# Coastal Adaptation Report

## Flood Mitigation Adaptation for Painkalac Creek Estuary, Aireys Inlet

Surf Coast Shire

7 July 2026

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## Project Details

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# ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.


*Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.*

*The symbolism in the artwork includes:*

- *Seven circles representing each of the States and Territories in Australia where we do our work*
- *Blue dots between each circle representing the waterways that connect us*
- *The animals that rely on healthy waterways for their home*
- *Black and white dots representing all the different communities that we visit in our work*
- *Hands that are for the people we help on our journey*

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# 1 INTRODUCTION

## 1.1 Overview

Water Technology has been commissioned by Surf Coast Shire (The Shire) to prepare the Flood Mitigation and Adaptation planning for the Painkalac Creek Estuary Study. The overall project aim is to understand climate impacts on the flood risk within the Painkalac Estuary and the coastal risk on the Aireys Inlet and Fairhaven open coastline, and to then begin preparing adaptation pathways for these.

This report deliverable (Coastal Adaptation Report) is one of multiple key deliverables of the wider project. Each reporting stage is shown below:

- 01: Gap Analysis Memo
- 02: Erosion Hazard Report
- 03: Coastal Inundation Hazard Assessment Report
- 04: Catchment Hydrology Report
- 05: Flood Mitigation Report
- **06: Coastal Adaptation Report – (this report)**

## 1.2 Study objective

The purpose of this report is to develop coastal adaptation pathway plans (CAPPs) for the study site, in accordance with the Victoria's Resilient Coast (VRC) Guidelines (DELWP, 2023). The CAPPs were to encompass the open coast (from Eastern View to Urquhart Bluff) and the Painkalac Creek estuary. The adaptation plans enable flexible, staged decisions that respond to sea-level rise and uncertainty over time, reducing risk, costs, and maladaptation while keeping future options open. These are key benefits and help to plan management of the region into the future.

## 1.3 Guiding Principles

The VRC Guidelines lay out the Victorian Government's framework for managing and adapting to coastal hazards under the Marine and Coastal Act 2018 (Vic) and the Marine and Coastal Policy 2020. The framework provides a consistent, best-practice approach to assessing and responding to coastal erosion, inundation and related hazards, with a long-term planning horizon extending to 2100 and beyond. The VRC Guidelines are to be followed when planning for, assessing or managing coastal hazard risk and adaptation, making sure adaptation decisions are evidence-based, transparent and aligned with State policy objectives.

The VRC framework adopts a staged risk management and adaptation pathways approach, supporting site specific decision-making that responds to changing coastal conditions over time. It emphasises understanding coastal processes, identifying current and future risks to coastal values and assets, and assessing a hierarchy of adaptation responses. Central to the framework is the recognition that coastal change is dynamic and uncertain, and that adaptation should be flexible and revisited through monitoring, trigger points and periodic review rather than relying on single, fixed end-state solutions.

This study applies the VRC framework and guidelines to the development of estuary focused and open-coast focused CAPPs within the study area. These have been prepared in accordance with the VRC principles, including early consideration of long-term coastal change, avoidance of maladaptive responses, and alignment with the Marine and Coastal Policy hierarchy. The CAPPs developed through this process provide a clear and transparent roadmap for managing coastal hazard risks over time, identifying near-, medium-, long-term actions and decision triggers to support resilient and sustainable outcomes for the coast and associated values to 2100+.

The primary objective of a CAPP is to avoid short-term actions that may lead to improper adaptation and to consider multiple potential futures, based on different adaptation pathways. The hierarchy of the Strategic Options and foundational questions are detailed below in Table 1-1 to identify the rationale and considerations required for each strategic objection.

**Table 1-1 Strategic Adaptation Approach Order of Consideration (after Marine and Coastal Policy (2020))**

| Strategic Approaches Order | Marine and Coastal Policy (2020) definitions | Planning considerations/types of actions |
|---|---|---|
| 1. Non intervention | Allow marine and coastal processes, and the hazards they may pose, to occur. | Triggers (event, timing, other) can be identified for when additional action may commence. |
| 2. Avoid | Locate new uses, development, and redevelopment away from areas that are or will be negatively impacted by coastal hazards. | This option typically applies to all coastal hazard areas. Does not apply to existing assets/values at risk. |
| 3. Nature-based methods | Enhancing or restoring natural features to mitigate coastal hazard risk. | This may include wetland restoration, enabling landward migration of habitat, and potential hybrid nature-based and engineering approaches (e.g. living shorelines). |
| 4. Accommodate | Structures can be designed to reduce the exposure to or decrease the impact of, coastal hazard risk, thus 'accommodating' the risk. | This may include movable infrastructure (e.g., life-saving towers, stairs/ramps), flood-resilient building design or the use of resilient materials. |
| 5. Retreat | Existing structures, assets or uses may be decommissioned or relocated away from areas that are or will be, negatively impacted by coastal hazards. | This may apply locally or more broadly as part of the adaptation planning process. |
| 6. Protect | Existing physical barriers are enhanced, or new ones constructed, to mitigate the impact of coastal hazards. Protect is an option of last resort; it is often expensive, its benefits tend to be very localised, and it frequently transfers the problem to nearby areas. | This may include a commitment to ongoing beach nourishment, construction of seawalls or other physical barriers/structures or interventions (revetments, groynes, breakwaters) that are likely to have a significant impact on natural coastal processes. |

# 2 LOCAL VALUES

## 2.1 Summary

Following the VRC Guidelines, adaptation planning should be directly linked to the local coastal values within the study area. These represent the fundamental environmental, cultural, social, and economic attributes prioritised by the community, Traditional Owners, and stakeholders. In the context of the Painkalac Creek estuary and the broader Aireys Inlet foreshore, identifying these values establishes a baseline for assessing vulnerability to coastal hazards such as storm tide inundation and coastal erosion.

