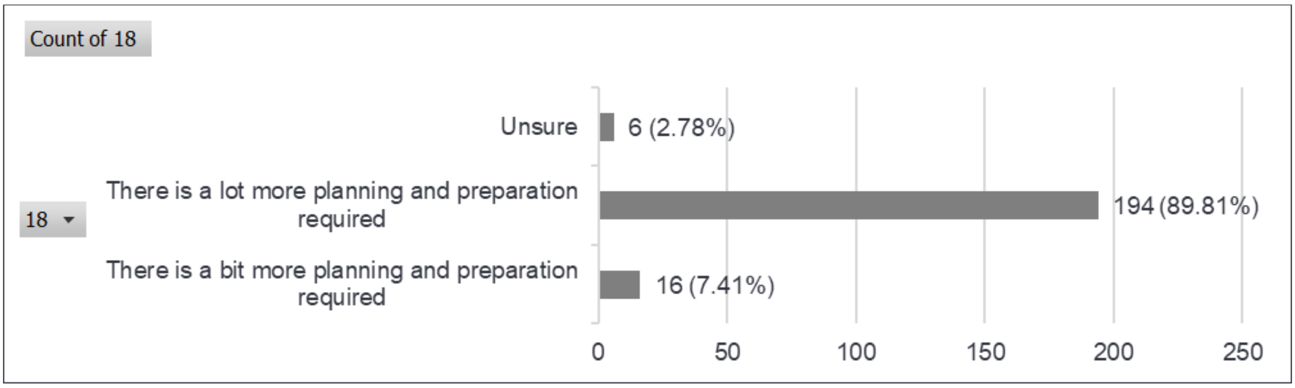

Figure A-12: Queston 18 – How prepared do you think the Silverleaves area is to withstand and recover from potential coastal erosion or flooding in the future?
Shows the number of responses received for each option, whereby respondents were only allowed to select one option.

13. Question 19 – Suggestions

A total of 174 respondents provided their ideas or suggestions on how the Silverleaves foreshore could be made more resilient over time and help to retain what we value about the coast (Figure A-13). Most respondents urged for immediate action to address erosion and protect the foreshore, advocating for short-term interventions and/or long-term planning. There was also mixed support for engineered solutions (e.g., rock walls or groynes), as well as softer or nature-based solutions (e.g., sandbagging and revegetation).
The overall sentiment leaned towards protecting the shoreline with a rock revetment, groynes, or sandbags. Many responses also considered habitat and wildlife protection, vegetation restoration and planting, as well as long-term planning and adaptation.

