



## **Phase 6 Identification of Adaptation Options**

### **Bundaberg Region Coastal Hazard Adaptation Strategy**

**Bundaberg Regional Council**



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## EXECUTIVE SUMMARY

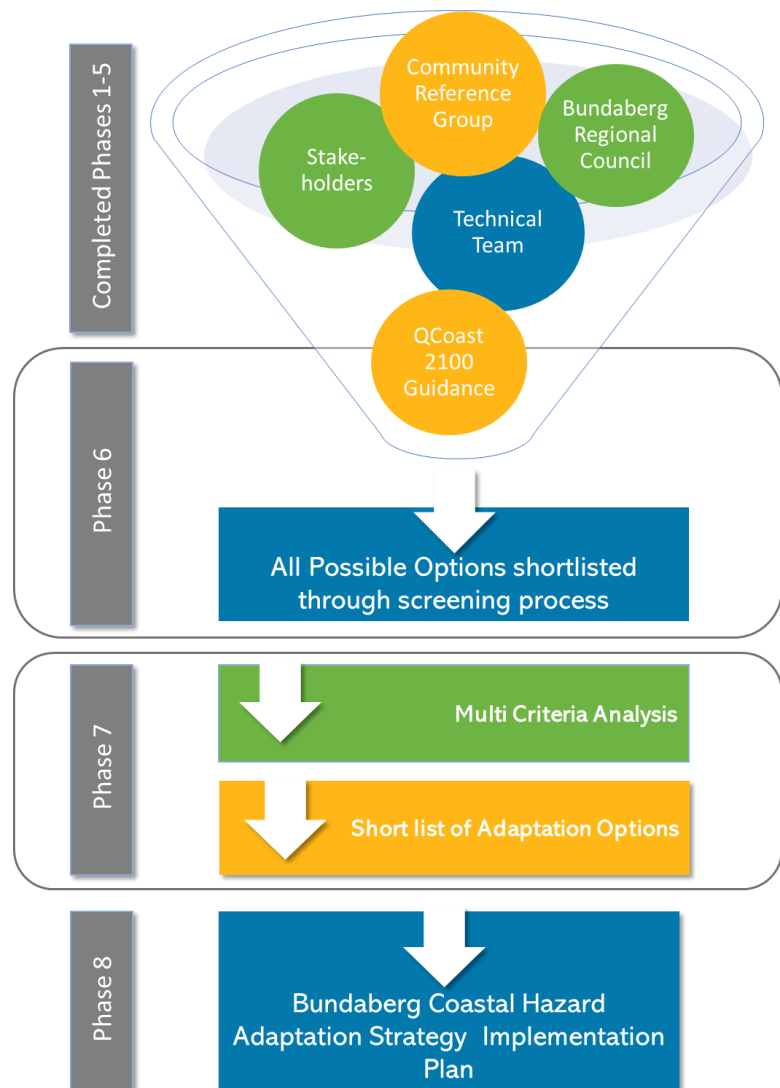
The Coastal Hazard Adaptation Strategy for the Bundaberg region will be delivered through eight phases of the QCoast2100 structure, with Phases 1-5 already complete. The early phases confirmed the scope and extent of the hazards for the Bundaberg region. The mid stages to Phase 5 is the technical analysis of the risk and exposure to determine the risk implications for specific settlements.

The Phase 6 'optioneering' is first of the phases which attempts to draw the technical information together and start the process of refining and developing options for inclusion in the closer analysis of Phase 7 and the final Phase 8 strategy. Phase 6 contemplates a long list of suggested mitigation and adaptation options. The optioneering process in this report is guided by a range of inputs:

- the first principles of the Bundaberg Coastal Hazard Adaptation Strategy which were developed by stakeholders and are outlined in section two of this report;
- the settlement visioning which was developed through discussion with the community and stakeholders and through analysis of the planning scheme. It is provided in section three of this report;
- the long list of potential adaptation options is worked through in section five in an optioneering process. This applies the option to the risk implications of each settlement which stems from Phase 5 and is outlined in section four. The process integrates the vision of the settlement to arrive at a shortened list of adaptation options to take forward into Phase 7; and
- initial screening of the shortened list of options in section six in table format by settlement. This initial screening broadly considers the community values, cost, benefits, constraints and efficacy to decide on the progression of that option into Phase 7.

The diagram summarises how Phase 6 fits into the overall adaptation option appraisal process and the inputs which contribute to the shortened list which will progress to Phase 7.

### PHASE 6 – OPTIONEERING PROCESS AND RELATIONSHIP TO PHASE 7 & 8 MODEL





The Phase 6 work does not decide a defined adaptation pathway, but rather determines the options which are most suitable to address the risk. The long list of options outlined in this report stems from the compendium and best practice guidance. Phase 6 considers the options within the following three adaptation categories:

- **'Maintain'** is an option usually applied where the risk requires action to reduce or maintain the current risk level. These include constant work in the areas of disaster management, land use planning, asset planning and maintenance, and community education and awareness programs. These activities do not lessen or remove the risk or the hazard.
- **'Modify'** options are generally proposed in settlements where the risk becomes intolerable and include physical options such as seawalls, beach nourishment or storm surge barriers. The nature of the risk at some settlements means physical intervention against one hazard is not effective in protecting the entire community from all hazards. This is the case at Moore Park Beach and Woodgate Beach. In some cases, defensive options may only be an interim adaptation method
- **'Transform'** options are applied where risk is intolerable, these include land use and tenure transition to change land use over time by acquiring the land. Land use and tenure transition is complex due to high capitalisation of coastal land and is generally only appropriate in certain circumstances.

Section six takes each settlement and adaptation option through the screening process using criteria including a broad cost estimate, an outline of the benefits and impacts of each adaptation option, whether the option is effective against the hazard, whether it aligns with the principles and the adaptation scenario for change.

The tables are arranged by place from north to south and provide a summary text of the above criteria with symbology to assist understanding of the range of variables. Concluding the screening is a decision pathway for each adaptation option to move into Phase 7. The decision pathways are:

- **Considered and short listed** for inclusion in the final adaptation strategy. These options are automatically included in the final adaptation strategy
- **Considered and short listed for the multi-criteria analysis.** These options will undergo further analysis in the Phase 7 work to determine suitability for the final adaptation strategy
- **Considered and not preferred.** These options are possible, but for one or more of the screening options present some challenges such as excessive cost or environmental impacts and likely do not align with the principles. These options will also undergo additional analysis in Phase 7 to determine suitability for the final strategy; and
- **Considered and ruled out.** These options have been omitted from the Phase 7 analysis due to clear conflict with multiple screening criteria.

The concluding decision pathway of the tables in section six of this report, is replicated in a diagram below to show the number of options screened and the number which will progress to Phase 7. The diagram simplifies the optioneering process to provide results at a glance. The yellow shapes on the left provide the list of options considered and discussed in this report. The green headings provide the nine settlements which have been considered as part of this project. The blue dividing bars categorise the options into the three adaptation strategies of maintain; modify and transform. The legend shows the adaptation option decision pathway moving forward to Phase 7.

Draft adaptation pathways are provided in section seven which informs the basis of the final strategy. The pathways will undergo further refinement once the multicriteria analysis is complete in Phase 7.



Phase 6									
All Possible Options									
Best practice , Land Use Planning, Design Options, Engineering Options	Miara W'field	Moore Park Beach	Burnett Heads	Bargara	Innes Pk & Coral Cove	Elliott Heads	Coonarr	Wood-gate Beach	Buxton
Maintain									
Disaster Management	✓	✓	✓	✓	✓	✓	✓	✓	✓
Education and Awareness	✓	✓	✓	✓	✓	✓	✓	✓	✓
Building Retrofitting	✗	✗	✗	✗	✗	✗	✗	✗	✗
Land Use Planning	✓	✓	✓	✓	✓	✓	✓	✓	✓
Resilient Infrastructure	—	✓	✓	✓	✓	—	—	✓	—
Roads and Access	—	✓*	—	—	—	—	✓*	✓*	—
Erosion Monitoring	✓	—	—	✓	—	—	✓	✓	✓
Modify									
Beach Nourishment	—	✓	—	✓	✓	—	✓	✓	—
Wetland Restoration	—	—	—	—	—	—	—	—	—
Artificial Reefs	—	—	—	✗	✗	—	✗	✗	—
Breakwaters	—	—	—	—	—	—	—	—	—
Seawalls	—	✓	—	✓	✓	—	✓	✓	—
Groynes	—	—	—	⊘	—	—	—	⊘	—
Dykes	—	—	—	—	—	—	—	—	—
Storm Surge Barriers	—	—	✓*	—	—	—	—	—	—
Transform									
Land Swap	✓	✓	✓	—	—	✓	—	—	—
Land use and tenure transition	—	—	⊘	⊘	⊘	⊘	✓	✓	✓
Key: — Not Applicable    ✓ Considered and Shortlisted    ⊘ Considered and not preferred    ✗ Considered and Ruled Out * Multiple options considered / partially shortlisted									

#### OPTIONEERING SUMMARY BY SETTLEMENT



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## 1 INTRODUCTION

### 1.1 Background to Coastal Hazard Adaptation Planning

Over the last few years, the Queensland coast (and specifically the Bundaberg Region) has experienced disasters which have resulted in significant economic costs and societal impacts. In response, Bundaberg Regional Council has pro-actively developed a unique perspective on the concepts of, approaches to, and challenges involved in building resilience and undertaking activities to adapt to changing circumstances. Relevantly, current projections for Queensland's coastline by 2100 indicate:

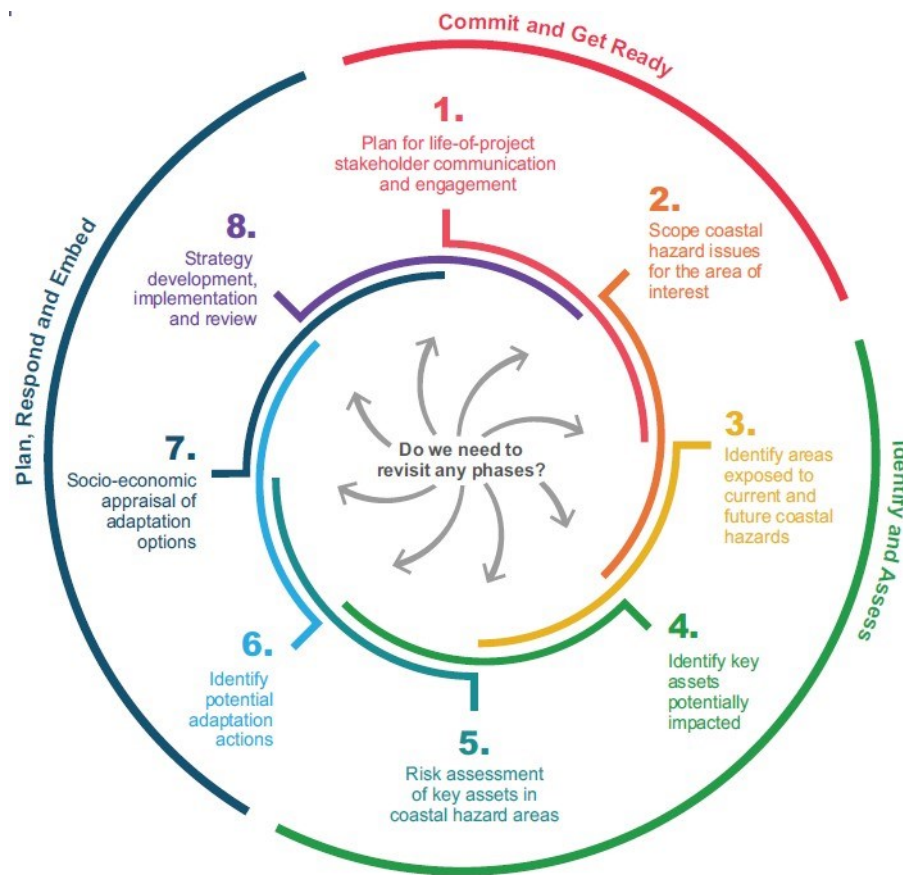
- a projected sea level rise of 0.8 m; and
- tropical cyclones are projected to become less frequent but those tropical cyclones that do occur are expected to be more intense and may track further south.

The likely impacts associated with these changes mean that rising sea levels combined with storm tides are likely to cause accelerated erosion and increased risk of inundation. For settlements and infrastructure this is likely to result in damage to and loss of dwellings and infrastructure with community-wide impacts. For ecosystems, sea level rise may lead to loss of habitat, and salinisation of soils may cause changes to the distribution of plants and animals. The impact of increasing coastal hazards will affect Queensland Councils in the areas of:

- litigation and legal liability;
- community expectations;
- land use planning and development assessments; and
- asset and infrastructure planning and management

In response to this, the Coastal Hazards Adaptation Program (QCoast2100) program was developed to provide Councils in Queensland with assistance to advance coastal hazard adaptation planning. The Program will facilitate the development of high-quality information enabling defensible, timely and effective local adaptation decision-making through access to tools, technical and expert support and grants for eligible Councils. The Coastal Hazard Adaptation Strategy (CHAS) program will be delivered through eight phases and each of the phases can be categorised under three themes:

- Commit and get ready
  - Phase 1: Plan for life-of-project stakeholder communication and engagement (Completed 2017)
  - Phase 2: Scope coastal hazard issues for the area of interest (Completed 2017)
- Identify and assess
  - Phase 3: Identify areas exposed to current and future coastal hazards (Completed 2019)
  - Phase 4: Identify key assets potentially impacted (Completed 2019)
  - Phase 5: Risk assessment of key assets in coastal hazard areas (Completed 2019)
- Plan, respond and embed
  - Phase 6: Identify potential adaptation options (current phase)
  - Phase 7: Socio-economic appraisal of adaptation options
  - Phase 8: Strategy development, implementation and review



**FIGURE 1-1 CHAS PROJECT PHASES**

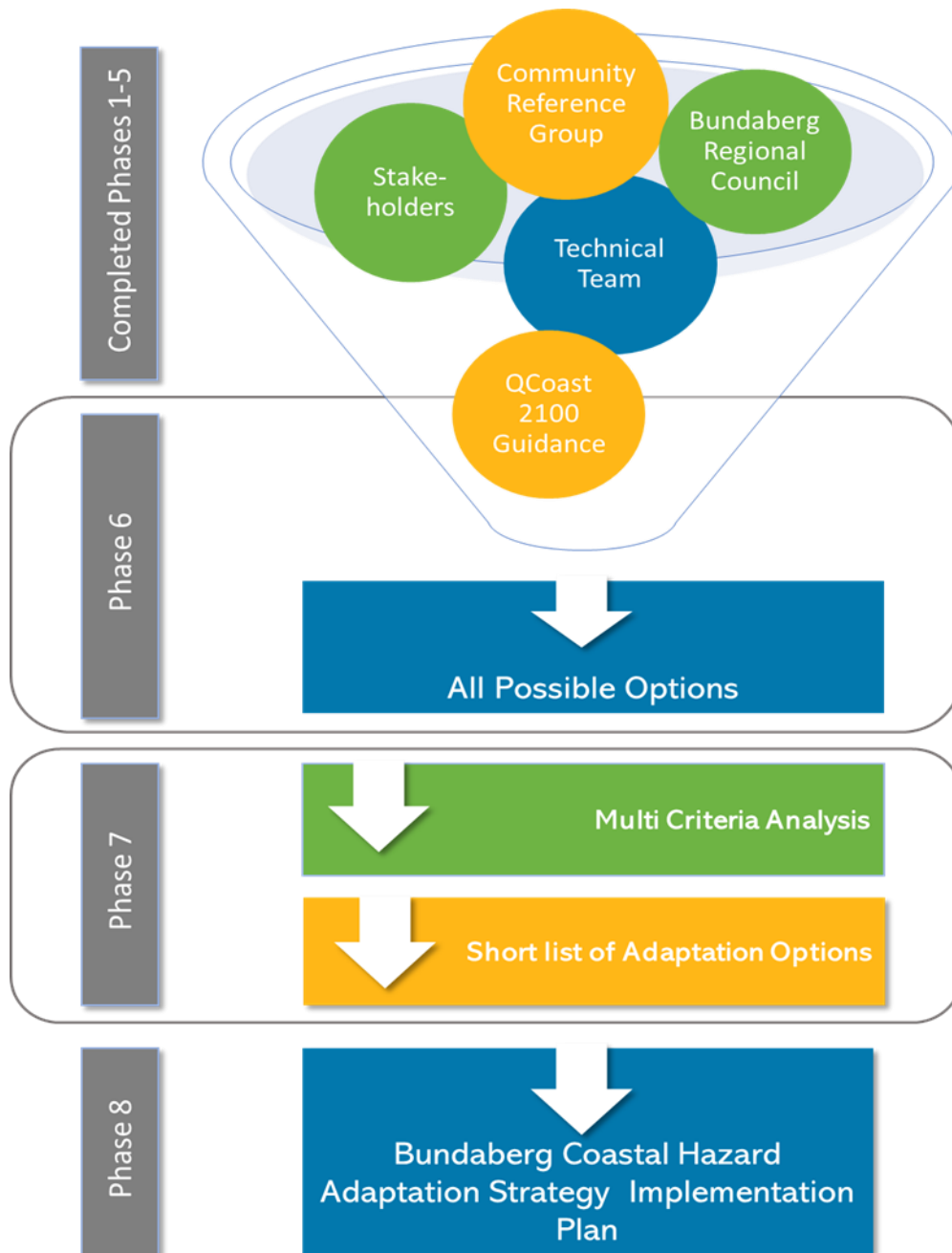
This report documents the Phase 6 tasks in a unique methodology developed specifically for Bundaberg.