Understanding these local priorities ensures that subsequent adaptation pathways are strategically developed to protect, accommodate, or respectfully transition the specific assets and characteristics that define the study area. This alignment is critical for evaluating adaptation options against the Marine and Coastal Policy 2020 hierarchy (non-intervention, avoid, nature-based, accommodate, retreat, and protect).

## 2.2 Data sources

Values information was provided by Council to inform the adaptation planning. This has drawn from various other sources such as:

- Publicly available datasets on CoastKit and NatureKit
- Community surveys
- Registered Aboriginal Party (RAP) Country plans
- Feedback and internal Council anecdotal knowledge

## 2.3 Environmental Values

The Painkalac Creek estuary and surrounding terrestrial environments support rich biodiversity and high value ecological assets. The terrestrial landscape features a mosaic of Coastal Salt Marsh and Mangrove shrubland, various Dry Forest types, Heathy Woodlands, and sandy well-drained Heathland. The area serves as a small mammal refuge under the Rewilding the Otways Initiative and contains significant Moonah dune vegetation. It achieves a high habitat value rating of 94 and supports endangered and EPBC listed flora and fauna.

The marine and estuarine environments feature a salt wedge community and support sensitive aquatic species that are also EPBC listed. Furthermore, the local community places a very high priority on environmental stewardship and values the Painkalac Valley as a critical wildlife corridor. There is strong community support for ecosystem protection, habitat restoration, maintaining dune and estuary health, and preserving the natural beauty of the area over private property interests.

## 2.4 Cultural Significance

The Painkalac Creek valley and estuary landscape hold deep cultural significance for both the Eastern Maar and Wadawurrung peoples, who are the Traditional Owners and custodians of the region. The study area also falls within active Native Title claim boundaries.

This project has not included any engagement with Traditional Owners at this stage. It is not culturally appropriate to presume any understanding of Cultural Values or to include these within adaptation planning without direct integrated involvement from the Traditional Owners.

## 2.5 Social Values

Painkalac Creek is deeply embedded in the social fabric and community identity of Aireys Inlet, serving as a central hub for social connection and recreation. The local community characterises the area as a quiet, nature-rich coastal village where the bush meets the sea, highly valuing its calm, non-urban feel, dark night skies, and unspoilt beaches. The creek and its surrounding valley are frequently described as the heart of Aireys Inlet, providing a harbour against modern pressures and offering significant mental health and wellbeing benefits through peace and reflection.

Recreational use of the creek and estuary is extensive and multi-generational. Community members consistently utilise the area for walking, running, birdwatching, canoeing, swimming, and picnicking. There is enduring support for low-impact, non-motorised, and nature-compatible recreation, such as walking tracks and bicycle paths, alongside strong opposition to motorised recreation and demand-inducing tourist developments. Scenic locations such as Butler's Bend and the dam wall are particularly celebrated for their panoramic views and serene environments.

The social values of the district have remained exceptionally stable over more than four decades, reflecting a community that prioritises environmental health, safety, liveability, and strong neighbourly connection over growth and large-scale events. Residents maintain a strong culture of volunteering and active stewardship, seeking careful, long-term management that protects the low-key coastal hamlet character. Consequently, there are notable community concerns regarding pollution, poor historical planning decisions, overdevelopment, and the impacts of climate change, with a clear mandate that infrastructure and amenity improvements must precede any further growth.

## 2.6 Built Values

The built environment and local economy of Aireys Inlet are intrinsically linked to the infrastructure surrounding Painkalac Creek. A critical built asset is the Great Ocean Road bridge, which provides the primary crossing over the creek. This crossing is vital for the connectivity of the town and serves as an essential emergency access and evacuation route for the community (including nearby townships). Other significant public infrastructure includes River Reserve Road, the local lighthouse, the Surf Club, and designated beach access points.

The economic value of the area is heavily underpinned by approximately 106 private dwellings and local businesses situated adjacent to the creek and foreshore. The community acknowledges the high economic and personal investment in these properties, though there are widespread concerns regarding the vulnerability of these low-lying assets to flooding and climate change impacts.

While tourism forms a component of the local economy, community sentiment strongly favours limiting commercial expansion and protecting the existing low-key village character. Built recreational assets, such as fishing pontoons, further support both the local lifestyle and the tourism economy. Furthermore, infrastructure resilience is a growing community priority, with an emphasis on maintaining and upgrading essential services like drainage and stormwater management to protect these built values.

# 3 ADAPTATION ACTIONS ASSESSMENT

## 3.1 Functional Types

The range of tools, decisions and physical works used to develop an adaptation pathway are referred to as adaptation actions. Adaptation actions can be grouped into three functional types:

- Land management planning and design
- Nature-based approaches (including hybrid approaches)
- Coastal engineering

**Land Management Planning and Design** actions are likely to apply in a range of ways for short and long-term adaptation at different locations. This includes relocation of readily moveable assets, upgrades with resilient material and design approaches, and longer-term planning of how the land will be used in the future (overlays, planning scheme amendments, tenure). These actions are informed by the hazard assessments, risk and economic studies, strategic planning and engagement, as CAPPs are developed. These options are less likely to constrain future adaptation alternatives.

**Nature-based actions** use the creation or restoration of coastal habitats for hazard risk reduction. This includes a suite of options associated with coastal wetland/ecosystem restoration, dune ecosystems, and hybrid engineering approaches (e.g., shellfish reefs). Nature-based actions often require specific environmental conditions to be successful and may require active management / ongoing action over shorter timeframes. Nature-based actions may be appropriate as part of a CAPP based on site-specific objectives and often assist with retaining natural site values while mitigating hazard impacts. These actions may partially restrict adaptation alternatives in future but are likely to allow for alternatives as needed.

**Coastal engineering** actions are often considered the least desirable type of CAPP action. The purpose of an engineering action is to change the natural processes acting on a coastal or estuarine environment or the response of the environment to natural processes. Engineering actions do not assist the community or stakeholders in adapting to these natural processes. Engineering actions restrict the ability to easily adapt to alternative actions in future and are most likely to lead to ‘lock-in’ with repeated upgrades and maintenance of engineering protection works being required.