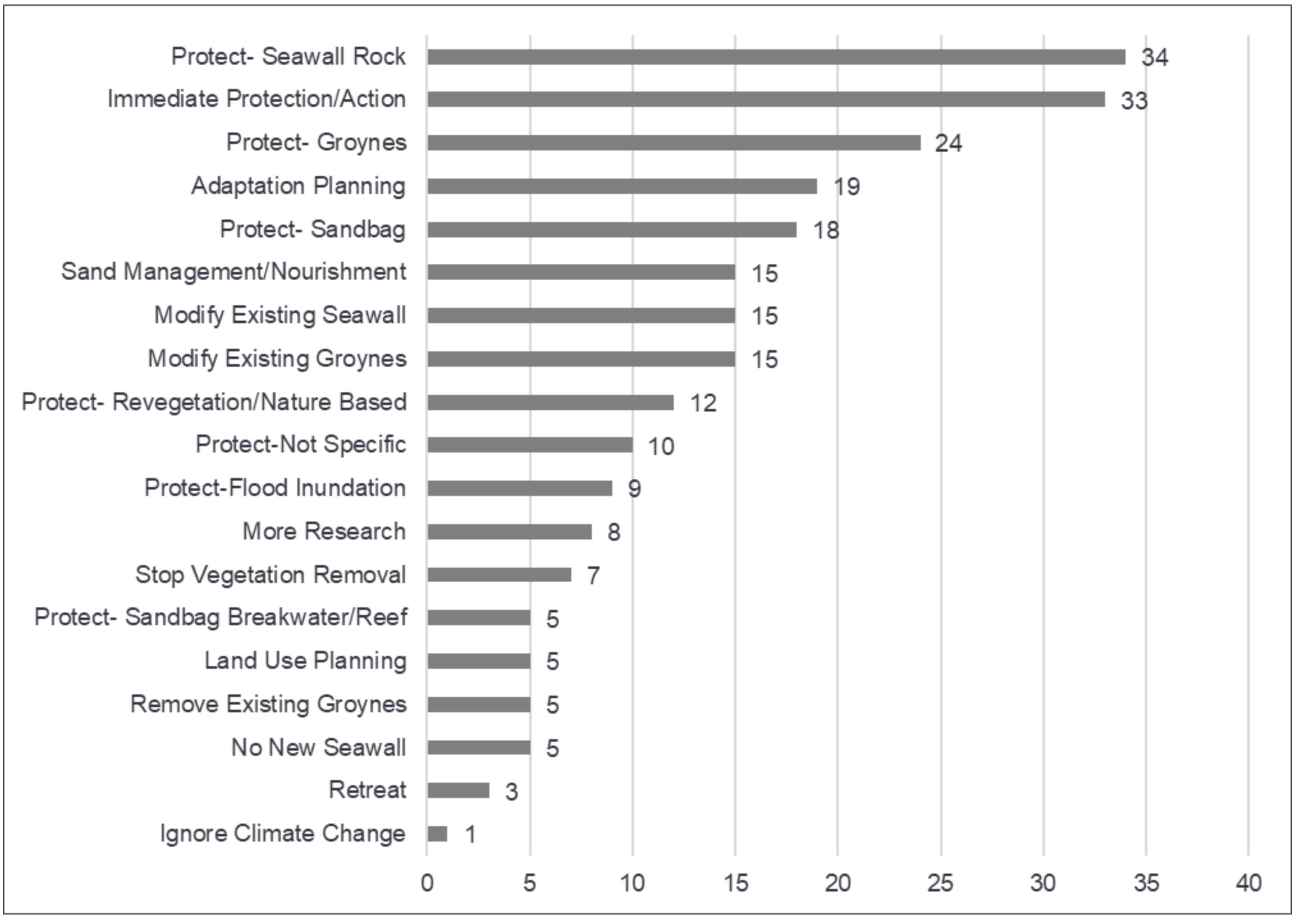

Figure A-13: Queston 19 – Do you have any ideas or suggestions on how the Silverleaves foreshore could be made more resilient over time, and help to retain what we value about the coast?
Shows the 15 most mentioned themes and the number of mentions for each theme. Respondents were able to provide freeform responses, allowing for a diverse range of ideas and suggestions to be captured.

14. Question 20 – Anything Else

A total of 130 respondents provided additional comments at the conclusion of the questionnaire (Figure A-14). These comments largely reflected themes captured in Question 19.