## 1.2 Phase 6 – Identification of Adaptation Options

In accordance with the QCoast (2016) *Developing a Coastal Hazard Adaptation Strategy Minimum Standards and Guidelines for Queensland Local Governments*, the purpose of Phase 6 is to identify and evaluate potential adaptation options to reduce or eliminate the risks identified in Phase 5. The Phase 6 minimum requirements include:

- identification of potential options using the categories of maintain, modify and transform;
- conducting a workshop with stakeholders to inform the option identification process;
- selecting appropriate adaptation options; and
- preparing an adaptation options document informed by the workshop and the options considerations criteria

This is a simple explanation of a relatively complex process of considering a range of criteria against numerous options in an initial screening process. Phase 6 is part of the overall appraisal process that brings together the data and findings of the phases to date to develop the reasonable list of options for adaptation. Phase 7 refines the adaptation pathways using multiple criteria and cost benefit analysis prior to deciding a final adaptation strategy in Phase 8. The process integrates the technical risk assessment with the settlement visions to arrive at a shortened list of adaptation options to take forward into Phase 7. Figure 1-2 illustrates how the long list of options has been created and filtered to inform this stage and the final two stages of the project. The previous work has been drawn together in Phase 6 as follows:



**FIGURE 1-2 CHAS OPTION APPRAISAL PROCESS**

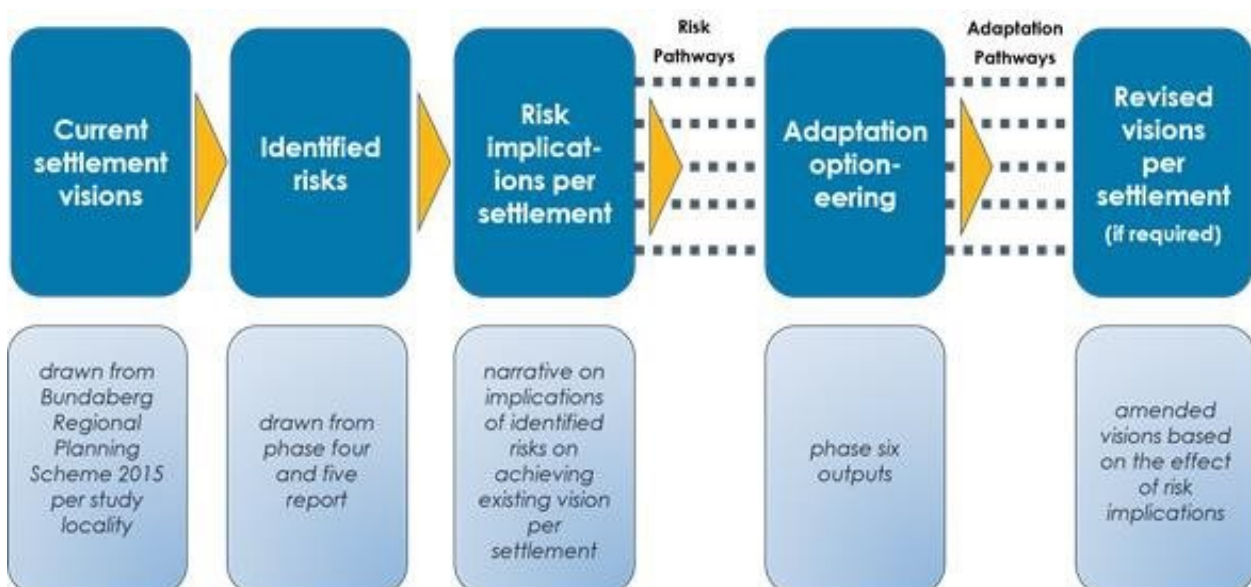
- the first principles of the Bundaberg CHAS were developed by stakeholders and are outlined in section two of this report. These represent ground rules for the options and were explored using the five lines of resilience which stem from Queensland Government policy frameworks;
- the settlement visioning was developed through discussion with the community and stakeholders and through analysis of the planning scheme, the intended growth for that settlement considering the Local Government Infrastructure Plan, the zoning and settlement pattern narrative of the strategic framework of the Bundaberg Region Planning Scheme 2015. The vision is a summary for each settlement and is provided in section three of this report;

- the risk implications of each settlement which stems from Phase 5 is outlined in section four, again in order of settlements. Each risk implications table provides details on the asset at risk, the likely scenario for the risk and some commentary.
- the long list of potential adaptation options is worked through in section five in an optioneering process. Examples and images are provided of the adaptation options where they are structural and non-structural options are also explored through design, land use planning and land use and tenure transition.
- the list of adaptation options then goes through an initial screening activity in section six in a table format of options by place. This initial screening takes into consideration the community values, cost, benefits, constraints and efficacy to decide on the progression of that option into Phase 7. Section six also has some Council-wide and non-place-based recommendations.

The process integrates the technical risk assessment with the settlement visions to arrive at a shortened list of adaptation options to take forward into Phase 7. The funnel above shows how Phase 6 draws in other components of the work to arrive at a shortlist of options for Phase 7. The stakeholders and community reference group has provided the first principles for the project and continued support each phase. Council also provides continued support, feedback, policy direction and guidance through the planning scheme, asset management and existing programs which address either disaster management or coastal processes.

The technical team has provided engineering and structural solutions with appropriate high-level cost estimates, advantages and disadvantages. The technical information includes an environmental impacts report, similarly, outlining the considerations for each adaptation option. Vision statements for each settlement to apply to the risk implications have been developed, and the adaptation pathways methodology introduced which will take the project through Phase 7. All supporting reports and investigations are found in the accompanying Technical Appendix document.

QCoast 2100 provides the minimum standards, technical and policy guidelines, process steps and funding arrangements to Phase 6. There are two primary modifications to the minimum standards which Phase 6 incorporates. These modifications enhance the minimum standards and are considered to contribute rigour to the process through tailoring to local conditions and are incorporated into Figure 1-3.



**FIGURE 1-3 COASTAL HAZARD RISK AND ADAPTATION ENHANCED METHODOLOGY**

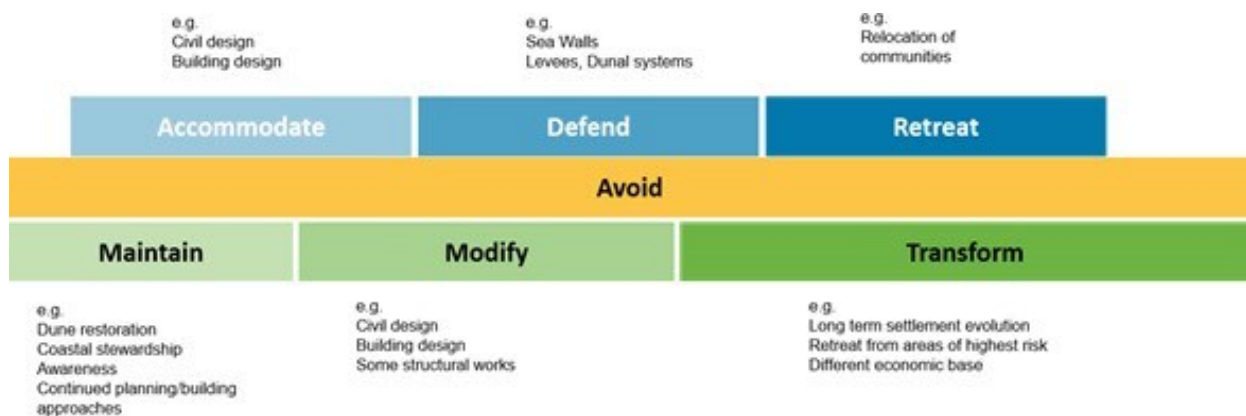




Firstly, the project team undertook a visioning exercise which is provided in section three of this report. The purpose of the exercise is to align the risk implications of Phase 5 to the planned vision for that settlement. In this way the community perspective on how settlements are expected to evolve over time could be given context with the risk assessment.

The second modification stemmed from stakeholder feedback on the digestibility of the strategy to the Bundaberg community. While terminology and language used by technicians is accepted and understood, this is not always the case for the general public. Terms such as 'retreat' and 'defend' are quite strong and may conjure similarly strong reactions from readers.

In recent collaboration with the CSIRO, it was discovered that using more understandable terminology is more easily accepted to describe risk and resilience processes and the CSIRO is moving to language in line with the translation model we have developed for Bundaberg shown in Figure 1-4. This uses simplified terms of maintain, modify and transform.



**FIGURE 1-4 REVISED LANGUAGE MODEL**

The language has been modified for the entirety of the CHAS reporting process.

### 1.3 Evaluation process for structural adaptation options

As part of the Phase 6 methodology, a high-level evaluation of identified structural options is included to address the risks identified in the previous CHAS phases. The key coastal hazards likely to impact this region were identified in Phase 3, and five priority settlements were identified as being subject to intolerable risk in Phase 5.

#### 1.3.1 Sensitivity analysis and conceptual design

In Phase 6, a sensitivity analysis will assess the extent and timeframe of each coastal hazard, and conceptual designs produced in the form of maps, illustrating indicative structural option locations. The indicative location of the identified adaptation option has been mapped using a straightforward GIS approach, these maps include locations for raising key access roads and 'structural options' such as seawalls, breakwaters, groynes etc. The maps show the 'before' and 'after' coastal hazard extent that provides the basis for the evaluation in this report and can be found in Appendix D and Appendix E and show the structural options and key access roads in the priority suburbs identified as being subjected to intolerable risk in Phase 5:

- Moore Park Beach
- Burnett Heads
- Innes Park



- Coonarr
- Woodgate

A sensitivity analysis for key coastal hazard event and sea level rise scenarios has been undertaken for each physical option to refine the extent and timeframe for implementation of adaptation.

### **1.3.2 Meeting QCoast2100 guidelines – holistic screening process**

As per the CHAS Minimum Standards and Guidelines (QCoast2100, 2016) the identification and selection of adaptation options has been mindful of the risks of maladaptation, where the social and environmental costs of the adaptation are higher than the actual benefits. Therefore, Phase 6 includes a screening process that considers the system including indicative costs, benefits, possible adverse impacts and challenges and likely effectiveness of the adaptation option.





## 2 PRINCIPLES FOR ADAPTATION

In June 2019 the project team facilitated a workshop with the Community Reference Group in Bundaberg to tease out the first principles of the Bundaberg CHAS. Through discussion, the workshop explored the principles for adaptation across the four themes of:

- resilient economy; resilient environment; resilient settlements; and resilient society

The workshop provided principles upon which the future actions, policies and recommendations can be based, tested and supported for future decision-making. Table 2-1 shows the foundation principles for adaptation recorded at the workshop. These principles are used as a benchmark in the initial screening process and taken forward into the tables in section six using the four lines of resilience. The simple symbology is used in section six: a tick if the option accords with the principle and a cross where it doesn't.

**TABLE 2-1 PRINCIPLES FOR ADAPTATION**

Theme	Principles for Adaptation
<b>Resilient Economy</b>	<ul style="list-style-type: none"> <li>■ create stronger relationships with the media – positive stories on the economy – before and after events; use 'Bundaberg Now' as an option and the more channels the better;</li> <li>■ incentivise tourism activities outside the hazard areas; and</li> <li>■ modify economic dynamics over time while maintaining economic vitality.</li> </ul>
<b>Resilient Environment</b>	<ul style="list-style-type: none"> <li>■ allow natural processes to happen as much as possible including coastal dynamics;</li> <li>■ communicate environmental changes using real examples and case studies;</li> <li>■ maximise the use of healthy, mature and resilient wetlands to buffer the community;</li> <li>■ protect cultural and valuable sites, e.g. shell middens; and</li> <li>■ recognise the need for partnerships and collaboration e.g. QPWS.</li> </ul>
<b>Resilient Settlements</b>	<ul style="list-style-type: none"> <li>■ maintain commercial centres resilient to coastal hazards;</li> <li>■ locate and design infrastructure sensitively;</li> <li>■ ensure new development adapts and considers risk;</li> <li>■ maintain multiple ways in and out from key locations;</li> <li>■ step adaptation pathways over time in a tailored approach;</li> <li>■ building design is critical; and</li> <li>■ ensure risk areas are clearly identified.</li> </ul>
<b>Resilient Society</b>	<ul style="list-style-type: none"> <li>■ maintain the connectivity of people and place;</li> <li>■ assist the community to overcome any fear of loss and create personal adaptation strategies;</li> <li>■ raise awareness of future frequency and intensity of events;</li> <li>■ raise awareness with knowledge and education on risk;</li> <li>■ communicate the 'real' situations during disaster events;</li> <li>■ a connected community drives success; and</li> <li>■ maintain confidence in our places and region.</li> </ul>

These principles are applied to the summaries and recommendations at the end of this Phase 6 report. A summary of all Community Reference Group meetings, community and stakeholder engagement undertaken for this project will be documented as part of Phase 8.



### 3 SETTLEMENT VISIONING

This brief analysis of the future visions for the Bundaberg coastal villages and settlements has been prepared to ascertain whether the current level of risk in each locality is appropriate given the growth and economic vision for the future.

There are a range of elements which make up the vision for a locality, city or region in the planning framework. A summary of the elements, which contribute to the visions, are shown in Table 3-1. The elements include the mandatory Local Government Infrastructure Plan (LGIP) and the visionary statements of the planning scheme to 2031, found in Part 3 of the Bundaberg Region Planning Scheme 2015. Some localities with particular attributes or characteristics benefit from a more detailed Local Area Plan. Zone codes also provide mandatory purpose statements.

These elements are applied to a place-based summary for each locality emerging as unique and short vision statements for the CHAS. It is noted that the areas intending to change have been provided with a short narrative, however some localities are intended to remain the same and thus a narrative is not needed. Further and more detailed information on the elements and considerations in the statutory framework for planning is provided in the accompanying Technical Appendix.

#### 3.1 Planning Visioning Elements

This table sets out the planning framework visioning elements, contents and purpose.

**TABLE 3-1 PLANNING VISION ELEMENTS**

Visioning Element Description	Purpose	Outcomes
<b>Strategic Framework</b> <b>Part 3</b> of a planning scheme sets out the strategic vision for the region to 2031.	<p>The strategic framework sets the vision for a region, localities and special area. It is achieved across a number of themes such as settlement pattern, environment and economy.</p> <p>These themes and visions should be consistent throughout the scheme document.</p>	<p>The scheme <b>lists settlements which are expected to contribute to population growth</b>. Winfield, Buxton, Coonarr and Miara are not mentioned as population centres.</p> <p>The scheme is relatively clear on targeted growth and which should remain as a settlement contributing to character and diversity.</p>



Visioning Element Description	Purpose	Outcomes
<b>Local Government Infrastructure Plan</b> The adoption of an LGIP into a planning scheme in <b>Part 4</b> , consists of a boundary area map which shows the area where the local government intends to provide services over the life of the planning scheme.	<p>Each local government in Queensland must prepare plans for trunk infrastructure under the Planning Act (Qld) 2016.</p> <p>The purpose of an LGIP is to integrate infrastructure planning with the land use planning identified in the planning scheme, matching infrastructure needs with projected growth to 2031.</p> <p>It enables local government to cost capital works and infrastructure projects, budget for it and in turn charge infrastructure charges transparently.</p>	<p>The LGIP boundary area map reveals that Buxton, Winfield, Coonarr, Elliott Heads (south), and Miara are outside the LGIP priority area. This means Council does not intend to provide trunk infrastructure to these areas in the period to 2031.</p> <p>Areas of Coral Cove, Elliott Heads (north), Innes Park, Moore Park Beach, Bargara, Burnett Heads, and Woodgate Beach are inside the LGIP boundary. This means that Council intends to provide trunk services.</p>
<b>Local Area Plans</b> Found in <b>Part 7</b> of a planning scheme.	<p>Local area plans allow special precincts to be nominated, provide opportunity for more detailed planning and allow variation on planning outcomes specific to a locality and its characteristics.</p>	<p>The Bundaberg Planning Scheme contains the <b>Central Coastal Urban Growth Area Local Area Plan</b> which is especially relevant to the CHAS. This plan establishes the hierarchy of centres and associated functions from Burnett Heads to Elliott Heads.</p>
<b>Zone Code Purpose</b> statements. Found in <b>Part 6</b> of the planning scheme.	<p>Each zone has a <b>mandatory purpose statement</b>. The purpose statement describes what the zone intention is and the outcomes it seeks to achieve. A full list of the zones used in the study area is found in <b>Appendix A</b>.</p>	<p>The coastal study area includes 14 zones:</p> <ul style="list-style-type: none"> <li>3 Urban residential zones;</li> <li>Community Facilities zone;</li> <li>Rural and rural residential zones;</li> <li>Emerging community zone for growth;</li> <li>3 Centre (commercial) zones;</li> <li>3 Green zones; and</li> <li>a limited-development zone for constrained land.</li> </ul>

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Additional information on the mandatory and statutory component of the planning framework as it applies to coastal hazards is contained in the Technical Appendix including the application of the State Planning Policy.