## 3.2 Preferred Actions

For the development of the Coastal Adaptation Pathway Plans (CAPPs), the project area was divided into three precincts. This approach was adopted because the area encompasses distinct geographical contexts, each requiring different adaptation measures. Accordingly, adaptation actions have been developed for three separate coastal environment precincts, as shown in Figure 3-1. The precincts are described below:

- **Precinct One**: Dune-dominated coast west of Painkalac Creek
- **Precinct Two**: Cliff-dominated coast east of Painkalac Creek
- **Precinct Three**: Painkalac Creek estuary

Adaptation actions have been considered based on the broader strategic order for the three domains, outlined in Figure 3-2 to Figure 3-4. These options represent the order in which each option should be considered. This preference in consideration is not prescriptive, and the different pathways are likely to depend on other constraints as triggers are met. The pathways seek to identify available options that can be considered and planned for.

Only options with a Benefit-Cost Ratio (BCR) greater than 1 (indicating economic viability) were considered in the adaptation plans, as identified in the Flood Mitigation Report (Water Technology, 2026). The exception is voluntary house purchase (retreat), for which the BCR is highly sensitive to assumptions about future property values and average annual damages. In practice, the willingness of residents to sell is a critical determinant of the feasibility of this option. Other planning tools may support such measures.

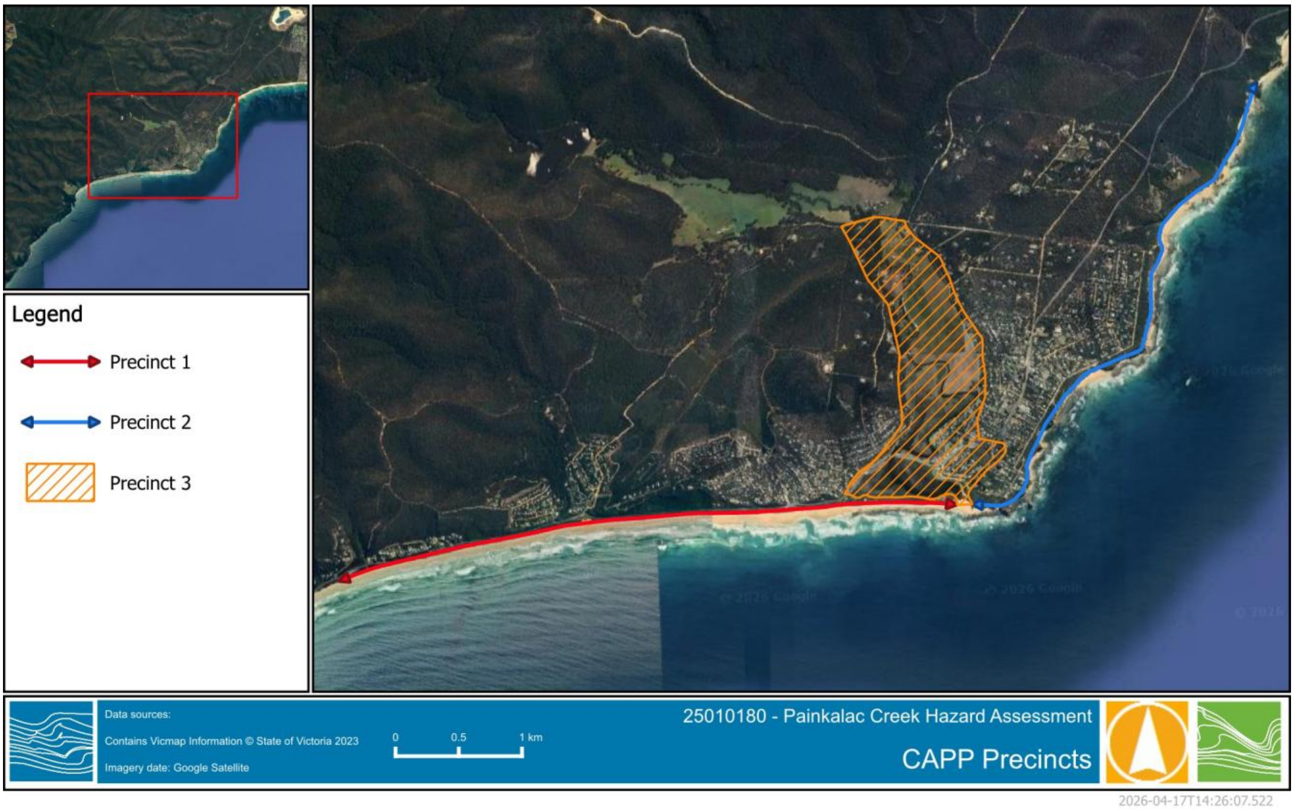


**Figure 3-1 CAPP precinct extents**

## Precinct One

**Non-intervention**

- Appropriate in the short term, supported by ongoing monitoring of the remaining coastal buffer.
- Not appropriate in the medium to long term, as continued erosion will expose coastal infrastructure, including the Fairhaven Surf Club and sections of the Great Ocean Road..

**Avoid**

- Appropriate for all timeframes.
- Restrict further development within areas vulnerable to coastal hazards.

**Nature-based methods**

- Appropriate in the short term.
- Maintain native vegetation on the dune face coupled with targeted nourishment at the due toe to increase protection against event-based erosion.
- Not a standalone long-term solution.

**Accommodate**

- Not appropriate.

**Retreat**

- Appropriate in the medium to long-term.
- Remove and relocate the Fairhaven Surf Club and Great Ocean Road landward, outside of the future hazard zones.

**Protect**

- Appropriate in the short to medium-term, using imported mass-nourishment or rock bags to protect the dune fronting vulnerable infrastructure.
- Appropriate in the medium to long-term, involving installation of a seawall fronting vulnerable infrastructure.