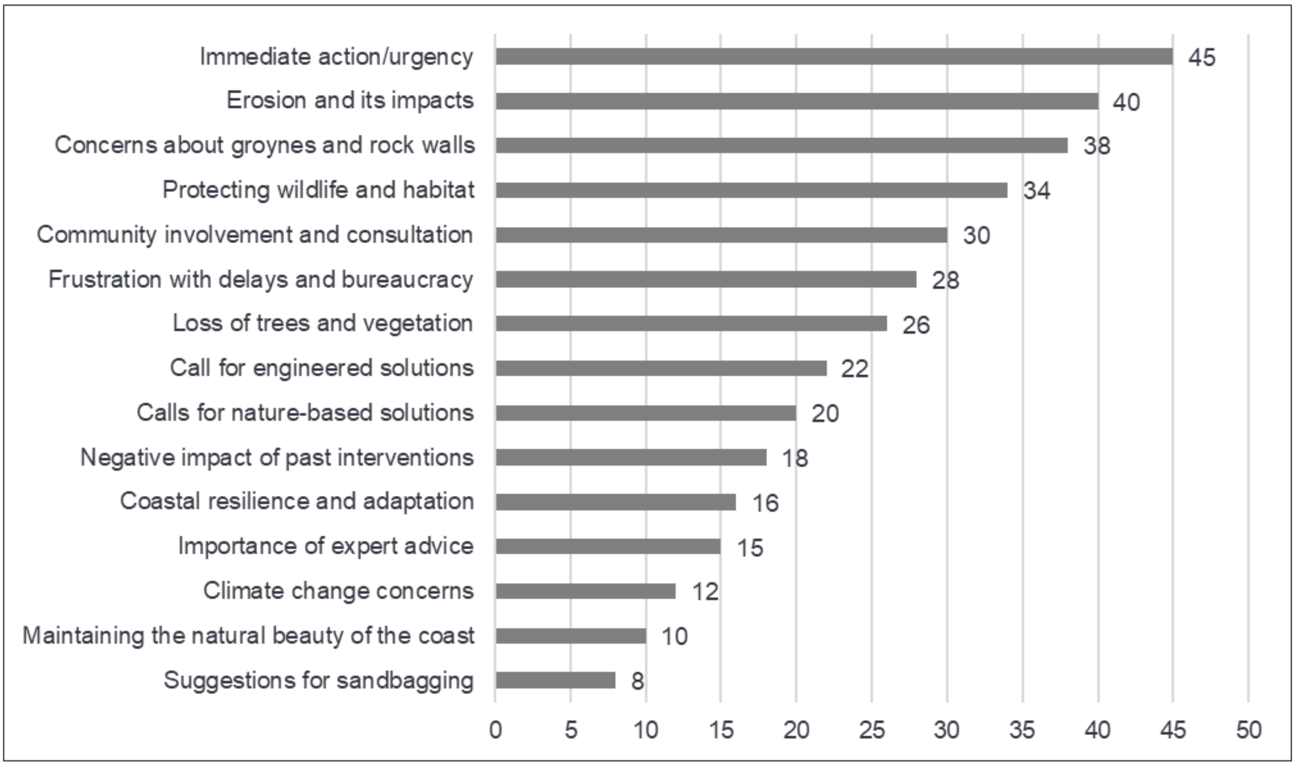

Figure A-14: Question 20 – Is there anything else you would like to share with us?
Shows the 15 most mentioned themes and the number of mentions for each theme. Respondents were able to provide freeform responses, allowing for a diverse range of ideas and suggestions to be captured.

15. Discussion

1. Data Reliability

There was a total of 216 responses received between 29 August 2024 and 27 September 2024., with a majority being unique responses (Figure A-15). However, several responses originated from identical IP addresses, potentially indicating duplicate submissions or multiple entries from the same household or location. Further analysis of these submissions shows similar responses and feedback from identical IP addresses.