This review is based on the planning scheme version 4.1. It is noted that there is currently a major amendment package No. 5 on public consultation at the time of writing, which includes some changes which may influence the visions, especially at Burnett Heads. Since the adoption of the scheme in 2015 the Bundaberg Port State Development Area (SDA) was expanded in 2017 and Council adopted the Burnett Heads Town Centre Local Area Plan (LAP) in late 2017. The LAP drove some proposed changes to the planning scheme, rather than being incorporated in its entirety.



In 2018, Council received funding to undertake works to enhance the Burnett Heads Town Centre and enliven the LAP. In 2019, the major amendment package incorporated some changes to this area including bringing in the updated SDA area and incorporating the Burnett Heads boat harbour in the Coastal Growth Centre Local Area Plan map.

### 3.2 Settlement Vision Statements

This section synthesises the above information to prepare vision statements for each of the settlements. Each settlement vision includes an initial summary vision statement and, in some cases, a more detailed paragraph including economic, growth and infrastructure statements. Where no growth is proposed, a second more detailed paragraph was not warranted. The figures below show the zone and LGIP features and a summary table provides a criterion at a glance.

Each settlement has been provided with a place typology in the heading which attempts to reflect the vision for that locality. The four place typologies are:

- **Destination Coastal Growth Hub** for Bargara reflecting its primacy in the coastal urban growth plan;
- **Coastal Townships** for Moore Park Beach and Woodgate reflecting small amounts of local centre and community use zones with services sufficient to support residences and modest growth visions;
- **Coastal Growth Centres** for Burnett Heads, Innes Park, Coral Cove and Elliott Heads reflecting their role in providing residential growth and supported by services at Bargara; and
- **Coastal Character Villages** for Buxton, Winfield, Miara and Coonarr reflecting the visions for limited growth and services.



**FIGURE 3-1 BUNDABERG PLACE TYPOLOGIES**

These typologies are shown in Figure 3-1 and are interspersed by rural and natural amenity landscapes. The visions for each settlement are brought into the screening process by considering the vision in the context of the risk implications for each settlement (from Phase 5) to determine any conflict and help shape the final adaptation options. The vision statements for each settlement in the study area is set out below from north to south.





### 3.2.1 Miara, Norval Park and Winfield

**Miara, Norval Park and Winfield are coastal character villages which will retain current form, preserving the distinctive character that reflects their connection with the landscape and the history of the region. They are almost entirely un-serviced.**

Miara is a small settlement of only 21 allotments, of which 13 are either vacant or only contain non-habitable shed structures. Winfield has a water service and is a small settlement of about 121 allotments with seven vacant. Both contain Low Density Residential (LDR) zone for existing development however Miara has the remaining properties zoned as Limited Development (constrained land). This zone type is used to limit development on historic subdivisions which applies to a number of localities within the Bundaberg Regional Council area. These dispersed settlements are separated by areas of rural and natural amenity landscape.

The areas between Miara to the south and Winfield to the north include Norval Park, Yandaran and Mullet Creek. These areas are entirely within the rural and environmental management and conservation zones. Each allotment has development rights for a dwelling house. There are a number of other dispersed structures and settlements on Baffle Creek including Rocky Point just upstream from Winfield and Gil Bas Point just downstream. These are private properties which feature beach shacks and camping areas. Norval Park features an aquaculture industry and isolated patches of intensive agriculture. The landscape is typically low-lying with coastal vegetation communities. There are no plans for infrastructure or growth in this area.



**FIGURE 3-2 MIARA LGIP BOUNDARY**



**FIGURE 3-3 WINFIELD ZONE MAP**



**FIGURE 3-4 MIARA ZONE MAP**

**TABLE 3-2 MIARA, NORVAL PARK AND WINFIELD SUMMARY**

Miara and Winfield	Summary
LGIP	All settlements are outside the LGIP boundary. Winfield has a partial water service.
Growth	Limited growth is envisaged in these areas.
Zones	Low density residential and large Limited development areas. The Miara tourist park is zoned Community facilities. The coast areas between is entirely within the rural and environmental management and conservation zones.

### 3.2.2 Moore Park Beach

**Moore Park Beach is a coastal township which will cater for modest growth reflecting and preserving character, identity and history of the relaxed coastal settlement. It supports facilities and services for local residents and visitors drawing its character and lifestyle from surrounding natural features.**

The smaller townships of the region such as Moore Park Beach and Woodgate Beach will be maintained generally in their current form, preserving the distinctive character that reflects their connection with the landscape and the history of the region, while continuing to develop in ways that service their locality and contribute to their long-term sustainability. Growth is modest and the lifestyle of these more remote villages focusses on a relaxed lifestyle on the pristine coastline.



FIGURE 3-5 MOORE PARK BEACH LGIP BOUNDARY



FIGURE 3-6 MOORE PARK BEACH ZONE MAP

TABLE 3-3 MOORE PARK BEACH SUMMARY TABLE

Moore Park Beach	Summary
LGIP	The land zoned for urban uses is inside the LGIP which excludes rural residential portion.
Growth	Moore Park Beach has a small area zoned for modest growth.
Zones	The village has a distinct rural residential area without services, mostly low density with some medium density, a small area of local centre zone and supporting open space and community zones.



### 3.2.3 Burnett Heads

**Burnett Heads is a coastal growth centre, with public foreshore parks providing open space and recreation opportunities. It services locals and the region with employment opportunities at the port and is provided with the full range of urban infrastructure.**

Burnett Heads remains separated from Bargara by natural areas and is part of the coastal urban growth area, accommodating significant levels of growth in accordance with local area structure planning. Growth is not anticipated at Burnett Heads in the life of this planning scheme given the extent of the infrastructure planning in the LGIP. The locality includes some constrained land. Port and marina operations should not be impacted by sensitive development. Enterprise outside the port is confined to local centre activities.



FIGURE 3-7 BURNETT HEADS LGIP BOUNDARY



FIGURE 3-8 BURNETT HEADS ZONE MAP

TABLE 3-4 BURNETT HEADS SUMMARY TABLE

Burnett Heads	Summary
LGIP	All existing areas are inside the LGIP boundary however none of the land in the emerging community zone is planned for infrastructure.
Growth	Growth is not expected in the life of the planning scheme to 2031.
Zones	Low and medium density, rural residential, emerging community zone, and limited development zones. Large areas of strategic port land at the mouth of the Burnett River. Some local centre zone land.

### 3.2.4 Bargara

**Bargara is the commercial and service hub for the Coastal Urban Growth Area. It is the primary tourism destination and provides services for coastal settlements. Its seaside setting with coastal themes and sub-tropical architecture influences development form as it grows to meet demand.**

Bargara is the main service centre for the central coastal urban area between Burnett Heads and Elliott Heads. It accommodates business and employment options in a compact format, meeting the needs of an expanding resident and visitor population. Niche shopping and dining areas, boutique shops, restaurants and eateries overlook the oceanfront and foreshore parkland in a vibrant centre. Non-residential uses complement tourist accommodation and enhance the attractiveness and function as a visitor destination. The district centre complements the role and function of Bundaberg City. Development is responsive to the sub-tropical climate and is sympathetic to the scale and character of surrounding development, including the Queensland 'coastal beach' vernacular. Bargara accommodates diversity in housing choice and is provided with all urban infrastructure.



FIGURE 3-9 BARGARA LGIP BOUNDARY

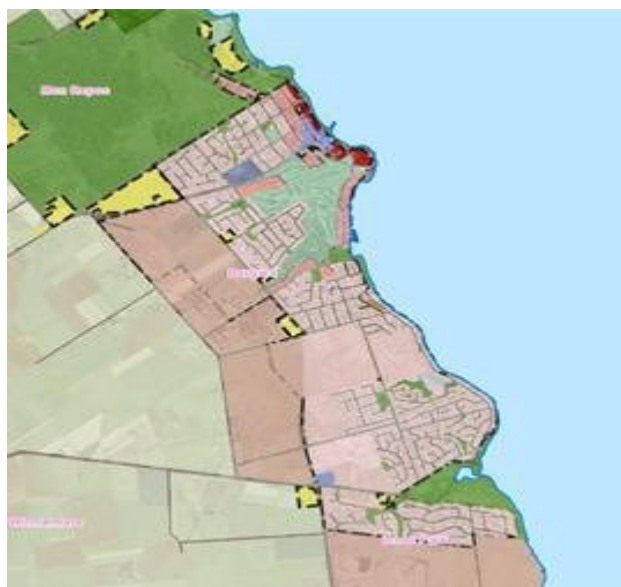


FIGURE 3-10 BARGARA ZONE MAP

TABLE 3-5 BARGARA SUMMARY TABLE

Bargara	Summary
LGIP	All established areas within the LGIP and about 40 per cent of the emerging community zoned land.
Growth	Significant growth is anticipated except for the interface between Innes Park and Bargara.
Zones	Low, medium and high density residential, emerging community, local and district centre and supporting community and open space zones

### 3.2.5 Innes Park and Coral Cove

**Innes Park and Coral Cove will contribute significantly to the urban growth of Bundaberg's coastal growth centres, supporting the full range of residential opportunities in a low-medium density format. Liveability and amenity are enhanced by the surrounding natural environment.**

Innes Park and Coral Cove will form part of the chain of sophisticated urban settlements between Elliott Heads and Burnett Heads. They will provide a quality lifestyle relaxed, coastal settlements, with public foreshore parks providing large public open space and recreation facilities, and a setting for community gatherings. The growth settlements support Bundaberg city focusing on residential development for lifestyle and amenity on the pristine coastline. The large growth areas will provide predominantly low-density residential development.



FIGURE 3-11 INNES PARK LGIP MAP



FIGURE 3-12 INNES PARK ZONE MAP

TABLE 3-6 INNES PARK AND CORAL COVE SUMMARY TABLE

Innes Park and Coral Cove	Summary
LGIP	Coral Cove and Innes Park are both within the LGIP boundary.
Growth	They will contribute significantly to residential growth in the future. There is significant capacity in the areas zoned low density residential and almost all the emerging community land is outside the life of the planning scheme.
Zones	Principally low density with some medium density residential. Large areas of sport and recreation zones. Small local centre zone areas and supporting community and open space zones.



### 3.2.6 Elliott Heads

**Elliott Heads is the southern-most coastal growth centre, with public foreshore parks providing open space and recreation opportunities. It is provided with the full range of urban infrastructure.**

The north of Elliott Heads completes the coastal urban growth areas that support Bargara. The locality has significant capacity within the LGIP and current low-density zone to accommodate growth to 2031. Small amounts of medium density zone can accommodate infill development. Elliott Heads is a relaxed residential area with predominantly low-density housing which supports Bargara as the coastal service centre. The lifestyle focusses on proximity to the pristine coastline.

The LGIP separates the locality into two distinct areas: Elliott Heads growth area and the traditional coastal village at the mouth of the Elliott River known as Riverview. The visions for these two areas are distinctly different: one for growth and one that is expected to have no growth and no increase in services.



FIGURE 3-13 ELLIOTT HEADS SUMMARY



FIGURE 3-14 ELLIOTT HEADS ZONE MAP

TABLE 3-7 ELLIOTT HEADS SUMMARY TABLES

Elliott Heads	Summary
LGIP	Partially included in the LGIP boundary.
Growth	Large tracts of land are targeted for growth at Elliott Heads but about 90% of this is outside the LGIP and not anticipated before 2031.
Zones	Low density residential with some medium density. Significant areas of emerging community zone. A small local centre zone and supporting open space and community zones.

### 3.2.7 Riverview (Elliott Heads South) – Coastal Character Village

Riverview (Elliott Heads south) is a coastal locality which will retain its current form, preserving the distinctive character that reflects their connection with the landscape and the history of the region. Riverview is mostly un-serviced.

Areas of rural and natural amenity landscape separate this coastal character village from the coastal growth areas. The Riverview area lies completely outside the LGIP area. The foreshore is surrounded by esplanade areas in the open space zone.



FIGURE 3-15 RIVERVIEW (ELLIOTT HEADS SOUTH) ZONE MAP

TABLE 3-8 RIVERVIEW (ELLIOTT HEADS SOUTH) SUMMARY

Elliott Heads (South)	Summary
LGIP	The locality is not included in the LGIP boundary.
Growth	No growth is forecast.
Zones	The area is entirely low density residential with approximately 11 vacant allotments.

### 3.2.8 Coonarr

**Coonarr is a coastal character village which will retain its current form, preserving the distinctive character that reflects their connection with the landscape and the history of the region. Coonarr has no urban infrastructure.**

The coastal character villages such as Buxton and Coonarr are separated by areas of rural and natural amenity landscape which reflects the inherent traditional cultured and relaxed lifestyle of the Bundaberg area. Coonarr is outside the local government infrastructure planning area. It features a small number of homes on the foreshore and rural residential development further inland.

The coastal areas at risk are shown in an enlargement below. There are nine coastal allotments. One is zoned open space and is part of the public esplanade, eight are private property, of which two are vacant (number 17 and 21 in Figure 3-16) and six have dwellings constructed: one on the south side of the access road and five on the north side.



**FIGURE 3-16 COONARR ZONE MAP WITH A RISK PROPERTY ENLARGEMENT**

**TABLE 3-9 COONARR SUMMARY TABLE**

Coonarr	Summary
LGIP	Coonarr is outside the LGIP boundary and is not serviced by any networks except roads.
Growth	Coonarr is a limited growth area.
Zones	Coonarr is a rural zone area with pockets of rural residential zone where there are approximately 10 vacant allotments.

### 3.2.9 Woodgate Beach and Walkers Point – Coastal Townships

**Woodgate Beach is a coastal township which will cater for modest growth reflecting and preserving character, identity and history of the relaxed coastal settlement. It supports facilities and services for local residents and visitors drawing its character and lifestyle from surrounding natural features.**

The smaller towns and villages of the region such as Moore Park and Woodgate Beach will be maintained generally in their current form, preserving the distinctive character that reflects their connection with the landscape and the history of the region, while continuing to develop in ways that service their locality and contribute to their long-term sustainability. Growth is modest and the lifestyle of these more remote villages focusses on a relaxed lifestyle on the pristine coastline.



FIGURE 3-17 WOODGATE BEACH LGIP BOUNDARY



FIGURE 3-18 WOODGATE BEACH ZONE MAP

TABLE 3-10 WOODGATE BEACH SUMMARY TABLE

Woodgate Beach	Summary
LGIP	The settlement area of Woodgate Beach is inside the LGIP
Growth	Woodgate Beach has a small area zoned for modest growth in the life of the planning scheme.
Zones	The village is mostly low density residential with some medium density, a small area of limited development zone, local centre zone and supporting open space and community zones.



### 3.2.10 Buxton

**Buxton is a coastal character village which will retain its current form, preserving the distinctive character that reflects the connection with the landscape, especially lifestyle allotments on the Burrum River and the history of the region. Buxton has no urban infrastructure**

Buxton includes a small area of low-density zoned homes on the Burrum River. Many are older and the village is separated by a drainage line shown as open space area in green on the zone map. Further upstream there is an extensive rural residential settlement on the Isis River before it joins the Burrum.



**FIGURE 3-19 BUXTON ZONE MAP**

**TABLE 3-11 BUXTON SUMMARY TABLE**

Buxton	Summary
LGIP	The area is outside the LGIP boundary and is not serviced by any urban networks except roads.
Growth	Buxton is a limited growth area.
Zones	The Isis River area features rural residential development. The Buxton village on the Burrum River is only low density residential however there are a significant number of vacant allotments (approx. 97). This is likely because there is no reticulated water.





## 4 RISK IMPLICATIONS

This section translates the risk assessment from the Phase 5 report to a place-based analysis of the implications of that risk level.

### 4.1 Miara, Norval Park and Winfield

The risk profile for the settlement study area indicates that risk from both storm tide inundation and coastal erosion remains in the tolerable range under all sea level scenarios. That said, Miara Road is likely to experience increasingly frequent inundation under all sea level scenarios and is likely to become permanently inundated under a 0.8 m sea level rise scenario. Due to the moderate adaptive capacity of the semi-permanent structures in the Miara Caravan Park, this is not deemed a catastrophic impact. The table below shows the priority assets in the area and summarises the risk implications.

**TABLE 4-1 RISK IMPLICATIONS – MIARA, WINFIELD AND NORVAL PARK**

Asset	Scenario	Comments
Beach and environmental assets	0.0 m - already occurring	The shoreline in this coastal settlement area and river frontage along Baffle Creek are subject to inundation and coastal erosion under present day conditions. These beach and environmental assets are considered highly critical to the settlement areas. Monitoring the erosion and impacts on the key environmental features is required here.
Residential buildings	0.0 m - already occurring	Residential buildings are exposed to coastal hazard, but risk is considered tolerable across all sea level scenarios due to moderate economic impacts on buildings.  The settlement study area is not identified for future growth, so action will be required to ensure the current risk level is maintained to people and property.
Roads / access Road bridges	0.8 m sea level rise	Miara Road is considered a key access route to the Miara Caravan Park and is likely to be permanently inundated in the 0.8 m sea level rise scenario. The social consequence analysis has considered this to be a tolerable risk due to the adaptive capacity of the semi-permanent structures in the caravan park.
Electricity distribution station	0.0 m - already occurring	Electricity distribution stations are exposed to coastal hazard, but risk is considered tolerable across all sea level scenarios, due to moderate economic impacts. The settlement is not identified for future growth intent, so action will be required to ensure services are continued to be provided to the existing settlements.