Figure 3-2 Adaptation options considered for each strategic approach for precinct one.

## Precinct Two

| | |
|---|---|
| Non-intervention | •Not appropriate.<br>•Continued monitoring of cliffs for signs of instability. Using technology like drones, LiDAR, and geotechnical investigations to track erosion rates and identify critical failure risks. |
| Avoid | •Appropriate for all timeframes.<br>•Restrict further development within areas vulnerable to coastal hazards. |
| Nature-based methods | •Not appropriate |
| Accommodate | •Not appropriate. |
| Retreat | •Appropriate for all timeframes.<br>•Risk is mitigated through managed retreat, as the lighthouse and several cliff-top properties lie within the present-day hazard zone.<br>•Ongoing monitoring of cliff movement will inform the level of risk associated with potential cliff failure. |
| Protect | •Appropriate for all timeframes.<br>•Manage cliff drainage by controlling stormwater and infiltrating water to reduce pore-water pressures that can lead to mass-movement instability<br>•Install cliff-toe protection structures, such as seawalls or rock revetments.<br>•Note: cliff-toe protection limits the landward progression of coastal hazard zones associated with sea-level rise but does not protect against cliff collapse, and residual risk remains. |

**Figure 3-3 Adaptation options considered for each strategic approach for precinct two.**

## Precinct Three

| | |
|---|---|
| Non-intervention | •Not appropriate.<br>•Properties will be impacted by flood waters under non-intervention. |
| Avoid | •Appropriate for all timeframes.<br>•Restrict any further development within areas vulnerable to flooding. |
| Nature-based methods | •Appropriate in the short term through berm opening or berm management.<br>•The effectiveness of berm opening at the current trigger level of 2 m AHD will progressively reduce over time as sea level rise decreases the hydraulic head differential typically required for a successful artificial opening. |
| Accommodate | •Appropriate through retrofitting building materials.<br>•Implementation can be undertaken through a staged approach over time.<br>•The timing of this measure depends on whether berm management is continued. |
| Retreat | •Appropriate through voluntary house purchase.<br>•Implementation is dependent on resident willingness to sell.<br>•Economic viability is influenced by the purchase price relative to average annual damages.<br>•Managed land transition.<br>•The timing of this measure depends on whether berm management is continued. |
| Protect | •Appropriate for all timeframes.<br>•Install a flood levee and road flood gate crossing. Suitable across all timeframes.<br>•The timing of this measure depends on whether berm management is continued. |

**Figure 3-4 Adaptation options considered for each strategic approach for precinct three.**

# 4 BERM / ENTRANCE MANAGEMENT SUMMARY

## 4.1 Summary

The Painkalac Creek estuary is currently managed through artificial openings of the sand berm to mitigate flood risks, primarily to protect nearby residential properties and critical infrastructure, including the Great Ocean Road bridge crossing. This intervention is effective under present conditions at mitigating the flood risk to properties and infrastructure. It is currently triggered by critical upstream levels within the Painkalac Creek estuary, along with rainfall forecasts and assessments of the existing estuarine water quality.

However, there is strong pressure amongst various groups to minimise this intervention on the grounds that it may impact on salt wedge communities within the estuary, and diverts the estuary from its natural cycle of closure, filling and eventual major opening. Community consultation highlights significant opposition to frequent mechanical openings, with residents citing concerns over cliff and dune erosion, water quality degradation, and broader ecological disruption. A strong community preference exists to let nature take its course and allow the creek to flow and flood naturally to support ecological health.

## 4.2 Sea Level Impacts

Projected sea level rise will significantly challenge the long-term viability of the current management practice. As sea levels increase, the physical dynamics required for a successful opening will change, decreasing the effectiveness of current management practices.

The success of an artificial opening relies heavily on a steep hydraulic gradient, which is the difference in height between the water level inside the estuary and the ocean. Sea level rise will cause the ocean level to increase, and consequently, the sand berm at the estuary entrance will also naturally build higher and shift landward. This process reduces the hydraulic gradient if the estuary water level remains the same.

Therefore, the current estuary water levels that may trigger a potential artificial opening will have insufficient outward flow to scour the channel under a higher sea level, significantly decreasing the likelihood of a successful and sustained opening. If openings are attempted at historic trigger levels under future sea level scenarios, the ocean will rapidly push sand back into the excavated channel, closing the estuary almost immediately.

With all other things remaining equal, to maintain the same likelihood of success (as present-day), the upstream water levels for opening the estuary will need to be raised in proportion with the mean sea level.

## 4.3 Shifting Triggers and Long-term Efficacy

Despite the declining effectiveness of sustained openings under the current arrangement, artificial interventions will always be successful at reducing peak flood levels for certain areas if the trigger for opening is increased.

Under higher estuary levels the openings will still always be successful, as the increased water volume will provide the necessary scouring force to keep the channel temporarily clear. Additionally, they will serve as a mechanism to reduce the flood levels upstream (albeit at a higher baseline level than at present day).

Therefore, higher sea levels and higher berm heights will naturally result in higher flood levels upstream. This systemic shift occurs with or without artificial opening, but the extreme peak flood extent is still mitigated by artificial opening. Consequently, adaptation planning will need to account for a new baseline of higher water levels within the estuary, as mechanical interventions cannot permanently offset the fundamental physical changes brought about by a rising ocean.