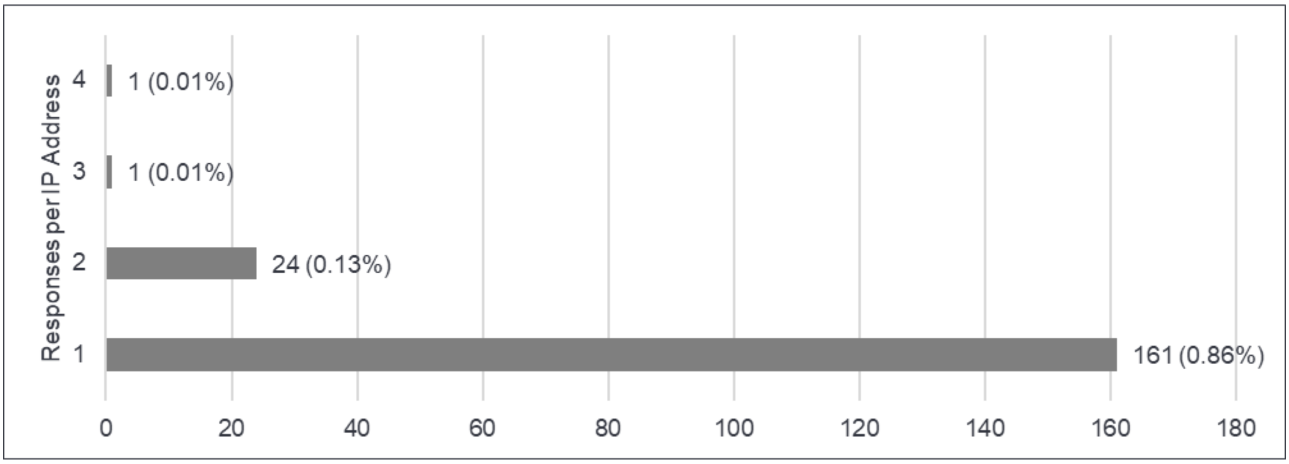

Figure A-15: Number of responses per IP address
Shows the number of responses received from a unique IP address.

2. Traditional Owners

There was a total of 2 respondents who identified as a "Traditional Owner" in Question 1 (Table A-5). These respondents also identified as a "resident within 1 km of Silverleaves" in Question 1. One of these respondents provided a response to Questions 19 and 20, reiterating an urge for immediate action and advocating for the eroded sand dunes to be rebuilt.

Table A-5: Responses by Traditional Owners

List of responses to Questions 19 and 20 from respondents who identified as "Traditional Owner" in Question 1.

Response to Question 19	Response to Question 20
-	-
Needs engineering work plus a rebuild of the sand dunes	Please get a move on!

APPENDIX B: EVALUATION OF SHORTLISTED OPTIONS

B-1: Supported Littoral Vegetation

Table C-1: Advantages of supported littoral vegetation

Advantage	Description
Coastal Protection	Effectively protects the shoreline from erosion hazards.
Natural Shoreline Growth	Promotes natural sediment accumulation and shoreline expansion over time.
Habitat Creation and Biodiversity	Establishes valuable habitat for marine and terrestrial species, enhancing local biodiversity.
Water Quality and Carbon Sequestration	Improves water quality through natural filtration and sequesters carbon, contributing to climate resilience.
Aesthetic and Community Value	Adds beauty and ecological health to coastal areas, providing benefits for both wildlife and the community.
Adaptability	Living shorelines can adapt naturally to sea level rise, provided the ecosystem has sufficient space and conditions to migrate inland. Sea-level rise projections should inform the design to ensure there is adequate space for plants to migrate and allow for incremental height adjustments of the structures as water levels increase.
Beach Nourishment Options	Options for added beach nourishment and/or dune construction to add beach amenity and increase habitat/biodiversity.

Table C-2: Disadvantages of supported littoral vegetation

Disadvantage	Description
Slow Establishment	Vegetation, especially species like mangroves, can take many years to mature and effectively protect the shoreline.
Site-Dependent	Success relies on favourable environmental conditions and may require trials or offsite plant propagation.
Maintenance	Requires ongoing monitoring and occasional care, particularly during establishment or after storms.

Table C-3: Considerations for supported littoral vegetation

Consideration	Description
Trial Section	To mitigate risks and confirm the suitability of the selected plants for the environment, a trial section may be useful. This test section would allow for the evaluation of plant growth, resilience, and adaptation to local environmental conditions before implementing the approach on larger sections of the coast.
Access Restrictions	Establishing vegetation may need to restrict human access and recreational activities in areas designated for planting, to ensure successful growth and minimise disturbance to the habitat. Access and areas of implementation would need to consider community values and be incorporated in the detailed design phase.
Modelling Needs	Numerical or physical modelling may be required to ensure the effectiveness of the rock sill or breakwaters design. These models will help assess their ability to protect the shoreline and vegetation, while also directing tidal flows to minimise erosion and ensure the long-term stability of the ecosystem.
Cost Factors	Initial construction and material sourcing involve capital costs, though material volume and hence costs for the low crested structures may be lower than traditional seawalls or revetments. Maintenance and vegetation monitoring will incur ongoing expenses.