### 4.2 Moore Park Beach

Moore Park Beach has been identified as a priority area for adaptation to future coastal hazards. The main issues at Moore Park Beach relate to coastal erosion of the shorefront, permanent inundation causing isolation of communities and the economic impacts of coastal hazard causing an intolerable risk profile under a 0.4 m sea level rise scenario. The table below provides a summary of the risk implications for the settlement of Moore Park Beach.



**TABLE 4-2 RISK IMPLICATIONS – MOORE PARK BEACH**

Asset	Scenario	Comments
Drainage system	0.0 m - already occurring	The tidal gates in the Fairydale Drainage System are currently overtopped above king tide events. The system specifically manages tidal flows to cane lands east of Moore Park Beach.
Beach and other environmental assets	0.4 m sea level rise	The beach and other low-lying environmental assets are currently exposed to coastal erosion and storm tide inundation, but the risk to the settlement becomes intolerable under a 0.4 m sea level rise scenario.
Water supply (inc groundwater supply)	0.4 m sea level rise	Whilst the water treatment plant at Vecellios Road is not exposed, further consideration and consultation is required to understand the impacts of sea level rise and saltwater intrusion upon groundwater supply in the area.
Electricity powerlines and substation	0.4 m sea level rise	The overall asset class is exposed in all sea level scenarios but the risk to the settlement becomes intolerable under a 0.4 m sea level rise scenario.
Moore Park Beach School	0.4 m sea level rise	A small portion of school buildings are exposed in all sea level scenarios but the risk to the settlement becomes intolerable under a 0.4 m sea level rise scenario.
Roads / access Road bridges	0.8 m sea level rise	Moore Park Road, Murdochs Linking Road, and Lindemans Road are considered key access routes to the settlement of Moore Park Beach and are likely to be permanently inundated in the 0.8 m sea level rise scenario. The social consequence analysis has considered this to be catastrophic and therefore an intolerable risk due to the likely isolation of the community.

### 4.3 Burnett Heads

Burnett Heads has been identified as an area subject to extreme risk of storm tide inundation. Burnett Heads is not subject to isolation, but many highly critical services are subject to intolerable risks under a 0.8 m sea level rise scenario. With some growth expected in the area and to continue servicing the community, new infrastructure and upgrades to existing services will need to be built with coastal hazard factored into the design

**TABLE 4-3 RISK IMPLICATIONS – BURNETT HEADS**

Asset	Scenario	Comments
Roads / access Road bridges	0.8 m sea level rise	Roads and bridges are likely to become inundated with increasing sea levels. However, there are alternative evacuation routes for all communities, so isolation is not a consideration at Burnett Heads.
Electricity distribution station, water supply, stormwater, wastewater treatment and waste disposal	0.8 m sea level rise	Many key services are critical to functioning of Burnett Heads settlement. Under a 0.8 m sea level rise scenario, the economic impacts are considered intolerable and therefore adaptation options will need to be actioned to continue servicing the needs of the residential community.



Asset	Scenario	Comments
Beach and environmental assets	0.8 m sea level rise	The beaches and other low-lying environmental assets are currently exposed to coastal erosion and storm tide inundation, but the risk to the settlement becomes intolerable under a 0.8 m sea level rise scenario.

#### 4.4 Bargara

Within Bargara, there are a range of risk levels. Kellys Beach (north and south) has had coastal erosion mapping refined as part of Phase 3. The coastal erosion risk to residential properties at Kellys Beach is considered intolerable. This is driven by the economic consequences of a coastal erosion impact upon the properties. Nielsen's Beach and the Bargara foreshore have been identified by Council as areas that may require further investigation as erosion events are occurring under present day conditions. The results of the risk evaluation from coastal erosion in Kellys Beach is considered tolerable under present-day sea level conditions. This increases to intolerable under a 0.8 m sea level rise scenario.

**TABLE 4-4 RISK IMPLICATIONS - BARGARA**

Asset	Scenario	Comments
Residential buildings	0.8 m sea level rise	Residential properties adjacent to the shoreline at Kellys Beach are subject to erosion risks. Under a 0.8 m sea level rise scenario, the impacts to these buildings is considered catastrophic.
Water supply, powerlines	0.8 m sea level rise	Highly critical assets that provide key services to Bargara are exposed to intolerable coastal hazard risks. Bargara is a settlement identified to grow and continue to be an important hub for the Bundaberg coastal region. Services to support this growth are expected to be provided, so adaptation of new and updated infrastructure is recommended because under a 0.8 m sea level rise scenario, the economic impacts upon buildings and infrastructure are considered intolerable.
Beach and other environmental assets	0.0 m already occurring	Nielsen's Beach and the Bargara foreshore are subject to erosion under present day conditions. These beach assets are considered highly critical to Bargara as a coastal destination hub and area of high growth. Monitoring the erosion and further investigation of potential mitigation measures are required here.

#### 4.5 Innes Park and Coral Cove

The settlement area of Innes Park and Coral Cove has been identified as an area for further refinement of the coastal erosion mapping in Phase 3. The shoreline of Innes Park is subject to erosion risks considered intolerable. Coral Cove is typified by a rocky foreshore, however, there are still assets and features mapped as being at risk to coastal erosion under a 0.8 m sea level rise scenario.



**TABLE 4-5 RISK IMPLICATIONS – INNES PARK AND CORAL COVE**

Asset	Scenario	Comments
Sewer mains, water supply	0.8 m sea level rise	Highly critical assets that provide key services to Innes Park are exposed to intolerable coastal hazard risks. New and upgraded infrastructure that provide services to support the continued moderate growth in this location will require adaptation because under a 0.8 m sea level rise scenario, the social impacts upon the community are considered intolerable.
Beach and other environmental assets	0.0 m – already occurring	Innes Park foreshore are subject to erosion under present day conditions. These beach assets are considered highly critical here to maintain the community value of coastal living. As a settlement with moderate residential growth expected, impacts upon the beach and environmental assets capacity to uphold community values in this location will need to be monitored over time.

#### 4.6 Elliott Heads

The risk profile for the settlement indicates that risk from both storm tide inundation and coastal erosion remains in the tolerable range under all sea level scenarios. That said, the risk present in the settlement is driven by economic impacts to residential buildings and associated infrastructure. The table below shows the priority assets in the area and summarises the risk implications.

**TABLE 4-6 RISK IMPLICATIONS – ELLIOTT HEADS**

Asset	Scenario	Comments
Residential buildings	0.0 m - already occurring	Residential properties along the Elliott River are subject to erosion risks. Under a 0.8 m sea level rise scenario, the impacts to these buildings are considered major and action will be required to ensure the risk profile to the communities is maintained under future sea level scenarios.
Water supply, powerlines	0.0 m - already occurring	Highly critical assets that provide key services to the smaller settlements in this locality are exposed to tolerable coastal hazard risks. New and upgraded infrastructure that provide the services to support the moderate residential growth expected in Elliott Heads will need to adapt to ensure the risk profile to this community is not increased, and that risk remains tolerable under all sea level scenarios.
Beach and other environmental assets	0.0 m – already occurring	Elliott Heads and the Elliott River mouth are subject to erosion under present day conditions. These beach assets are considered highly critical to the settlement areas. As a settlement with moderate residential growth expected, impacts upon the beach and environmental assets capacity to uphold community values in this location will need to be monitored over time.

#### 4.7 Coonarr

The coastal settlement of Coonarr has been identified as a priority area for consideration in Phase 6. The main issues at Coonarr relate to coastal erosion of the shorefront, permanent inundation causing isolation of the small community and the associated social impacts of coastal hazard causing an intolerable risk profile under a 0.2 m sea level rise scenario. Coonarr Beach Road is likely to experience permanent inundation under a 0.2



m sea level rise scenario, causing likely isolation of the properties along Coonarr Beach and loss of access for the public. Table 4-7 below shows the priority assets in the area and summarises the risk implications.

**TABLE 4-7 RISK IMPLICATIONS - COONARR**

Asset	Scenario	Comments
Roads / access	0.2 m sea level rise	Coonarr Beach Rd is the only access to properties on Coonarr Beach and is likely to be permanently inundated in the 0.2 m sea level rise scenario. The social consequence analysis has considered this to be catastrophic due to the likely isolation of the small community.
Powerlines	0.2 m sea level rise	Highly critical assets that provide key services to this locality are exposed to intolerable coastal hazard risks. New and upgraded infrastructure that provide the services to the existing settlements will need to continue to support the functioning of the settlement. There is minimum growth expected in Coonarr.
Beach and other environmental assets	0.0 m – already occurring	Coonarr shoreline is subject to erosion under present day conditions. These beach assets are considered highly critical to the settlement areas. The impacts of hazards upon the beach and environmental features will need to be monitored over time.

#### 4.8 Woodgate Beach and Walkers Point

Woodgate Beach and Walkers Point have been identified as a priority area for consideration in Phase 6. The main issues at Woodgate Beach relate to coastal erosion of the shorefront, permanent inundation causing isolation of communities and the associated social and economic impacts of coastal hazard causing an intolerable risk profile under a 0.4 m sea level rise scenario. The coastal settlement of Woodgate Beach and Walkers Point contain a large residential population and is expected to experience moderate growth into the future.

**TABLE 4-8 RISK IMPLICATIONS – WOODGATE BEACH AND WALKERS POINT**

Asset	Scenario	Comments
Residential buildings	0.4 m sea level rise	Residential properties in both Woodgate Beach and Walkers Point are subject to erosion risks. Under a 0.8 m sea level rise scenario, the impacts to these buildings is considered major and action will be required to ensure the risk profile to the communities is reduced under future sea level scenarios.
Roads/access	0.4 m sea level rise	Walkers Point Road, Woodgate Road, Acacia Street, and Theodolite Creek Drive are considered key access routes to the settlement of Woodgate Beach and Walkers Point and are likely to be permanently inundated in the 0.4 m sea level rise scenario. The social consequence analysis has considered this to be catastrophic due to the likely isolation of the community.
Powerlines, stormwater, wastewater treatment and waste disposal	0.4 m sea level rise	Highly critical assets that provide key services to the settlements in this locality are exposed to intolerable coastal hazard risks. New and upgraded infrastructure that provide the services to support the modest residential growth expected in Woodgate Beach will need to adapt due to the intolerable risk profile under a 0.4 m sea level rise scenario.



Asset	Scenario	Comments
Beach and other environmental assets	0.0 m – already occurring	Woodgate Beach and Walkers Point shoreline and backwaters are subject to inundation and coastal erosion under present day conditions. These environmental assets are considered highly critical to the settlement areas. Monitoring the erosion and impacts on the key environmental assets is required here.

#### 4.9 Buxton

The coastal settlement of Buxton situated on the Burrum River, is considered to have a risk profile from both storm tide inundation and coastal erosion hazard that remains in the tolerable range under all sea level scenarios. That said, the risk present in the settlement is driven by economic impacts to residential buildings and associated infrastructure from coastal erosion. Existing coastal erosion issues in the settlement will require ongoing monitoring and investigation into possible mitigation measures required. Action will be required to ensure the risk profile within Buxton remains in the tolerable under all future scenarios. Table 4- 9 below shows the priority assets in the area and summarises the risk implications.

**TABLE 4-9 RISK IMPLICATIONS - BUXTON**

Asset	Scenario	Comments
Residential properties	0.0 m – already occurring	Residential properties along the Burrum River in Buxton are subject to inundation and coastal erosion risks in present-day sea-level conditions. Action will be required to ensure the risk profile to the communities is maintained under all future sea level scenarios.
Powerlines	0.0 m – already occurring	Highly critical assets that provide key services to Buxton are exposed to tolerable coastal hazard risks. New and upgraded infrastructure that provide the services to support the settlement will need to continue to ensure the risk profile stays in the tolerable range.
Beach and other environmental assets	0.0 m – already occurring	Buxton is subject to erosion under present day conditions. Key shoreline and environmental assets are considered highly critical to the settlement. Monitoring the erosion and further investigation of potential mitigation measures are required here.



## 5 ADAPTATION OPTIONS

Options for adaptation are drawn from the following categories in accordance with QCoast 2100 Guidelines (2016):

- Avoid the risk
- Accommodate the hazard
- Defend from the hazard; or
- Retreat from the hazard zone

These are the categories QCoast2100 requires the adaptation options to use however the team has taken on board modified language emerging from research by the CSIRO and will use maintain, modify and transform:

- **'Maintain'** is an option usually applied where the risk requires action to reduce or maintain the current risk level. These include constant work in the areas of disaster management, land use planning, asset planning and maintenance, and community education and awareness programs. These activities do not lessen or remove the risk or the hazard.
- **'Modify'** options are generally proposed in settlements where the risk becomes intolerable and include physical options such as seawalls, beach nourishment or storm surge barriers. The nature of the risk at some settlements means physical intervention against one hazard is not effective in protecting the entire community from all hazards. This is the case at Moore Park Beach and Woodgate Beach. In some cases, defensive options may only be an interim adaptation method.
- **'Transform'** options are applied where risk is intolerable, these include land use and tenure transition and change in land use over time by acquiring the land. Land use and tenure transition is complex due to high capitalisation of coastal land and is generally only appropriate in certain circumstances.

The need to avoid risk in the first instance is a mainstay of natural hazard policy. The three adaptation terms have been adopted for the entirety of the Bundaberg CHAS and will be used in the Phase 8 strategy document.

### 5.1 Leading practice

Leading practice prioritises the selection of adaptation options according to the following hierarchy from QCoast 2100 Guidelines (2016):

1. Avoid placing new assets into hazard areas and transition existing assets out over time;
2. Build resilience by protecting or reinstating natural coastal ecosystems;
3. Build community resilience by providing the means to strengthen their capacity to absorb stress and maintain economic, social and cultural functions;
4. Adapt existing and future assets to maintain the level of service and settlement patterns; and
5. Modify existing assets or settlement patterns to endure the impacts of defined events.

This broadly aligns with the principles put forward by the community and stakeholders in section two of this report such as continued education and awareness and allowing natural processes to continue as much as possible.

### 5.2 Current Coastal Hazard Management Practices

Existing coastal hazard adaptation measures within Bundaberg Regional Council are summarised below, Table 5-1 considers existing policies, procedures and measures currently in place. The CHAS process will bring together these existing tools in one strategy that mitigates coastal hazard now and into the future.





**TABLE 5-1 EXISTING ADAPTATION MEASURE IN COUNCIL**

Management Tool	Description
Policies	<p>Council's corporate plan and vision outlines the intention to maintain sustainable and affordable essential services, sustainable built and natural environment and involve the community in planning, management and protection of natural resources and ecosystems.</p> <p>Corporately, a focus on adaptation and resilient infrastructure will need to be included to ensure sustainable services are provided.</p> <p>Council is also committed to delivery of education and community awareness programs and to increase community resilience to disaster events.</p> <p>The Bundaberg Planning Scheme ensures sustainable development via multiple elements: flood hazard mapping, storm tide hazard mapping, zoning, local government infrastructure plan. Council continues to ensure land use planning policy addresses contemporary and emerging planning matters.</p> <p>Water and sewerage infrastructure planning takes the lead from the planning scheme and will continue to meet industry and legislative standards, there is also a Wide Bay Burnett Regional Organisation of Councils standard for wastewater approvals that provides a regional benchmark.</p> <p>Other key infrastructure networks funded by Council will continue to enhance and review standards and infrastructure specifications with a broader commitment to focus on the impacts of climate change.</p> <p>And finally, Local Laws such as bathing reserves and permissible coastal activities are implemented and enforced by Council to meet statutory requirements that reflect the community's interest.</p>
Procedures	<p>The Local Disaster Management Plan (LDMP) for Bundaberg details the disaster management structure, roles and responsibilities and guidance for preparedness, prevention, response and recovery. The Local Disaster Management Group is constantly monitoring implications for the environment and infrastructure emanating from the Australian Government outputs on climate change.</p> <p>Council will continue to adapt the LDMP based on updated mapping and knowledge with due consideration on existing and future infrastructure, evacuation centres, the changing nature of communications and the ability to warn people. Council currently provides community education on storm tide and disseminates storm tide evacuation plans.</p> <p>Water and waste operation plans identify priorities year to year to deliver the corporate plan. Similarly, environmental operational plans undertake works in sensitive areas up and down the coast. The CHAS will help to provide strategic direction for operations.</p> <p>Implementation of the Woodgate SEMP which provides a framework for the sustainable use, development and management of foreshores at risk of erosion along Woodgate Beach.</p>





Management Tool	Description
Management Measures	<p>Council's asset management and maintenance schedules rely on a number of assumptions including future population growth and climate change to deliver capital forecasts</p> <p>Council implement a plan of long-term maintenance and monitoring of erosion in Winfield, Bargara, Nielson Park; and Buxton and will implement an operational works to maintain beach access to the communities of these suburbs.</p> <p>With regards to water supply, the suburb of Moore Park Beach is already monitored regularly and there is intention to maximise surface water use and utilise a low-pressure system which is resilient to groundwater ingress. Council is also monitoring the effects of sediment movement near the water supply overflow pipes in Bargara.</p>

### 5.3 Description of Options

Griffith University Centre for Coastal Management and GHD Pty Ltd have prepared *The Compendium*, a guidance on coastal adaptation options for coastal ecosystems and the built environment. *The Compendium* groups coastal hazard adaptation options into four themes to assist in identifying and evaluating potential response options:

- regenerative options, including beaches, dunes, riparian vegetation and wetlands restoration;
- coastal engineering options, including a range of structures for erosion and flood control;
- human settlement design options, covering building and infrastructure retrofitting and design, and the raising of land levels; and
- planning options, including development setbacks, land use and tenure transition and change in land use over time by acquiring the land.