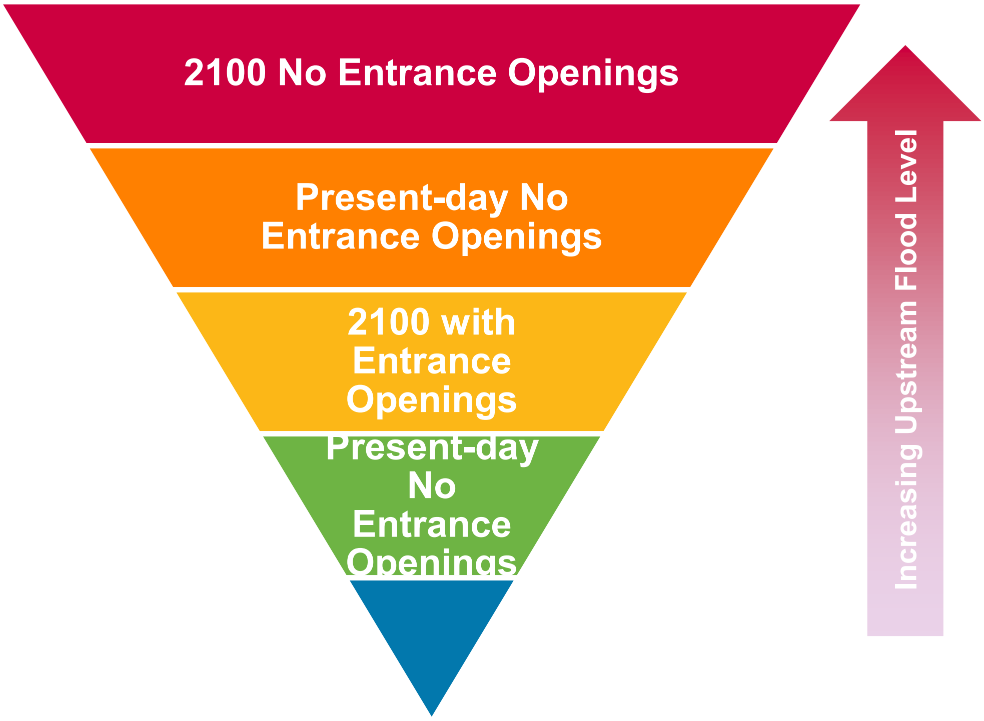


**Figure 4-1 Infographic showing comparison of future scenarios**

## 4.4 Analysis of Medium-term efficacy

McSweeney and Stout (2023) found that the hydraulic gradients required for natural openings was 1:10 or steeper. Based on typical beach slopes, this is only likely at Aireys Inlet when either the berm is overtopped by the river height, or is near overtopping and the beach erodes. There is limited data on natural openings as the entrance is typically artificially opened and such hydraulic gradients are not able to develop.

Artificial openings can be successful at lower hydraulic gradients. Typically when there is a gradient less than ~1:60, there is not enough driving force to trigger a large opening. Gradients close to this are also in a 'Zone of Risk' and may not be successful in all cases.

Based on VCMP data, the following assumed variables have been analysed:

- Beach slope (typical) – 1:10
- Slope behind berm (typical) – 1:50
- Lowest tide level achievable within a 6-hour period has been selected as 0.0 mAHD.

Based on the above, there is a 2.0 m water level difference that can be expected to be reasonably achieved under most days when the upstream water level is at or near 2.0 mAHD. For a 1:50 hydraulic gradient this requires that the berm width be less than 100m.

Using the typical beach slopes, a berm width of 100m would be likely under these water levels with a berm height of less than 3.33 mAHD.

With 1.1m of sea level rise, this maximum berm height reduces to 2.6 mAHD for the same opening success. This is not likely sustainable however, as the following high tide is likely to reach 1.91 mAHD anyway, so the inflowing tidal water will rapidly close the entrance and/or limit the outflow of flood waters.

# 5 RECOMMENDED PATHWAY PLAN

The recommended CAPPs for the three domains are as follows.

## 5.1 Precinct One

A diagram outlining the CAPP for precinct one is presented in Figure 5-1. This section of coast is subject to progressively increasing erosion and coastal hazard risk under projected sea-level rise, placing the Fairhaven Surf Club and sections of the Great Ocean Road at risk.

In the short term, risk can be progressively managed through:

- Avoidance of new development
- Monitoring of dune condition and sand volumes
- Nature-based measures including dune vegetation management and targeted nourishment at the dune toe following erosion events fronting vulnerable infrastructure.

As sea levels rise, erosion increases and sand volumes become insufficient, the pathway transitions to protective measures, including:

- Temporary rock bags, or
- Mass-nourishment to maintain a defensive buffer fronting vulnerable infrastructure.

In the medium to long term, where rock bags or mass-nourishment become structurally or economically unviable, the proposed long-term responses are either:

- Planned retreat of infrastructure landward, or
- Hard protection (i.e. a seawall), acknowledging the associated loss of beach and ongoing maintenance requirements and ongoing lateral extension to combat terminal scour.

## 5.2 Precinct Two

A diagram outlining the CAPP for precinct two is presented in Figure 5-2. This section of coast is subject to a hazard zone of potential event-based cliff collapse. This zone increases landward in response to cliff retreat in line with sea level rise. The Aireys Inlet lighthouse and several cliff top properties fall within the present-day hazard extent.

In the short term, risk can be progressively managed through:

- Avoidance through planning controls such as mandatory setbacks.
- Monitoring, supported by ongoing cliff stability assessment to identify early signs of movement or instability.
- Accommodation options are not appropriate due to the potential for sudden and catastrophic cliff failure.
- Protect through improved surface and sub-surface drainage. This can be implemented where appropriate to reduce moisture-driven erosion and instability, recognising these measures manage risk but do not prevent long-term cliff retreat

In the medium to long-term, risk can be progressively managed through:

- Planned retreat as a preferred response, with cliff-top infrastructure progressively relocated landward as monitoring indicates increasing instability leading to unacceptable risk.

- Hard protection at the cliff toe (e.g. seawalls or rock revetments) may be considered where critical assets require protection; however, these measures only reduce progressive erosion due to sea level rise at the base of the cliff and do not prevent cliff collapse, requiring acceptance of residual risk.

## 5.3 Precinct Three

A diagram outlining the CAPP for precinct 3 is presented in Figure 5-3.