Consideration	Description
50-Year + Design Life	With proper establishment, supported littoral vegetation can last over 50 years, especially if adaptive measures (like ensuring sufficient accommodation space) allow for landward migration as sea levels rise. Additionally, the lifetime of breakwaters or rock sills can be 50+ years and be extended by incremental height adjustments as sea levels rise.
Hybrid Approach	This hybrid approach combines a buried rock revetment with a vegetated dune, integrating natural and engineered elements to provide coastal protection and enhance ecological value. The buried revetment acts as a hidden structural core, providing stability and erosion resistance, while the vegetated dune on the surface restores a natural coastal landscape. Native dune vegetation, such as spinifex and other salt-tolerant plants, is planted over the dune to stabilise sediments and improve resilience against wind and wave forces.

B-2: Living Seawall

Table C-4: Advantages of living seawall

Advantages	Description
Coastal Protection	Effectively protects the shoreline from erosion hazards.
Biodiversity	Provides habitat for marine species, improving local ecological health.
Aesthetic Value	Enhances visual appeal while providing ecosystem services.

Table C-5: Disadvantages of living seawall

Disadvantages	Description
High Initial Cost	More expensive than traditional seawalls due to materials and design.
Maintenance	Requires ongoing care to maintain structural integrity.
Scour and Beach Lowering	Seawalls can cause scour and the lowering of the beach profile, leading to the loss of beach amenity and potential long-term erosion of the beach in front of the structure.
Adaptability	Living seawalls have low to moderate adaptability to future sea level rise. While initial designs can incorporate future sea level projections and additional habitat units may be added to accommodate SLR, significant modifications or reconstructions are often needed to increase the wall height or extend its lifespan.

Table C-6: Considerations for living seawall

Consideration	Description
Capital Costs	Higher than traditional seawalls due to custom design and material requirements.
50-Year Design Life	Typically 50 years with proper maintenance.

B-3: Rich Revetment

Table C-7: Advantages of rich revetment

Advantage	Description
Coastal Protection	Effectively reduces erosion hazards.
Biodiversity	The revetment toe or concrete units provide intertidal habitat, enhancing marine biodiversity.
Aesthetic and Community Value	Adds ecological and visual value to the coastline, blending nature with engineered protection.

Table C-8: Disadvantages of rich revetment

Disadvantage	Description
Maintenance	The tidal pool feature requires monitoring to ensure it remains functional and supports the intended habitat.
Cost	Higher initial construction costs than traditional revetments due the increased quantity of materials and/or engineered concrete units.
Adaptability	Rock revetments have moderate adaptability to future sea level rise. Initial designs can incorporate future sea level projections and additional rocks or units may be added to the toe to accommodate sea level rise, though significant modifications may be required to increase the crest height or extend its lifespan.

Table C-9: Considerations for rich revetment

Disadvantage	Description
Capital Costs	Moderate to high initial capital and construction costs, depending on the complexity of the design and materials, minimal to moderate maintenance costs.
50+ Year Design Life	50+ years with regular maintenance.

B-4: Rock Revetment

Table C-10: Advantages of rock revetment

Advantage	Description
Coastal Protection	Effectively reduces erosion hazards.
Long Lifespan	Well-designed rock revetments can last for decades.