The Bundaberg Region CHAS will also consider disaster management and community education and awareness measures as an effective method of reducing risk from coastal hazards now and into the future.

#### 5.3.1 Environmental Considerations

The Bundaberg region is well known as a turtle nesting locality with major sites at Mon Repos. There is already local protection for turtles in a number of local policies such as the planning scheme. Turtle eggs are laid within a few metres above or below the Highest Astronomical Tide (HAT), and these areas are consequently highly vulnerable to impacts from sea level rise and storm surge.

The State Government has recently introduced a Temporary Local Planning Instrument (TLPI) to strengthen protection of turtles from development. This provides an interim policy response to protect sea turtles from the adverse impacts on sea turtle nesting and activity, and to provide greater certainty to building heights at Bargara. While Mon Repos is the most significant beach for turtle nesting in the area, there is also significant nesting at Moore Park Beach and Bargara, with turtles also nesting in lower numbers at other beaches in the area including Coonarr and Woodgate. Combined, this may result in some beaches increasing in importance as turtle nesting areas.

In addition to turtle nesting, other environmental considerations are discussed in the FRC report in the Technical Appendix. The environmental considerations report has been prepared to support the optioneering process and determine significant environmental issues which may arise from the options put forward. The report considered:

- the significance of local rocky and coral reefs to beach morphology;



- shallow offshore reefs in some localities;
- shallow offshore sea grasses;
- tidal flushing of mangroves, lagoons and wetland areas and subsequent water quality issues;
- dunal erosion or retreat due to interventions; or
- beach nourishment which may impact turtle nesting;
- complete loss of tidal and complex vegetation including fish habitat from extensive works; and
- complete loss of fish movement and connectivity including restrictions of tidal water flows.

The recommendations of this report are included in section six tables, as part of the benefits and impacts discussion.

### 5.3.2 Regenerative Options

#### BEACH NOURISHMENT / DUNE REGENERATION

Beach nourishment is the artificial addition of sand to a beach system, increasing the buffer against erosion or halting erosional losses. Beach nourishment reduces the risk of storm tide inundation when combined with dune creation and vegetative stabilisation.

A long-term beach nourishment strategy requires continuous monitoring of shoreline changes to identify timing of renourishment campaigns. Monitoring campaigns are typically carried out annually or in response to significant erosion events. Monitoring campaigns can be conducted with remote cameras or traditional survey techniques. Operational plans to mobilise sand in the short term from strategic sand deposits should be put in place to reduce risks for settlements and infrastructure during emergencies.

Negative environmental impacts of depositing additional sand on the foreshore are minimal, assuming the sand is installed outside of the turtle nesting hatching season. In addition, sand is not placed over rocky foreshores or seagrass beds, is of a similar particle size to the sand already on the beach and is placed gradually, allowing vegetation to colonise. It has been assumed the sand is sourced from offshore and will not result in the depletion of sand on nearby beaches.



**FIGURE 5-1 BEACH NOURISHMENT – OFFSHORE SAND PUMPING**

## **WETLAND RESTORATION**

Wetland restoration is used to stabilise sediments and reduce coastal erosion, with the additional advantages of contributing organic resources that benefit adjacent fisheries, intercepting nutrients and sediments from terrestrial runoff and facilitating carbon sequestration.



### 5.3.3 Coastal Engineering Options

The indicative location of the adaptation option identified has been mapped using a simple GIS approach, and these maps available in the Appendix D showing a 'structural option' such as seawalls, breakwaters, groynes etc and the anticipated 'before' and 'after' coastal hazard extent. This provides the basis for the evaluation in this report.

When considering hard-engineering solutions to mitigate the risk of coastal hazards, the following best management practices must be considered to reduce the adverse impacts of erosion control structures (such as seawalls, groynes and artificial reefs):

- design structures to minimise scouring and other hydrological impacts that may cause changes to sediment composition and profiles;
- use design elements that provide habitat complexity;
- design structures to allow for fish and water movement above the structure during high tides but to prevent stranding of fish, (e.g. gabions or revetments with openings) when structures need to be located in areas with riparian vegetation;
- increase the amount of intertidal habitat available, with structures to be sloping rather than vertical if this can be achieved without the loss of important natural habitats;
- enhance structure designs to allow uses such as fishing, while minimising any disturbance of fishing activities in the vicinity;
- undertake construction outside of target species' key times of biological activity and fishing in the area;
- use structures that may be modified or removed (e.g. geotextile structures) if required; and
- fill geotextile structures used along shorelines with sand sourced from above the highest astronomical tide, either onsite or off site, or the trench where the structure is to be placed (where applicable).

### ARTIFICIAL REEFS

Artificial reefs are submerged structures designed to reduce wave energy and erosive processes on the coastal foreshore. Typically, artificial reefs are constructed with sand filled geotextile bags by a split-hull hopper dredge. Once filled, the bags are transported offshore and dropped at pre-determined locations in accordance with the design. In some cases, reefs have been constructed with rock or concrete blocks, where units are placed on the seabed according to design specifications using an excavator mounted on a barge.

It is noted that the protective benefits of artificial reefs in these areas are doubtful, due to low sediment transport and availability in the area. In addition to providing foreshore protection, ecological benefits of appropriately designed artificial reefs include increased habitat diversity – providing hard habitat in an area of predominantly soft habitat and shelter from predators for small and juvenile fish and mobile invertebrates. The reefs provide substrate for colonisation by algae and invertebrates (barnacles, corals, sponges, etc.) increasing biodiversity, increased food diversity and availability, and fish aggregation.

### RAISING KEY ACCESS ROADS

Key access roads have been identified and mapped using a straightforward GIS approach. These maps, available in the Appendix E, show the location of potential civil construction works such as road raising, constructing a causeway or renewed 'post-event' maintenance works. The extent of the road and location provides the basis for the evaluation in this report.



**FIGURE 5-2 ARTIFICIAL REEF – GOLD COAST, QLD**

## BREAKWATERS

Breakwaters are a structure protecting a shore area, harbour, anchorage or basin from waves. The most common breakwaters are in the form of a sloping wall protected by rocks or concrete armour units. They may be attached to the coast, or detached, forming an offshore structure (Figure 5-3). They normally have a crest exposed above high tide but on occasions may be submerged, providing partial protection.

Because of openings for navigation, breakwaters cannot mitigate against impacts from sea-level rise; however, the design of breakwaters must take into account future sea levels and changed wave climate by having the capability of raising the crest height and having suitably sized armour units (CoastAdapt, IM 7, 2016).



**FIGURE 5-3 DETACHED BREAKWATER – REDCLIFFE, QLD**



## SEAWALLS

Seawalls are structures separating land and water areas designed to prevent coastal erosion and other damage due to wave action and storm tide inundations. Seawalls are normally very large structures as they are designed to resist the full force of waves and storm surges.

Seawalls are often incorporated into a Shoreline Erosion Management Strategy in combination with beach nourishment and dune regeneration to provide a last line of defence under the coastal dune, reducing the risks of erosion and floods. There are some advantages of seawalls and other structures in providing additional sheltered habitat. Environmental considerations are discussed in detail by locality in the relevant sections.



FIGURE 5-4 STEPPED SEAWALL – SUTTONS BEACH, QLD

## GROYNES AND ARTIFICIAL HEADLANDS

Groynes are structures built perpendicular to the shoreline that trap sand moving along the coast, causing sand build up on the downdrift side. A variant of a groyne is an artificial headland which acts in the same manner but has a larger footprint. They can be effective in controlling coastal erosion and longshore transport.

Groynes are only effective in areas with sufficient longshore sediment transportation rates. They cause the accumulation of material on one side and erosion on the lee side. Therefore, it is often required to build a whole groyne field to avoid negatively impacting on lee-side assets. Groynes are therefore recommended for a whole beach compartment.

Groynes would provide additional reef habitat, particularly if they were rocks, which would be a positive impact. However, if the groynes were placed over seagrass beds this would be a negative impact.





**FIGURE 5-5 ROCK SEAWALL AND GROYNES**

## SEA DYKES

A sea dyke (or levee) is an artificially constructed wall/fill commonly designed to regulate water levels and to avoid inundation from storm tides. It is usually earthen, covered with vegetation and parallel to the shore of low-lying coastlines. Sea dykes can be used to control extreme water levels associated with storm tides and in conjunction with sea level rise.

A large sea dyke or barrier structure which prevents tidal water inundation would lead to the degradation of an eco-system. The sediment in the mangrove and saltmarsh areas would remain saline, preventing colonisation by freshwater wetland plants. Other impacts are loss of fish habitat and prevention of fish passage. Ponding or flooding landward of the dyke following storm events (resulting in poor water quality in the existing creek and upstream ponded area) is a risk which has many flow-on effects, including death of vegetation and the associated impacts to fauna dependent on that vegetation.

## STORM SURGE BARRIERS

Storm surge barriers are hard engineered structures designed to prevent coastal flooding but maintain navigation at other times. They are normally part of a combined system of barriers (dykes, dunes, etc.) preventing storm tide water levels to flood waters within estuaries, lagoons or waterways.

### 5.3.4 Disaster Management

Council currently undertakes disaster management activities in accordance with the current legislation, regulations and performance standards, principally the *Disaster Management Act (Qld) 2003*. Council has significant information available on-line for the public, including a disaster dashboard. Disaster Dashboards are being rolled out across the State as a very effective one-stop management tool. Table 5-2 classifies current actions into the four stages of disaster management.



**TABLE 5-2 BUNDABERG LOCAL DISASTER MANAGEMENT ACTIVITIES**

Stage	Disaster Management Activity
Prevention	<ul style="list-style-type: none"> <li>■ Build resilience through communication, messaging, historical inundation and evacuation route signage.</li> <li>■ Community engagement and education, on-line and 'get ready' programs land use planning and infrastructure improvements.</li> <li>■ Maintenance (e.g. vegetation management programs).</li> </ul>
Preparedness	<ul style="list-style-type: none"> <li>■ Planning for disasters including the Local Disaster Management Plan updated in 2018, sub-plans, locality-specific plans and mapping.</li> <li>■ State Emergency Service support and participation.</li> <li>■ Volunteer and local disaster management group training and exercises.</li> </ul>
Response	<ul style="list-style-type: none"> <li>■ Local Disaster Coordination Centre operation: planning, logistics, communication and media, operations and multi-agency liaison.</li> <li>■ Communication to all through the Disaster Dashboard, warnings and warden network evacuation centre coordination.</li> <li>■ Liaison with district and State coordination centres.</li> </ul>
Recovery	<ul style="list-style-type: none"> <li>■ Coordination of four pillars of recovery: human and social, infrastructure, economy and environment.</li> <li>■ Local Disaster Management Group and recovery sub-group membership.</li> <li>■ Accessing funding through national and state response funds for repairs and betterment.</li> <li>■ Application of lessons learnt to future planning.</li> </ul>

The education and awareness of the risk of hazards includes specific information on flooding, bushfire, earthquakes, tsunamis and heatwaves. There is no information currently available for the general public on sea-level rise. The storm-tide inundation awareness information includes a suite of evacuation routes which is split into four zones: red for one metre above the Highest Astronomical Tide (HAT) mark to blue for four metres above HAT.

Bundaberg Regional Council provides extensive resources as part of their disaster management activities discussed above for awareness in preparation phase. The information is valid for all hazards and assists the community in the lead up to potential natural hazard events. The resources provided include:

- a household emergency plan guide;
- an emergency kit guide;
- an evacuation plan template;
- preparing pets information; and
- relevant emergency contact numbers.

During an event, the Disaster Dashboard provides real-time, 'one-stop' information on warnings, road conditions, news and updates, power outages, and social media along with links to mapping and contact information.



## 5.4 Coastal Settlements Design Options

Design options in at-risk areas for natural hazards can assist to mitigate risk and where effective, can be incorporated into local building and planning codes. This section briefly discusses building design options, infrastructure and access.

### 5.4.1 Building retrofitting and improved design

The project team analysed possible building retrofitting and improved design in the context of sea level rise and erosion prone areas. For individual buildings and sites, the conclusion is that building design options including setback lines and raising floor levels will have limited utility for the coastal hazard risks.

Raising floor levels may keep essential infrastructure clear of inundation and is potentially a solution for structures which do not require a natural ground level such as car parks or viewing platforms, based on an assumption that access to that structure remained viable. Raising structures may provide a solution in isolated cases but is not considered viable as a community wide strategy.

To a degree, inundation of natural ground or erosion of land impacts residential uses, and this is unmitigable. Dwellings or residential units on land with sea water intrusion cannot support essential open space functions, landscaping or underground services. In addition, it is assumed that access to that property would similarly be affected.

For these reasons the project team has not offered design solutions as a mitigation option for the CHAS. Building lines are effective where allotments are already created, and development has proceeded to ensure any alterations or changes in use do not intrude into areas that are at risk. The region already has a number of building lines which are in fully developed areas. New development is better placed using the Erosion Prone Zone and Coastal Management District as a tool to limit development in areas at risk. Amendments to the planning scheme can ensure these existing tools are used to prevent construction in at-risk areas.

### 5.4.2 Asset Management and Resilient Infrastructure

This option is tailored to specific priority asset classes that provide a key function to the community and settlement such as water supply, electricity network, stormwater drainage and sewerage mains.

This option applies to existing infrastructure only and involves the full reconstruction of an asset. The CHAS process will provide evidence to influence future infrastructure planning and design and informed infrastructure decisions based on an understanding of coastal hazards. The CHAS outputs can be integrated into the following policies and procedures:

- Drainage, roads, transport and active transport strategies;
- Strategic Asset Management Planning; including:
  - long-term asset management view,
  - financial planning for climate change,
  - asset valuation,
  - life expectancy of assets,
- Maintenance and operational works; and
- Design standards; including:
  - Design levels for sea level rise resilience.

Costs may be reduced by minimising the impact of the coastal hazard extent by relocating the assets when the existing asset requires replacement.



**FIGURE 5-6 RAISED MANHOLE ABOVE DESIGN FLOOD LEVEL – BRISBANE, QLD**

### **5.4.3 Raise Key Access Roads**

Raising key access routes reduces the likelihood of isolation to communities. Several options are available to Council that reduce the impacts of isolation to affected communities, these include:

- Raise the road above the level where the community becomes isolated;
- Construction of causeway crossing which may experience inundation; and
- Maintaining the existing road and undertaking reconstruction/repairs when required.

Key access roads have been identified and mapped (available in Appendix E).

When considering raising key access roads or the construction of new waterway crossings, fish movement and connectivity throughout waterways and within and between fish habitats should be maintained so that the health and productivity of fisheries resources and fish habitat is maintained. Community and fishing sectors' use of the area and access to fisheries resources is maintained and barriers are only constructed when there is a need for the development and no other reasonable alternative exists.

Where this solution is chosen, the provision is made for adequate fish passage should be included (e.g. a fish way), if necessary and impacts on marine plants, waterways that provide for fish passage and declared fish habitat areas that are matters of state environmental significance are avoided. Where avoidance is not reasonably possible, impact minimisation and mitigation should be completed, and provide an offset for significant residual impacts where appropriate.

## **5.5 Land Use Planning**

There are a range of planning options local governments can employ to address coastal processes to protect people and property from the impacts of climate change, sea level rise, coastal erosion, permanent inundation





or storm surge. In the first instance, land use planning options are always employed to avoid the risks for new development in a strategic and future sense. Other tools can be used to maintain, modify and transform over time in established settlements.

This section looks briefly at the existing mandatory requirements of the State Planning Policy, the current Bundaberg Planning Scheme 2015, the current regulatory response in various sections of the scheme and any other land use planning options available. The interactions of the various regulatory tools are considered as well as how some of the mechanisms currently available can be used, where the CHAS finds communities are at intolerable risk. The range of tools discussed is set out in Table 5-3 for convenience. More detailed information can be found in the Technical Appendix.

Planning responses to sea level rise and inundation can be strategic in nature and presented through intent and purposes statements in strategic framework or zone purpose statements. The intended strategic outcome may be to maintain or modify a settlement pattern over time through long term change or a no change position. The strategic positions are generally across a wider area, locality or geographic feature.