The key trigger assessed for flood mitigation has been the inundation of housing and infrastructure, representing a threat to property and life. In the short term, this flood risk can be progressively managed through:

- Avoidance of new development within the flood risk zone.
- Retrofitting building materials
- Levee construction.
- Berm management, including artificial berm opening when estuary water levels reach a defined threshold (current practice), or berm grooming.

The effectiveness of artificial berm opening will progressively reduce over time as sea levels rise in the medium to long-term, via two mechanisms. Firstly, the rise in sea level will decrease the hydraulic head differential required for successful artificial berm opening, leading to an increase in failed opening attempts, leading to increased flood risk in the future. Secondly, once the berm is opened, the new channel bed level (the level the channel will scour down to) will also increase vertically in line with sea level rise. Therefore, overtime, a reduction of flow conveyance will occur, leading to higher flood levels in the estuary.

Discontinuing artificial berm opening leads to an immediate increase in flood risk compared with a berm-managed scenario. As a result, adaptation measures that would otherwise be required in the medium to long term become necessary much earlier when the berm remains closed. This effectively accelerates the need to consider accommodation, protection, and retreat options. Overall, the comparison demonstrates that estuary entrance management has a strong influence not only on the nature of required adaptation responses, but also on the timing of their implementation.

In the medium to long-term, flood risk can be progressively managed through:

- Accommodation measures, including retrofitting buildings with flood-resilient materials, are appropriate to reduce impacts where flooding cannot be fully avoided.
  - This may be undertaken through a staged approach, with progressive retrofitting of dwellings over time as properties are increasingly encompassed by the flood risk extent. Flood risk mapping should be periodically updated, with retrofitting requirements reviewed and adjusted in alignment with revised study outputs.
  - This may allow artificial entrance management to be reduced in frequency, with associated potential benefits to environmental values within the estuary.
- Planned retreat, including voluntary house purchase and managed land use transition.
  - Note: voluntary house purchase is typically conducted under a ‘buy-back’ scheme and requires a willingness of residents to sell.
  - Economic viability is largely dependent on the ratio between purchase price average annual damages.
  - This may be implemented through a staged approach, aligned with the progressive expansion of risk over time under climate change.

- Managed land use transition is a planned, gradual shift of development and land uses away from high-risk flood areas over time, using planning controls and investment decisions to reduce exposure.
- This may provide substantial opportunities to other values such as environmental, social and cultural, should the land-use be transitioned.

- Hard protection measures, such as a flood levee coupled with a road flood-gate crossing, may be implemented to manage flood risk, particularly where retreat or accommodate is not supported by the community.
  - Note: this option requires community acceptance of visual impacts.
  - This option is applicable over the short to long term, subject to the degree of flood exposure at each stage.
  - This option decreases the available space for fringing vegetation to migrate, however may allow for reduced artificial entrance management. Therefore, it prioritises estuarine and salt-marsh communities, but may impact terrestrial habitat. These systems are likely at least partially linked, so would require a specific detailed investigation to understand the likely net impacts over time.