Table C-11: Disadvantages of rock revetment

Disadvantage	Description
Aesthetic Impact	Rock revetments can detract from the natural appearance of the coastline, potentially reducing visual amenity and community satisfaction.
Scour and Beach Lowering	Revetments can cause scour and the lowering of the beach profile, leading to the loss of beach amenity and potential long-term erosion of the beach in front of the structure.
Adaptability	Rock revetments have moderate adaptability to future sea level rise. Initial designs can incorporate future sea level projections, though significant modifications may be required to increase the crest height.

Table C-12: Considerations for rock revetment

Consideration	Description
Capital Costs	Moderate to high initial capital and construction costs, minimal maintenance costs.
50+ Year Design Life	50+ years with minimal maintenance.

B-5: Vertical Seawall

Table C-13: Advantages of vertical seawall

Advantage	Description
Coastal Protection	Effectively reduces erosion hazards.
Long Lifespan	Can last several decades with minimal maintenance.

Table C-14: Disadvantages of vertical seawall

Disadvantage	Description
High Initial Cost	Significant construction and material costs.
Environmental Impact	Can disrupt local ecosystems and reduce beach areas.
Limited Adaptability	While initial designs can incorporate future sea level projections, significant modifications or reconstructions are often needed to increase the wall height or extend its lifespan.
Scour and Beach Lowering	Seawalls can cause scour and the lowering of the beach profile, leading to the loss of beach amenity and potential long-term erosion of the beach in front of the structure.

Table C-15: Considerations for vertical seawall

Consideration	Description
Capital Costs	High initial capital and construction costs, minimal maintenance costs.
50+ Year Design Life	50+ years with minimal maintenance.

B-6: Nearshore Breakwater (inc. artificial reef)

Table C-16: Advantages of breakwater

Advantage	Description
Coastal Protection	May help mitigate erosion hazards. However, they do not provide the same "hold the line" protection as revetments or seawalls and therefore may need to be considered in conjunction with one of these coastal protection measures.

Table C-17: Disadvantages of breakwater

Disadvantage	Description
Suitability	Breakwaters are less effective at accumulating sediments at this location due to longshore tidal currents.
High Construction Costs	Initial construction costs are typically higher than shoreline options, with shorter construction windows (e.g. low tide).
Sediment Redistribution	May cause erosion down-drift from the structure.

Table C-18: Considerations for breakwater

Consideration	Description
Modelling for Effective Design	Numerical or physical modelling of waves and currents may be required to ensure the effectiveness of the breakwaters design.
Capital Costs	High initial cost.
Lifetime	Typically, 50+ years with proper maintenance.

B-7: Groyne Field

Table C-19: Advantages of groyne field

Advantage	Description
Sediment Management	Helps to stabilise the beach and reduce erosion. However, they do not provide the same "hold the line" protection as revetments or seawalls and therefore may need to be considered in conjunction with one of these coastal protection measures.

Table C-20: Disadvantages of groyne field

Disadvantage	Description
Sediment Redistribution	Groynes disrupt littoral transport and can cause unintended environmental and geomorphic impacts, including erosion of downstream beaches and adjacent areas not protected by the groynes.
Maintenance	Requires regular monitoring, upkeep and nourishment following erosive events to ensure continued effectiveness and continued sediment bypassing to downstream beaches to mitigate negative downstream impacts.

Table C-21: Considerations for groyne field

Consideration	Description
Spacing and Length	Needs careful planning and potentially numerical modelling to optimise sand retention and minimise adverse effects on neighbouring areas.
Capital Costs	Moderate, depending on the number and size of groynes.
50 Year Design Life	Typically 50 years, with periodic maintenance.

FSC RANGE

Project & Engineering Management
Engineering Design & Consulting
Environment & Sustainability

HQ: Level 1 / 366 Bridge Rd, Richmond VIC 3121
NSW: 20/40 Meagher St, Chippendale NSW 2008
QLD: 123 Eagle St, Brisbane City QLD 4000

Range Consulting Pty Ltd
ABN 97 644 088 344
1300 372 477