Where development exists and the response is to maintain, ensure a no worsening situation, or mitigate risk on a property-scale basis, planning can take a more immediate regulatory position on a focussed building and site-based approach. This approach includes controls to building form and relationships with the land such as setbacks, floor heights and density. This approach is also valid where risk can be mitigated through building solutions such as noise abatement through building materials, permeable surfaces or light access. As discussed above in section 5.4.1 site-based approaches, especially in building form are not considered to have utility in the face of the three hazards of permanent inundation; erosion and storm surge. These hazards are not of a nature such as floods, where water recedes, or cyclones pass and building standards can mitigate risk. The risk of permanent inundation and natural coastal morphology including erosion and deposition is difficult to mitigate through traditional policy and regulatory control tools.

In recent planning reform the *Planning Act 2016* now provides the option for local government to adjust zoning as new information on risk to life and property becomes available, without fear of compensation action through the preparation of a Feasible Alternatives Assessment Report (FAAR). The circumstances where this is appropriate as an option is mentioned in this report and expanded upon in the accompanying Technical Appendix. The scale of the CHAS coastal hazard risk mapping and storm tide inundation does not allow cadastral-based advice to be provided on the appropriateness of zones on particular allotments but does recommend review and further scrutiny in at risk areas.

The preparation of a FAAR is required in conjunction with planning scheme amendments which seek to minimise development potential or can be regarded as an adverse planning change. The definition of an adverse planning change is one that reduces the value of an interest in premises. The FAAR releases local government from the adverse definition by confirming the change is made to reduce a material risk **on the premises**. The focus of the *Planning Act 2016* and associated explanatory notes gives rise to some uncertainty whether the FAAR would be applicable in circumstances where the erosion and inundation cause a community to be isolated despite individual premises remaining intact.

Table 5-3 below shows the components of the land use planning framework and how they could be considered as tool for risk mitigation in relation to erosion and storm tide inundation.



**TABLE 5-3 LAND USE PLANNING OPTIONS SUMMARY TABLE**

Land Use Planning Option	Outcomes	Considerations
Strategic planning, including zone allocation and vision statements in the strategic framework	Conveying the growth and development intent at a locality scale. e.g. maintaining a low or no growth scenario in an area of high amenity.	To make significant content changes such as policy and intent in Part 3 – Strategic Framework, involves a major planning scheme amendment, including public consultation. All changes must comply with the State Planning Policy in force at the time of the change or where alternatives are proposed, be supported by technical evidence at a local scale.  Local governments are free to set the vision for localities based on the technical evidence supporting the planning scheme.
Local area plans, nominating special precincts or amending overlays	Qualify development in a constrained area or an area with particular characteristics or undertaking more detailed planning in a specific neighbourhood. e.g. defining a small precinct on a main street and setting a building height limit because of heritage values.	Inclusion of local area plans, new precincts or overlays are considered a policy change to the planning scheme and also require a major scheme amendment as described above.
Zone amendments	To reduce or change the development capacity or intensity of a small range, or single properties . e.g. reverting a medium density residential zone to a low-density residential zone.	Local government expose themselves to compensation to landowners when development opportunities are diminished unless the local government can demonstrate that people and property are put at intolerable risk if the zone remains on the premises, through preparation of a Feasible Alternatives Assessment Report (FAAR). It is unclear that isolation would satisfy the criteria of a FAAR.
Built form regulations	Built form is controlled and constructed to mitigate risks. e.g. a minimum floor level is set in a flood prone area.	It is considered that there is limited capacity for built form regulation to assist with coastal hazards as the issues of isolation and sea water inundation are not mitigated through a rise in floor levels or decrease in plot ratio for example.
Levels of assessment	Increasing the levels of assessment to accepted subject to requirements or code assessment, provides Council with the power to levy building regulations, setbacks, exclusion zones and the like.	The planning system prescribes that certain development cannot be required to obtain approval. It is 'accepted' development and need only comply with the building regulations.  This would likely be viewed as a policy shift and therefore a major planning scheme amendment.





Land Use Planning Option	Outcomes	Considerations
Set back lines and building location controls	New built form achieves greater clearances to risk areas.	<p>These tools can apply to newly developed areas where building has not yet occurred. It is a trigger for building certification for accepted development. It is only useful for coastal erosion and will not mitigate other risks.</p> <p>Where development is already in place it has limited utility but can prevent more development at risk into the future.</p> <p>Other tools which can regulate the location of building on a lot include the enforcement of building envelopes, the application of easements or environmental covenants on title.</p> <p>The disadvantage with notations on title, despite being legally binding, is often the information on title is not researched by certifiers and can be lost over time.</p>
Strategic Exclusion Zones	<p>To limit development to areas outside an intolerable risk area.</p> <p>e.g. mapping noise and odour impacts</p>	<p>To enable this the risk or area of impact needs firstly to be mapped and included in a planning scheme. To an extent the Erosion Prone Zone (EPZ) already achieves this.</p> <p>The Bundaberg Planning scheme does not include the State medium and high inundation maps, so this is potentially a first step.</p>
Land swaps and relocations	To remove at risk property from intolerable risk	Create a scheme for landowners to voluntarily relocate homes and business to areas outside the risk.
Land use and tenure transition	To remove at risk property from intolerable risk	<p>Most local government have an environmental levy imposed with rate collection. This levy is used to purchase strategic environmental land (among other things). In some cases, land use and tenure transition is the best option however, many properties in areas of high amenity have high levels of capital investment.</p> <p>Land which has not been over-capitalised does present good opportunity to use environmental levy funds to purchase and can add to the public opportunities for access to foreshores and open space.</p>

The above information is applied on a place-based approach below, in consideration of the risk implications late in this report to provide some recommendations for planning options.

### 5.5.1 State Planning Policy

The minimum requirements for local governments are to integrate the state interests for management of coastal matters which are set out in two sections of the State Planning Policy 2017 (SPP). The state interest of Planning for Safety and Resilience to Hazards covers planning policy for sea level rise, the erosion prone zone (EPZ) and storm tide inundation. The state interest in protecting coastlines is found in the Environment and Heritage section of the policy. This interest includes the adopted Coastal Management District (CMD)



which defines an area over which the state has a particular interest. The SPP outcomes are mandatory for local governments to integrate into planning instruments, as they apply to the local context.

The Bundaberg Planning Scheme was adopted in 2015 after the first version of the current SPP was issued in 2014. The scheme confirms that SPP interactive mapping has been adopted (refer table 1.7.4 in the scheme) and that the scheme has integrated all state interests effective July 2014 (refer section 2.1 of the scheme).

After the ascension of the *Planning Act* in 2016 and its commencement on 1 July 2017, the state issued a new version of the SPP also dated 1 July 2017. Thus, there are differences in the SPP mandatory components, between 2014 and 2017 and therefore implications for the Bundaberg Region Planning Scheme 2015. The policy statement for the natural hazards, risk and resilience component of the Planning for Safety and Resilience to Hazards says:

**The risks associated with natural hazards, including the projected impacts of climate change, are avoided or mitigated to protect people and property and enhance the community's resilience to natural hazards. (SPP, 2017, p.51)**

This part of the SPP includes state interests for coastal biodiversity, cultural heritage, water quality and the coastal environment. The CMD is mapped under this policy interest. The policy statement for the coastal environment is:

**The coastal environment is protected and enhanced, while supporting opportunities for coastal-dependent development, compatible urban form, and maintaining appropriate public use of and access to, and along, state coastal land. (SPP, 2017, p.41)**

The policy includes tidal waters dunes and wetlands and seeks to maintain existing landforms and access for all to coastal areas for liveability and scenic amenity. The policy requires that future development is achieved through infill and reclamation occurs only in very limited circumstances.

The provisions of the SPP are considered at plan-making stage and generally do not have a role in local development assessment, especially where the most current policy has been integrated. The SPP is purposefully, a strategic plan making tool and local planning instruments should apply the policy intent in a more detailed and localised manner when plan-making. Due to this conscious plan-making position by the Queensland Government, generally, the CMD is clipped around the land zoned for urban purposes based on the assessment of the appropriateness of the urban purpose at the time the plan was made. There are some minor exceptions to this, however where new development is proposed in the Coastal Management District, referral to the Queensland Government may be required.

### **5.5.2 The Bundaberg Planning Scheme 2015**

Planning schemes are both strategic planning tools and a regulatory instrument for current development activity. The Bundaberg Planning Scheme 2015 has a strategic planning horizon to 2031 and the scheme vision for the coastal settlements is provided in section two above. The visions outline growth aspirations on a broader scale and define the role settlements have in the future of Bundaberg. The planning scheme influences development through a number of sections:

- Part 3 – the strategic vision;
- Part 4 – the provision of infrastructure to support growth in the LGIP;



- The settlement vision and risk comparison process in this phase found that the strategic visions for the settlements in the planning scheme did not present significant locality-wide conflicts with the risk implications. There is some concern for projected in fill development in coastal townships which require further investigations. The planning review in the CHAS is not of an appropriate scale to provide direction on a property-scale or street-scale basis. Additional discussion and recommendations for all settlements are provided in the Technical Appendix.

The final part of the planning scheme which is relevant is the Tables of Assessment. The local government must maintain prescribed levels of assessment for dwelling houses and dual occupancies unless they are covered by an overlay (among other matters). The Bundaberg planning scheme generally affords development with low levels of regulation making the development of dwelling houses and dual occupancies accepted development which does not require a planning permit.

## 5.6 Land use and Tenure Transition

*This charge is a separate charge which is will be applied across the whole region area for the general benefit of the regional community. This charge will provide Council with approximately \$2 million per year which will be applied to partially finance important infrastructure and maintenance projects which may not otherwise have been possible and will be beneficial to the community in terms of growth and development. Council's strategic approach is to foster a better future for our community and to attract investors and businesses to which will grow our commercial rating base and relieve rates on residents.*

Logan City also collects an environment levy as do many other Councils. Logan specifically advises that the funds can be used to make strategic land purchases. See <https://www.logan.qld.gov.au/environment-water-and-waste/environmental-programs/environmental-levy>



Research and experience show, that landowners must feel an immediate threat to consider allowing their property to be purchased. In addition, the market value of their property must have decreased to an extent that they do not feel they will get a better price on the open market. This adds up to a tough call on land with significant scenic amenity which has major capital improvement.

There are a number of full programs underway in the United States for larger communities. For example, in Arlington Texas the county has budgeted US\$17m to purchase properties which flood repeatedly. The area is adjacent to existing parkland and will be used to extend and enhance the open space for the community. <http://nrcsolutions.org/rush-creek-property-acquisition-project-arlington-tx/>

## 5.7 Land swap

Queensland has Australia's first example of extensive land swap activities after the devastating 2011 floods which swept about one third of the small town's homes away. Through the Rebuilding Grantham Development Scheme and with the cooperation of the Lockyer Valley Regional Council and the direction and funding from the Queensland Reconstruction Authority, residents were re-settled on higher ground.

Recently the Tweed Shire was recognised in the Resilient Australia awards for its industrial land swap program. This involves 14ha of land which was severely impacted by the post-cyclone Debbie flooding. This program is being initiated through an expressions of interest format and is funded by the NSW Government Climate Adaptation funds. See <https://www.yoursaytweed.com.au/landswap>.





## 6.1 Potential Options

In accordance with the QCoast2100 Guidelines (2016), workshops with key internal stakeholders, the community and consultants were held to discuss each settlement, the visions and growth prospects, the likely consequences, risk and hazards the community would face and the basket of options applicable to these settlements. The following tables summarise the potential options or 'long-list' for consideration that align with the present-day and future risks, visions and strategic objectives.

**TABLE 6-1 MIARA, NORVAL PARK AND WINFIELD OPTIONEERING**

Aspect	Description
Vision	Coastal Character Settlement (limited growth).
Hazard	Impacts from storm tide inundation and coastal erosion – not subject to intolerable risk.
Notes	Maintain vision for limited growth. Miara Holiday Park to transform.
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning</li> <li>■ Monitoring erosion</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ No physical options</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ Land Swap - Miara Holiday Park.</li> </ul>

**TABLE 6-2 MOORE PARK BEACH OPTIONEERING**

Aspect	Description
Vision	Coastal township (self-sufficient, modest growth visions).
Hazard	Isolation, groundwater (saltwater intrusion) issues, septic tanks issues, coastal erosion (front) and storm tide inundation, subject to intolerable risk from coastal erosion.
Notes	Planning Strategy: reconsider vision, where Moore Park Beach might not expand in area size (due to inundation extent) but grow in population by means of sub-divisions and land use intensification. How does this affect ability to evacuate?





Aspect	Description
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning (reduce intensification ability)</li> <li>■ Remove tidal gates and allow fish passage and tidal inundation.</li> <li>■ Improve catchment runoff to improve estuarine water quality</li> <li>■ Resilient infrastructure – raise access roads</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ Beach nourishment &amp; dune regeneration</li> <li>■ Seawall</li> <li>■ Groynes</li> <li>■ Artificial Reef</li> <li>■ Levees</li> <li>■ Shoreline Erosion Management Plan</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ Land use and tenure transition or land swap (Moore Park Beach Surf Club).</li> </ul>

**TABLE 6-3 BURNETT HEADS OPTIONEERING**

Aspect	Description
Vision	Coastal Growth Centre (providing residential growth, supported by Bargara).
Hazard	Storm tide inundation risk is deemed intolerable due to economic impacts, erosion risk mapping mostly due to 0.8 m default erosion prone area.
Notes	Current vision for growth is proposed to change. Local Aaea planning is underway.
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning (reduce intensification ability)</li> <li>■ Resilient infrastructure – network strategy</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ Dyke / Storm surge barrier</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ Lighthouse Tourist Park.</li> </ul>



**TABLE 6-4 BARGARA OPTIONEERING**

Aspect	Description
Vision	Coastal Growth Hub.
Hazard	Coastal erosion risk is considered intolerable due to economic impacts on residential properties.
Notes	Kellys Beach is where erosion has been identified for further investigation as part of the CHAS. Council is undertaking activities to investigate and monitor erosion in Nielsen's Park and along the Bargara foreshore – these are included in the CHAS optioneering process.
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning (reduce intensification ability)</li> <li>■ Resilient infrastructure and asset management</li> <li>■ Monitor erosion Kellys Beach, Bargara Foreshore Park and Nielsen's Park</li> <li>■ Asset management and resilient infrastructure (active strategy for infrastructure planning)</li> <li>■ Allow estuarine wetlands to migrate landward coastal dune ecosystems;</li> <li>■ Improve catchment runoff to improve estuarine water quality</li> <li>■ Mon Repos: Specific site investigation</li> <li>■ Option to work with Marine Parks and Approvals bodies regarding turtles and reef-related ecosystems</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ Beach nourishment and dune regeneration</li> <li>■ Artificial Reef</li> <li>■ Seawall</li> <li>■ Groyne</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ No transform options.</li> </ul>

**TABLE 6-5 INNES PARK AND CORAL COVE OPTIONEERING**

Aspect	Description
Vision	Coastal Growth Centre (providing residential growth, supported by Bargara)
Hazard	Coastal erosion risk is not considered intolerable, critical infrastructure such as water supply and sewerage needs protection
Notes	Erosion risk mapping in this settlement is mostly attributed to the 0.8 m default Erosion Prone Area.

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Aspect	Description
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning</li> <li>■ Resilient infrastructure – (active strategy for infrastructure planning)</li> <li>■ Allow Intertidal and subtidal reefs to be inundated more frequently / to greater depths.</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ Beach nourishment / dune reconstruction</li> <li>■ Artificial reef</li> <li>■ Seawall.</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ No transform options.</li> </ul>

**TABLE 6-6 ELLIOTT HEADS OPTIONEERING**

Aspect	Description
Vision	Coastal Growth Centre (providing residential growth, supported by Bargara)
Hazard	Impacts from storm tide inundation and coastal erosion – not subject to intolerable risk
Notes	Erosion risk mapping in this settlement is mostly attributed to the 0.8 m default Erosion Prone Area.
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning</li> <li>■ Resilient infrastructure – (active strategy for infrastructure planning)</li> <li>■ Monitoring erosion and conserve vegetation</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ No physical options</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ No transform options.</li> </ul>



**TABLE 6-7 COONARR OPTIONEERING**

Aspect	Description
Vision	Coastal Character Settlement (limited growth)
Hazard	Coastal (shorefront) and creek (backwaters) inundation, isolation to beach front residences caused by road inundation is considered an intolerable risk.
Notes	While Council has not planned growth for the area, there may be plans for road upgrade of the Coonarr Beach Rd (resurfacing). It is assumed that Council wants to maintain the current settlement as it exists.
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning</li> <li>■ Resilient infrastructure – raise access roads</li> <li>■ Monitoring erosion and conserve vegetation</li> <li>■ Allow estuarine wetlands to colonise dune habitat – will result in loss of dune habitat and increase in estuarine wetland.</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ Beach nourishment/ dune regeneration</li> <li>■ Seawall / sandbags</li> <li>■ Artificial reef</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ Land use and tenure transition</li> </ul>

**TABLE 6-8 WOODGATE BEACH AND WALKERS POINT OPTIONEERING**

Aspect	Description
Vision	Coastal township (self-sufficient, modest growth visions)
Hazard	Isolation, coastal erosion (front) and storm tide inundation, subject to intolerable risk from coastal erosion.
Notes	Shoreline Erosion Management Plan is underway (near Woodgate boat ramp) and outcomes could be a driver for adaptation options



Aspect	Description
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning</li> <li>■ Resilient infrastructure – raise access roads</li> <li>■ Asset Management and resilient infrastructure (active strategy for infrastructure planning)</li> <li>■ Monitoring erosion and conserve vegetation</li> <li>■ Allow estuarine wetlands to colonise dune habitat along the Burrum River to colonise dune habitat – will result in loss of dune habitat and increase in estuarine wetland.</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ Beach nourishment/ dune regeneration</li> <li>■ Seawall / sandbags</li> <li>■ Groynes</li> <li>■ Artificial reef.</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ Land use and tenure transition.</li> </ul>

**TABLE 6-9 BUXTON OPTIONEERING**

Aspect	Description
Vision	Coastal Character Village (limited growth)
Hazard	Impacts from storm tide inundation and coastal erosion – not subject to intolerable risk
Notes	
Options	<p>Maintain</p> <ul style="list-style-type: none"> <li>■ Disaster management</li> <li>■ Education and awareness campaigns</li> <li>■ Building retrofitting</li> <li>■ Land use planning</li> <li>■ Monitoring erosion and conserve vegetation.</li> </ul> <p>Modify</p> <ul style="list-style-type: none"> <li>■ No physical interventions.</li> </ul> <p>Transform</p> <ul style="list-style-type: none"> <li>■ Land use and tenure transition.</li> </ul>

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The above tables detail the long list of adaptation options conserved for each settlement. The next section will apply that list to a range of considerations to determine if they progress to the Phase 7 multi criteria analysis task.