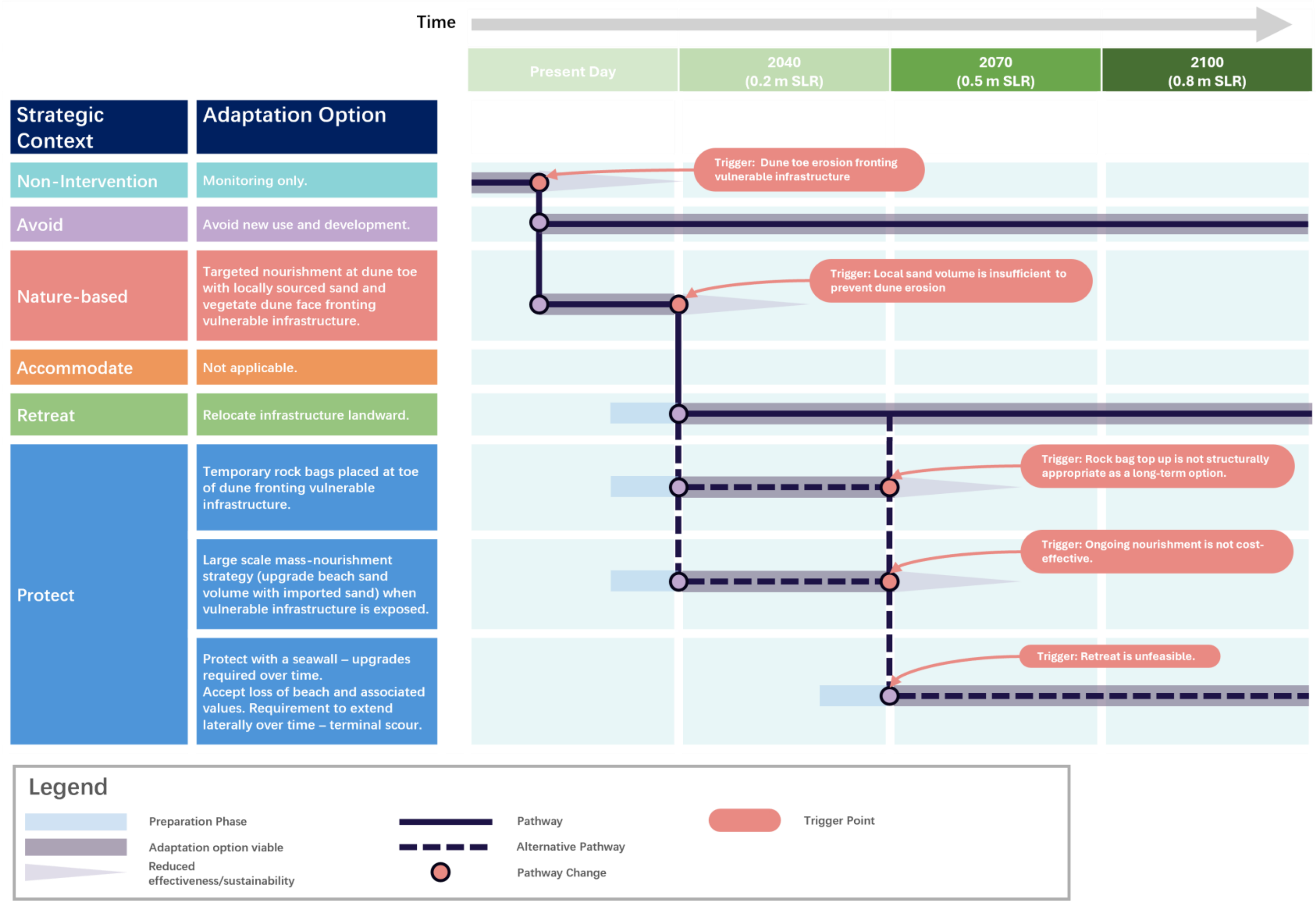


**Figure 5-1** Coastal adaptation pathway plan for Precinct One

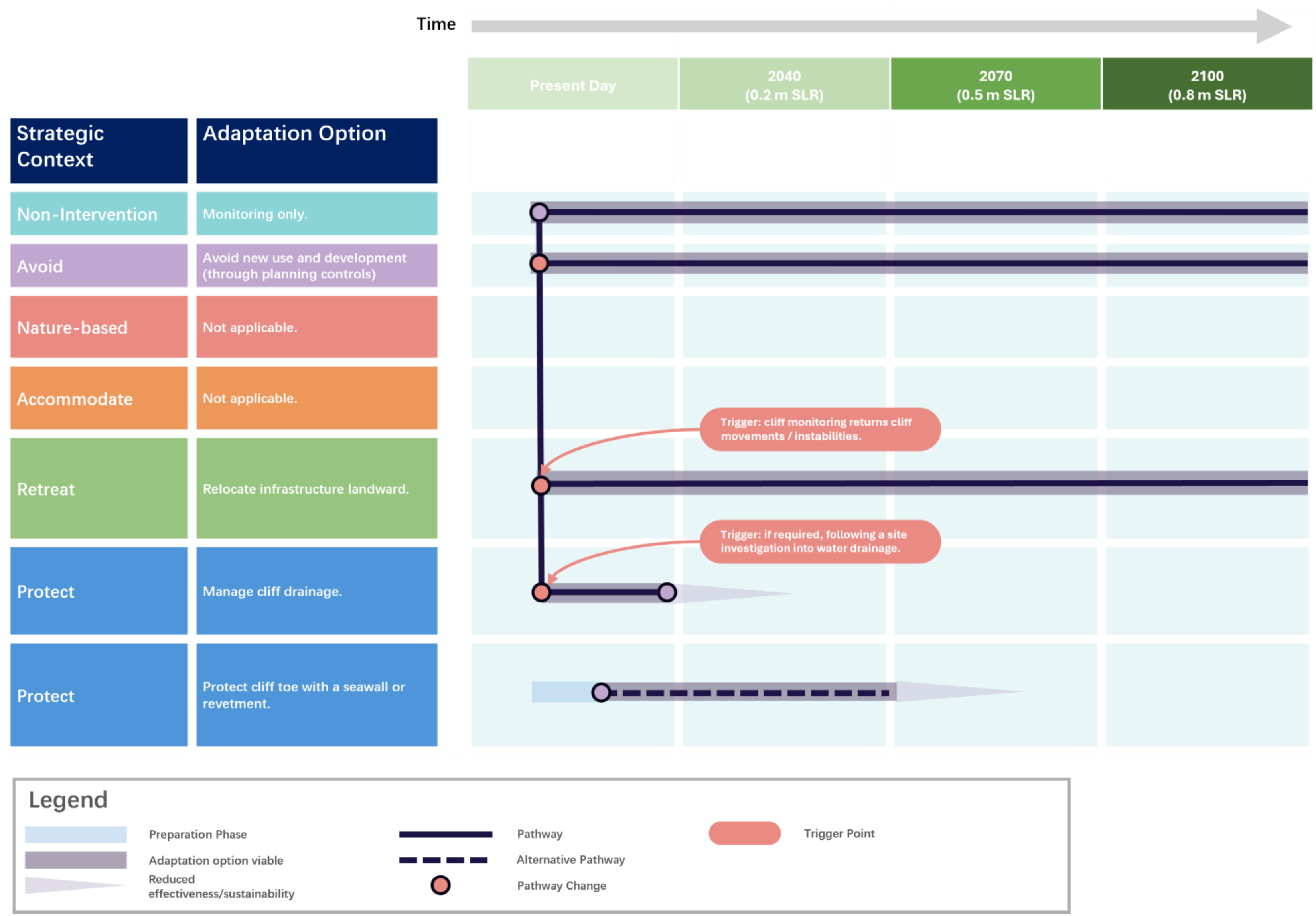


Figure 5-2 Coastal adaptation pathway plan for Precinct Two

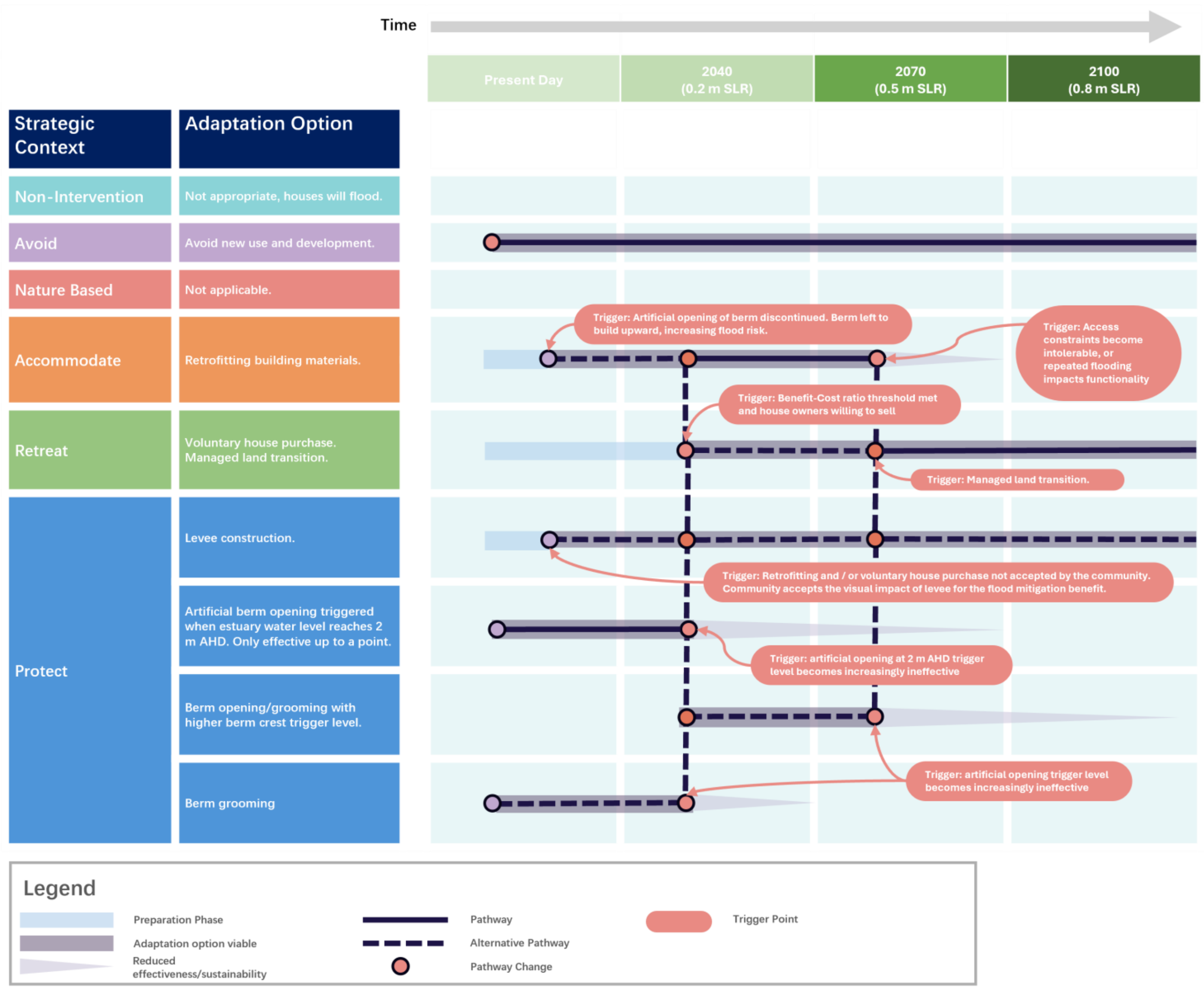


**Figure 5-3 Coastal adaptation pathway plan for Precinct Three**

# 6 SUMMARY

Coastal Adaptation Pathway Plans (CAPPs) have been developed for three coastal precincts across the study site:

- The dune-dominated open coast west of the creek (**Precinct One**)
- The cliff-dominated open coast east of the creek (**Precinct Two**)
- The Painkalac Creek estuary (**Precinct Three**)

For **Precinct One** increasing erosion under sea-level rise places the Fairhaven Surf Club and sections of the Great Ocean Road at growing risk. In the short term, risk can be managed through avoidance of new development, monitoring of dune condition and sand volumes, and nature-based measures such as dune vegetation management and targeted nourishment. As sea levels rise further, erosion intensifies, and shorelines retreat, the pathway transitions to protective measures including temporary rock bags or mass-nourishment. In the medium to long term, where these measures become unviable, the preferred long-term responses are either planned retreat of infrastructure landward or hard protection via a seawall, with acceptance of beach loss and ongoing maintenance requirements.

For **Precinct Two** hazards are driven by event-based cliff collapse and long-term cliff retreat, with the Aireys Inlet Lighthouse and several cliff-top properties already within the present-day hazard zone. In the short term, risk management focuses on avoidance through planning controls, monitoring of cliff stability, and targeted protection measures to reduce moisture-driven instability, if required. In the medium to long term, planned retreat is the preferred response as cliff erosion continues with sea level rise. Hard protection at the cliff toe may be considered for critical assets, recognising that such measures reduce marine erosion but do not prevent cliff collapse and therefore leave residual risk. However, these structures will need maintaining and upgrading over time in response to sea level rise and are not a one-stop solution.

For **Precinct Three** in the short term, flood risk can be managed through avoidance of new development within flood-affected areas, continued estuary entrance management (including artificial berm opening or grooming), construction of levee infrastructure, and retrofitting of buildings with flood-resilient materials.

If artificial berm opening is discontinued, flood risk increases immediately, accelerating the need to implement adaptation measures that would otherwise be required in the medium to long term. This highlights the strong influence of estuary entrance management on both the type and timing of adaptation responses.

Artificial berm opening plays an important role in managing flood risk in the near term; however, the effectiveness of berm opening progressively declines over time as sea-level rise reduces hydraulic head and flow conveyance.

Over the medium to long term, flood risk management will increasingly rely on accommodation, protection, and retreat measures. Accommodate approaches, such as staged retrofitting of buildings with flood-resilient materials, can reduce flood impacts. Planned retreat, including voluntary house purchase and managed land-use transition, provides a pathway to progressively reduce exposure as flood risk expands under climate change, subject to economic viability and community willingness. Such approaches should continue to be informed by regularly updated flood mapping.

Where retreat, accommodate or berm management are not supported by the community, hard protection measures, such as levees combined with flood-gate road crossings, may be considered, noting potential visual and amenity impacts. Overall, adaptation options for Precinct Three are applicable across the short to long term, with their appropriateness dependent on the evolving level of flood exposure and community preferences.

# 7 REFERENCES

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