## 6.2 Adaptation Options Screening Elements

This chapter is set out in a place-based approach which collates the vision for the settlement, a summary of the risk levels, the settlement adaptation optioneering and screening in a table format; and a short discussion on the adaptation optioneering table contents. The table is set out in accordance with options for adaptation categories of maintain, modify and transform as described in section five of this report.

The section 6.2 tables below consider adaptation options for each settlement carried forward from the long list in section 6.1 and include high level details on cost, benefits, adverse impacts and effectiveness considerations.

### 6.2.1 Cost

Commentary is provided on the indicative cost for implementing an adaptation option. Preliminary costing of the coastal engineering options and resilient infrastructure works have been developed for a 50-year whole of life cost. Rather than provide a lump sum cost Table 6-10 provides an indication of potential cost range. The Phase 7 multi criteria analysis will make a more detailed cost assessment. The costs represented in the Technical Appendix calculated by HIG Engineering are preliminary in nature and are not to be used as a cost for capital works programming.

**TABLE 6-10 ADAPTATION OPTIONEERING TABLE COST KEY**

Symbol	Range	Comment
Private cost	\$0	Example: property-specific actions. This has no cost implications to Council, adaptation option to be implemented by private asset owners.
\$	\$0 to \$1million	Example: Typical annual budget to implement a program of works internal to Council.
\$\$	\$1 to \$5million	Example: Land use and tenure transition, which uses the assumed land value per hectare multiplied by the number of properties that may be considered eligible for it.
\$\$\$	\$5 to \$10 million	Examples: Capital projects to construct a physical option. Includes implementation cost of constructing the solution plus annual maintenance for life of the asset i.e. whole of list cost.
\$\$\$\$	\$10 to \$20 million	
\$\$\$\$\$	\$20 million +	

### 6.2.2 Benefits

The benefits cell provides a description of the benefits that may be achieved by implementing the option. This may cover comments about the effectiveness and how the option may provide multiple benefits, i.e. ecosystem health or improving community resilience. The benefits are considered along the resilience themes of society, economy, environment and infrastructure. Detailed economic analysis of benefits are considered in Phase 7.

### 6.2.3 Adverse Impacts or Challenges

This cell outlines clear adverse impacts of the proposed action or some of the limitations and challenges which may be encountered. For example, public awareness is very effective, based on the assumption everyone is








listening. A challenge for this action is capturing the audience. The impacts are considered along the resilience themes of society, economy, environment and infrastructure

#### 6.2.4 Assessment of Effectiveness

Commentary about the effectiveness of the option in reducing risk from coastal hazards to the community and how the solution mitigates the impacts of sea level rise, if at all. This consideration is divided into two parts: a symbolic indicator of how effective the proposed adaptation option is in simple colour code for 'not effective', 'partially effective' and 'fully effective'. The adjacent cell provides some text description or explanation of why an indicator was given. Table 6-11 below shows the effectiveness symbol and meaning.

**TABLE 6-11 ADAPTATION OPTIONEERING TABLE EFFECTIVENESS KEY**

Symbol	Meaning
Not effective 	This means the adaptation option will have no effect in mitigating the risk to life and property.
Partially effective 	This means the adaptation option will have a partial effect in mitigating the risk to life and property. Most options are completely effective as tools in themselves, however some are not completely effective in the case of risk mitigation. Many of these partially effective options are parts of a suite of adaptation activities and in isolation cannot be given a completely effective notation as residual risk remains.
Completely effective 	The adaptation option will completely mitigate the risk to life and property. It is noted that the only adaptation category which achieves complete mitigation of risk is transform. For all other options risk remains but is no longer intolerable. Options most likely to be undertaken along with other 'basket' of options.

#### 6.2.5 Alignment to Principles

In 2019 the project team undertook a first principles exercise which is outlined in section two of this report. This cell provides an assessment of the alignment to the adaptation principles identified along the resilience themes of society, economy, environment and infrastructure.

#### 6.2.6 Scenario Planning

Actions are taken from the risk assessment tasks in phase five and the summary and recap of risk from section four of this report. There are four triggers shown in Table 6-12 below which are replicated in the place-based adaptation options to indicate when the adaptation activities need to occur. This scenario timeframe aspect will be taken forward to Phase 7 in the pathways approach to the adaptation options and is therefore an important part of the optioneering understanding process.

**TABLE 6-12 ADAPTATION OPTIONEERING SCENARIOS**

Scenario	Meaning
Now	The settlement is already exposed to a level of risk which requires action and suggested adaptation options should commence now or are already in place.
0.2 m sea level rise	The level of risk to the settlement becomes intolerable at a projected sea level rise of 0.2 m.
0.4 m sea level rise	The level of risk to the settlement becomes intolerable at a projected sea level rise of 0.4 m.







Scenario	Meaning
0.8 m sea level rise	The level of risk to the settlement becomes intolerable at a projected sea level rise of 0.8 m.

### 6.2.7 Screening Process

Using the above categories, a high-level screening process has been undertaken. The following table provides a brief explanation of the screening symbols. These symbols introduce the reader to the pathways approach that will be undertaken as part of Phase 7 which combines, results of the multi criteria analysis and the triggers over time to map the pathways for adaptation.

**TABLE 6-13 ADAPTATION OPTIONEERING SCREENING PROCESS KEY**

Symbology	Screening Description
	<b>Considered and short listed for the MCA</b> Option will be taken automatically into the short list for further investigation. To be included in the pathways approach and the implementation strategy
	<b>Considered and requires assessment via MCA</b> Option to be included in the multi criteria analysis to directly compare with other similar options. To be ranked and prioritised for consideration for pathways diagrams in Phase 7 and preferred options to be included in the implementation strategy.
	<b>Considered and not preferred</b> Option not recommended for the implementation strategy but not ruled out. To be included the pathways diagrams.
	<b>Considered and ruled out</b> Option has been omitted from further investigation via the high-level screening process.

### 6.3 Adaptation Options by Settlement

A screening process has been applied to each settlement. The settlement starts with a reminder of the vision and a summary of the risk exposure from section four of this report and where appropriate some reminders from Phase 5 findings. The screening elements discussed above are provided in a table format for each settlement with the purpose being to define a shortened list which is carried into the multi criteria analysis of Phase 7.

In all cases the 'maintain' options have been recommended for shortlisting and straight to the implantation strategy. This includes continuation of disaster management activities, education and awareness campaigns which in some instances need to be targeted depending on the risk and triggers. Land use planning must also play a primary role in shaping appropriate development into the future.

Building retrofitting, which in this case should also encompass any kind of change in building regulation, legislative or policy response has been ruled out as ineffective for every settlement, essentially because even if the building withstands an event, the surrounding land upon which the building depends for landscaping, open space, infrastructure, access and parking is rendered unusable in the case of permanent inundation.

Land use and tenure transition, in addition to change in land use over time by acquiring the land is considered at every location. In many it is not considered viable at this time but may be in the future. Physical interventions are discussed in each table as they apply to that settlement.



### 6.3.1 Miara, Winfield and Norval Park

**Miara, Winfield and Norval Park are coastal character villages which will retain current form, preserving the distinctive character that reflects their connection with the landscape and the history of the region. They are entirely un-serviced.**

The risk profile for this settlement study area indicates that risk from both storm tide inundation and coastal erosion remains in the tolerable range under all sea level scenarios.

Miara Road is likely to be inundated in all scenarios and is considered a key access route to the Miara Holiday Park and is likely to be permanently inundated in the 0.8 m sea level rise scenario. The social consequence analysis has considered this to be a tolerable risk due to the adaptive capacity of the semi-permanent structures and the low asset value supports the ability to transform. The settlement has the second lowest economic exposure after Coonarr.

It is evident from the optioneering that only one land use is at risk and the transform category may be applied to the Miara Holiday Park. The land is a reserve and therefore land use and tenure transition is not proposed, rather a gradual process of relocation where an alternative suitable location can be found. Due to the risk level at this settlement, no constructed interventions are recommended. It is recommended the settlement pattern and vision is maintained for limited growth to the extent currently possible and urban services are not extended. It is noted there is some private property at risk in the northern region both east and west of Winfield where targeted engagement may be suited in the future. In all cases the best practice and on-going tasks of disaster management and community awareness should continue.

The settlement of Winfield is outside the intolerable risk area. The table below provides the adaptation options for Miara, Winfield and Norval Park for the maintain and transform categories. No physical intervention is proposed.



TABLE 6-14 ADAPTATION OPTIONS FOR MIARA, WINFIELD AND NORVAL PARK

Options	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion. May lead to complacency in community or not all community engaged. May not achieve complete audience – selective hearing.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events. Minimises loss of life, livelihoods and damages.	Now  Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Promotes understanding frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted. In many cases the community is unable to visualise solutions. Fear of loss.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Natural processes are to continue in this locality which is suited to general education and awareness programs. Targeted engagement should be considered for specific at-risk properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now  Shortlisted
Building Retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	✗ Society — Economy ✗ Settlements — Environment	Not effective 	Not effective long-term solution Isolates people and property. Sea level rise renders most land uses unusable due to salinization.	N/A  Ruled out
Land Use Planning	\$\$	Locating uses commensurate with the risk. Evidence-based planning.	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only. Does not deal with residual risk Land is irrevocably impacted.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	The settlement pattern and vision are maintained for limited growth and urban services are not extended. Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping). Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix.	Now  Shortlisted
Monitoring Erosion <i>Colonial Cove</i>	\$	Provides the evidence for any future physical response to erosion.	Does not remove hazards of sea level rise, inundation or erosion. Short-term solutions may be advised due to potential conflict with planning horizon for settlements.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Council is currently monitoring erosion in Colonial Cove and will implement ongoing baseline surveys. Does not remove the coastal hazard, further site investigation and feasibility will be required in the form of a SEMP. Included in short list of options – not for MCA process.	Now  Shortlisted
<b>Transform</b>							
Land Swap - Miara Holiday Park	\$\$	The community can continue to enjoy holidays proximate to the coast at a safer location.	Does not remove hazards of sea level rise, inundation or erosion. Natural processes to continue.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Completely effective 	Should the Miara Holiday Park begin to plan to modify operations in the short-medium term and transforming to a new location at .4 m sea level rise, this option is completely effective. Risk to life and property is removed in preparation for the 0.8 m permanent inundation.	0.4 m sea level rise  Shortlisted



### 6.3.2 Moore Park Beach

**Moore Park Beach is a coastal township which will cater for modest growth reflecting and preserving character, identity and history of the relaxed coastal settlement. It supports facilities and services for local residents and visitors drawing its character and lifestyle from surrounding natural features.**

Storm tide and permanent inundation at 0.8 m sea level rise scenario places almost the entire community at intolerable risk. Where individual properties are not specifically impacted the surrounding infrastructure and access loss may lead to isolation of the community.

Moore Park Beach has the highest value of assets subject to coastal hazard, as presented in the Phase 5 exposure analysis and has been identified as a priority area for adaptation to future coastal hazards. Areas specifically at risk include homes on the foreshore, the Moore Park Beach Surf Club and Holiday Park.

Overtopping of tidal gates is already occurring and the risk to the settlement becomes intolerable under a 0.4 m sea level rise scenario. Access routes to the settlement of Moore Park Beach are likely to be permanently inundated in the 0.8 m sea level rise scenario. The social consequence analysis has considered this to be catastrophic due to the likely isolation of the community.

The table below provides the adaptation options for Moore Park Beach three areas: maintain, modify and transform. The modify options includes construction of a physical solution which will be effective against erosion but may have other impacts. Significant costs are incurred in accommodating the risk with relocation of underground services. The transform options are related to community assets on the foreshore with low capital value but high community value. It appears there is sufficient land available to move the surf club back however relocation of the holiday park may be a more complex task. The options to raise and maintain roads are complex and are explored in detail in the table below.

In addition, any proposal to provide physical intervention from storm tide on the beach front will not address the erosion and permanent inundation running parallel to the coast at the rear of the settlement which is characteristic of both Moore Park Beach and Woodgate Beach.

The final strategy and implementation will require targeted consultation and awareness with the Moore Park Beach community to allow understanding of the unique characteristics and problems this brings for Moore Park Beach in the future.





TABLE 6-15 ADAPTATION OPTIONS FOR MOORE PARK BEACH

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion May lead to complacency in community or not all community engaged. May not achieve complete audience – selective hearing.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events. Minimises loss of life, livelihoods and damages.	Now  Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Understand frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted. In many cases the community is unable to visualise solutions. Fear of loss.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Moore Park Beach requires a bespoke campaign to inform residents of the nature of the risk and natural behaviours, including the implications for isolation. Targeted engagement can be considered for specific at-risk properties. Risk is not able to be accommodated at some properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now  Shortlisted
Building retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>— Economy</li> <li>✗ Settlements</li> <li>— Environment</li> </ul>	Not effective 	Not effective long-term solution Isolates people and property. Sea level rise renders most land uses unusable due to salinization.	N/A  Ruled out
Land Use Planning	\$\$	Removes potential for increased intensification. Communicates risk through clear policy changes. Change zoning patterns within Coastal Management District.	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only Potential loss of land value for individuals. Required additional conversations with community.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Maintain a vision for low or no growth and the characteristics of a coastal township. Development capacity should not increase in future planning schemes. <i>Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping).</i> <i>Consider informing residents on a more personal level such as letters to each household once the Bundaberg Coastal Hazard Adaptation strategy is released.</i> <i>Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix.</i>	Now  Shortlisted
Resilient Infrastructure (for specific road details refer table 6-16 below)	\$\$	Increased service to the community. Necessary for the ongoing function of settlement. Minimises interruptions during events.	No environmental impacts Short-term solution.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Effective against inundation. Not effective against erosion. Erosion or scour protection might have to be installed.	Now  Shortlisted



Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Modify</b>							
Beach nourishment / Dune (re-) construction	\$\$\$\$	Natural solution, creates additional buffer for erosion and inundation protection.	May impact tidal flushing of small creeks water quality and ecology. Scenic views. Potential for rapid sand displacement. Ensure appropriate sand sourcing and have consideration of a changed run off regime.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Effective against erosion and inundation if built high enough, can also be effective against sea level rise. If no regular re-nourishment is undertaken the effectiveness will be reduced. Does not address inundation from the creeks and wetlands behind the dune. Dune planting increases effectiveness compared to beach nourishment alone. Prevents inundation if built high enough.	Now To be assessed in MCA
Seawall / Rockwall / Buried Seawall	\$\$\$	Mitigates shore-front erosion and inundation, provides a hard line of defence (very limited residual risk for erosion to occur landwards of the seawall). Often constructed as buried seawalls with nourishment to provide amenity and satisfy state approval requirements.	Loss of beach in front of seawall. Create hard barrier to beach access. Can be built to current condition and retrofitted to account for SLR. Long beach compartment and therefore long seawall required. May adversely impact turtle nesting. May impact tidal flushing of small creeks water quality and ecology.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective 	Effective against erosion. Design options available that provide amenity. Does not address inundation from the creeks and wetlands behind the dune.	0.4 m sea level rise To be assessed in MCA
<b>Transform</b>							
Land Swap Moore Park Beach Surf Club & Tourist Park	\$\$\$	Natural processes to continue. Open space on shoreline is maintained. Community access to surf club is maintained.	Disruption to surf club operations. Ongoing uncertainty for surf club future. Loss of foreshore open space. Loss of a caravan park	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Completely effective 	Continue plans to modify the surf club in the short term and transforming to a safe location and seek funding from a resilience fund to rebuild in a safer location. Completely effective. Aligns with principles of stepping change over time, allowing the community to appreciate slowly and maintain confidence in ability to adapt.	0.4 m sea level rise Shortlisted



## RAISING KEY ACCESS ROADS

The following options are considered to address the isolation issue identified in Moore Park Beach. Table 6-16 shows the key access roads discussed in the table – Moore Park Road, Murdochs Linking Road, Malvern Drive.

**TABLE 6-16 OPTIONS FOR RAISING ROADS IN MOORE PARK BEACH**

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Raising Moore Park Road</b>							
Raising Moore Park Rd (800 m, incl. bridge)	\$\$\$	Prevents isolation of the settlement. Available as an evacuation route. Allow emergency services access and improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater, regular tidal ingress and egress to the estuarine wetlands. Impacts to the aquatic ecology unless fish passage is maintained. May cause dieback of the estuarine wetlands.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective 	High cost - recommend raising other shorter access roads due to cost effectiveness. Will prevent isolation of community if undertaken.	Now  Not preferred – recommend raising Murdochs Linking Road
Causeway Moore Park Rd (800 m) Minimal road level increase, inclusion of concrete protected causeway, excludes new bridge construction protected	\$\$	Reduces isolation of the settlement. Allow the road to be more frequently available as an evacuation route. Allow emergency services access for search/rescue operations in a greater number of storm events. Improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater flood waters.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective 	Moore Park Road becomes inundated at HAT in present day conditions, therefore will improve access/ egress.	Now  Shortlisted – in conjunction with raising Murdochs Linking Road
Routine Maintenance	\$	Repair after inundation event to reduce cost.	Flooding of road and isolation of community still occurs. No additional impact in environment.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Not effective 	Significantly lower cost than bridge option. Inundation will still occur. Not effective against sea level rise.	Now  Not preferred
<b>Raising Murdochs linking Road</b>							
Raising Murdochs Linking Road (350 m inc minor drainage)	\$\$	Prevents isolation of the settlement. Available as an evacuation route. Allow emergency services access and improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater, regular tidal ingress and egress to the estuarine wetlands to be maintained. The works would likely be located are between two cane fields. Current value to aquatic ecology is low, impacts to current ecosystems would be low. Increase with time with increased saline intrusion.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Completely effective 	Built to the level of sea level rise. Will prevent isolation of community – recommend undertaking with other road upgrades elsewhere	0.8 m sea level rise  Shortlisted



Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Causeway Murdochs Linking Rd Minimal road level increase, inclusion of concrete protected causeway, excludes new bridge construction protected	\$\$	Reduces isolation of the settlement. Allow the road to be more frequently available as an evacuation route. Allow emergency services access for search/rescue operations in a greater number of storm events. Improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater flood waters.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Murdochs Linking Rd becomes likely to be inundated permanently at 0.8 m sea level rise, therefore causeway will improve access / egress. Option not cost effective compared to raising road above level.	0.8 m sea level rise	 Not preferred
Routine Maintenance Murdochs Linking Road	\$	Repair after inundation event to reduce cost.	Flooding of road and isolation of community still occurs.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>✗ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Not effective 	Inundation will still occur, passable and will need maintenance to recover from inundation event.	Now	 Not preferred
<b>Raising Malvern Drive</b>								
Raising Malvern Drive (70 m inc bridge)	\$\$	Prevents isolation of the settlement. Available as an evacuation route. Allow emergency services access and improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater, regular tidal ingress and egress to the estuarine wetlands to be maintained.  The proposed works are between two cane fields. Current value to aquatic ecology is low, impacts to current ecosystems would be low. Increase with time with increased saline intrusion.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective 	High cost - recommend raising other shorter access roads due to cost effectiveness. Will prevent isolation of community if undertaken.	0.8 m sea level rise	 Not preferred – recommend raising Murdochs Linking Road
Causeway Malvern Drive (800 m) Minimal road level increase, inclusion of concrete protected causeway, excludes new bridge construction protected	\$	Reduces isolation of the settlement. Allow the road to be more frequently available as an evacuation route. Allow emergency services access for search/rescue operations in a greater number of storm events. Improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater flood waters.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective 	Malvern Drive becomes inundated at HAT in present day conditions. Causeway will improve access / egress. Significantly lower cost than bridge option.	0.8 m sea level rise	 Shortlisted – in conjunction with raising Murdochs Linking Road
Routine Maintenance Malvern Drive (10yr program)	\$	Repair after inundation event to reduce cost.	Flooding of road and isolation of community still occurs.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>✗ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Not effective 	Inundation will still occur, passable and will need maintenance to recover from inundation event.	0.8 m sea level rise	 Not preferred



### 6.3.3 Burnett Heads

**Burnett Heads is a coastal growth centre, with public foreshore parks providing open space and recreation opportunities. It services locals and the region with employment opportunities at the port and is provided with the full range of urban infrastructure.**

Burnett Heads has been identified as an area subjected to intolerable risk of storm tide inundation in a 0.8 m sea level scenario. Burnett Heads is not subject to isolation, but many highly critical services are subject to intolerable risks under a 0.8 m sea level rise scenario. With some growth expected in the area and to continue servicing the community, new infrastructure and upgrades to existing services will need to be built with coastal hazard factored into the design.

Recently the settlement has undergone additional local area planning including expansion of the state-declared Port of Bundaberg area. The current planning scheme amendments propose changes to the Coastal urban growth area to incorporate a boat harbour at Burnett Heads and associated supporting land uses. The vision in the Burnett Heads LAP is quite different to the statutory vision in the Bundaberg Planning Scheme 2015.

The appropriateness of intensification of land uses and coastal development of a boat harbour is questioned given the risk profile of this settlement. However, it is also noted that any development of a boat harbour of a marine would change the risk profile of this area. The Lighthouse Tourist park along with large areas of land zoned medium density residential and many homes on the river side of the headland are currently at intolerable risk of permanent inundation at 0.8 m sea level rise. Any approvals should ensure risk is lessened through development.

There are no considerations for Burnett Heads at this time for road or infrastructure works as isolation has not been identified to impact this settlement.





TABLE 6-17 ADAPTATION OPTIONS FOR BURNETT HEADS

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion. May lead to complacency in community or not all community engaged. May not achieve complete audience – selective hearing.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events. Minimises loss of life, livelihoods and damages.	Now  Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Understand frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted In many cases the community is unable to visualise solutions. Fear of loss.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Targeted engagement can be considered for specific at-risk properties. Risk is not able to be accommodated at some properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now  Shortlisted
Building retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>— Economy</li> <li>✗ Settlements</li> <li>— Environment</li> </ul>	Not effective 	Sea level rise renders most land uses unusable due to salinization. Not effective long-term solution Isolates people and property.	N/A  Ruled out
Land Use Planning	\$\$	Removes potential for increased intensification. Communicates risk through clear policy changes. Change zoning patterns within Coastal Management District.	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only. Potential loss of land value for individuals. Required additional conversations with community.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping); Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix. Maintain communication with the Port of Bundaberg throughout its development and ensure proposals for the SDA area are cognisant of risk exposure. Consider applying the risk profile as a relevant matter for the assessment of development proposals at Burnett Heads to ensure development contributes to adaptation and mitigation of that risk.	Now  Shortlisted



Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Resilient Infrastructure	\$\$	Increased service to the community. Necessary for the ongoing function of settlement. Minimises interruptions during events.	No environmental impacts. Short-term solution.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Partially effective 	Effective against inundation. Not effective against erosion. Erosion or scour protection might have to be installed.	Now	 Shortlisted
Modify								
Storm Surge Barrier	\$\$\$\$	Prevents storm tide inundation up to the design event - in this case the 1% AEP event plus 0.8 m SLR.	Large structure, with negative effect on access to foreshore. Highly likely any beach will disappear in front of large barrier. Must cover the full-length front and may require expensive upgrade in the future. Loss of visual amenity and degradation of this eco-system. Mangroves and saltmarsh likely to die- off. Loss of fish habitat. Landward ponding or flooding.	✔ Society ✔ Economy ✔ Settlements ✗ Environment	Partially effective 	Effective against wave force and inundation, very effective in combination with other options, can be arranged as green corridors along tidal waters.	0.8 m sea level rise	 Not preferred
				✔ Society ✔ Economy ✔ Settlements ✔ Environment	Partially effective 	Located to protect houses but keep wetlands. Possible to combine with Port's build of Port Bypass road from cane fields or to Buss Street to save cost.	0.8 m sea level rise	 To be assessed in MCA
Transform								
Land use and tenure transition	\$\$\$\$\$	Complete removal of any residual coastal risk is possible. No environmental impacts.	Loss of community and community values (beach/coastal), however, the whole community can be potentially be moved as one. Limitation of available land outside of coastal hazard area and acceptance for the community. Perceived loss of home. Heavy burden on ratepayers.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Completely effective 	Not viable due to number of properties making this option cost prohibitive. Properties in highly desirable locations can be highly capitalised or zoned for intensification (with development rights) As time passes this may become more affordable as an option. Consider vacant and low asset value land, for land use and tenure transition in the area north of Geary Street and along Rowlands Road.	0.8 m sea level rise	 Not preferred
Land Swap <i>Lighthouse Tourist Park</i>	\$\$	The community can continue to enjoy holidays proximate to the coast at a safer location.	Does not remove hazards of sea level rise, inundation or erosion. Natural processes to continue.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Completely effective 	Consider planning to transform the Burnett Heads Lighthouse Holiday Park away from the at-risk areas. Completely effective i.e. risk to life and property is removed in preparation for the 0.8 m permanent inundation	0.4 m sea level rise	 Shortlisted



#### 6.3.4 Bargara

**Bargara is the commercial and service hub for the Coastal Urban Growth Area. It is the primary tourism destination and services for coastal settlements. Its seaside setting with coastal themes and sub-tropical architecture influences development form as it grows to meet demand.**

The vision for Bargara is to be the coastal hub for the region. The north end of Bargara at Mon Repos and Rookery Road is exposed to erosion and inundation; however, this is not zoned for development nor does it have an existing settlement.

The coastal erosion risk at Kellys Beach is considered intolerable. This is driven by the economic consequences of a coastal erosion impact upon the properties. Nielsen's Beach and the Bargara foreshore has also been identified by Council as areas that may require further investigation as erosion events are occurring under present day conditions.

The results of the risk evaluation from coastal erosion in Kellys Beach (Bargara) is considered tolerable under present-day sea level conditions. This increases to intolerable under a 0.8 m sea level rise scenarios.

Transformation is not considered at this time in these intolerable risk areas due to the highly capitalised nature of these allotments in currently desirable places to live.



TABLE 6-18 ADAPTATION OPTIONS FOR BARGARA





Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion. May lead to complacency in community or not all community engaged. May not achieve complete audience – selective hearing.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events. Minimises loss of life, livelihoods and damages.	Now  Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Understand frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted. In many cases the community is unable to visualise solutions. Fear of loss.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Targeted engagement can be considered for specific at— risk properties. Risk is not able to be accommodated at some properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now  Shortlisted
Building retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	✗ Society — Economy ✗ Settlements — Environment	Not effective 	Not effective long-term solution. Isolates people and property. Sea level rise renders most land uses unusable due to salinization.	N/A  Ruled out
Land Use Planning	\$\$	Removes potential for increased intensification. Communicates risk through clear policy changes. Change zoning patterns within Coastal Management District..	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only. Potential loss of land value for individuals. Required additional conversations with community.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping). Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix.	Now  Shortlisted
Resilient Infrastructure	\$\$	Increased service to the community, Necessary for the ongoing function of settlement. Minimises interruptions during events.	No environmental impacts. Short-term solution.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Effective against inundation. Not effective against erosion. Erosion or scour protection might have to be installed. Necessary for the ongoing function of settlement.	Now  Shortlisted



Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Monitoring Erosion <i>Foreshore and Nielsen's Beach</i>	\$	Provides the evidence for any future physical response to erosion.	Does not remove coastal hazard. Short-term solutions may be advised due to potential conflict with planning horizon for settlements.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective	<p>Council is currently monitoring erosion in Kellys Beach, Bargara Shorefront and Nielsen's Park and will implement ongoing baseline surveys.</p> <p>Does not remove the coastal hazard, further site investigation and feasibility will be required in the form of a SEMP.</p> <p>Included in short list of options – not for MCA process.</p>	Now	<p>Shortlisted</p>
Site Specific Investigation at Mon Repos	\$	Potential to build resilience of Mon Repos Turtle Centre through multiple mechanisms.	No additional impact to environment.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective	Investigation only, will require partnership with State government – Queensland Parks and Wildlife Service.	Now	<p>Shortlisted</p>
<b>Modify</b>								
Beach nourishment Dune (re-) construction	\$\$	Natural solution, creates additional buffer for erosion and inundation protection.	<p>May impact tidal flushing of small creeks water quality and ecology</p> <p>Scenic views.</p> <p>Potential for rapid sand displacement.</p> <p>Ensure appropriate sand sourcing.</p> <p>Consider changed run off regime.</p>	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective	<p>Effective against erosion and inundation if built high enough, can also be effective against sea level rise.</p> <p>If no regular re-nourishment is undertaken the effectiveness will be reduced.</p> <p>Does not address inundation from the creeks and wetlands behind the dune.</p> <p>Dune planting increases effectiveness compared to beach nourishment alone.</p> <p>Prevents inundation if built high enough.</p>	Now	<p>To be assessed in MCA</p>
Seawalls /Rock wall / Buried Seawall	\$\$\$\$	<p>Mitigates shore-front erosion and inundation, provides a hard line of defence (very limited residual risk for erosion to occur landwards of the seawall).</p> <p>Often constructed as buried seawalls with nourishment to provide amenity and satisfy state approval requirements.</p>	<p>Loss of beach in front of seawall. Create hard barrier to beach access.</p> <p>Can be built to current condition and retrofitted to account for SLR.</p> <p>Long beach compartment and therefore long seawall required.</p> <p>May adversely impact turtle nesting</p> <p>May impact tidal flushing of small creeks water quality and ecology.</p>	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective	<p>Effective against erosion.</p> <p>Design options available that provide amenity.</p> <p>Does not address inundation from the creeks and wetlands behind the dune.</p>	0.8 m sea level rise	<p>To be assessed in MCA</p>
Groynes	\$\$\$	<p>Increased amenity compared to seawall as a beach can be maintained.</p> <p>Can be effective in creating turtle habitat.</p>	<p>Only effective where sufficient long- shore sediment transport.</p> <p>Only effective against erosion if undertaken in combination with beach nourishment.</p> <p>Not effective against inundation or SLR.</p> <p>Impacts sedimentation patterns downdrift.</p>	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✗ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective	<p>Not a preferred option and as only effective in combination with beach nourishment.</p> <p>Existing headlands are already providing a holding structure.</p>	0.8 m sea level rise	<p>Not preferred</p>





Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Artificial Reef	\$\$\$	No visual impact on existing beach amenity.	Can accelerate erosion. Usual lifespan of 20 years, not designed for permanent inundation Initial costs can be high. Possible impact on existing natural reefs.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>✗ Economy</li> <li>✗ Settlements</li> <li>✗ Environment</li> </ul>	Not effective	 <p>Only effective if there is sufficient sediment supply in the area. Not effective against sea level rise.</p>	0.8 m sea level rise	 Ruled out
<b>Transform</b>								
Land Swap	\$\$\$\$\$	Complete removal of any residual coastal risk is possible. No environmental impacts.	Loss of community and community values (beach/coastal), however, the whole community can be potentially be moved as one. Limitation of available land outside of coastal hazard area and acceptance for the community. Perceived loss of home. Heavy burden on ratepayers.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Completely effective	 <p>Not viable due to number of properties making this option cost prohibitive. Properties in highly desirable locations can be highly capitalised or zoned for intensification (with development rights). As time passes this may become more affordable as an option.</p>	0.8 m sea level rise	 Not preferred



### 6.3.5 Innes Park and Coral Cove

**Innes Park and Coral Cove will contribute significantly to the urban growth of Bundaberg's coastal growth centres, supporting the full range of residential opportunities in a low-medium density format. Liveability and amenity are enhanced by the surrounding natural environment.**

The settlement area of Innes Park and Coral Cove has been identified as an area for further refinement of coastal erosion mapping in Phase 3. The shoreline of Innes Park is subject to erosion risks considered intolerable. Coral Cove is typified by a rocky foreshore, however, there are still assets and features mapped as being at risk to coastal erosion under a 0.8 m sea level rise scenario.

Much of the area benefits from open space on the foreshore which buffers residential uses and coastal process with reserve land. It is imperative that this pattern is maintained for future development and is reflected in the Coastal Urban Growth Local Area Plan. The vision for this area is of growth, but much of the land for growth is set back from the foreshore.

The potential for land swap remains within all settlement however there are no properties which are exposed to intolerable risks and the process of widening the open space reserve involves many highly capitalised allotments. Some physical interventions are proposed for partial mitigation of risk.



TABLE 6-19 ADAPTATION OPTIONS FOR INNES PARK AND CORAL COVE

Option	s	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion. May lead to complacency in community or not all community engaged. May not achieve complete audience— selective hearing.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events Minimises loss of life, livelihoods and damages.	Now  Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Understand frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted In many cases the community is unable to visualise solutions. Fear of loss.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Inform residents on the nature of the risk and natural behaviours, including the implications for isolation. Targeted engagement can be considered for specific at-risk properties. Risk is not able to be accommodated at some properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now  Shortlisted
Building retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>— Economy</li> <li>✗ Settlements</li> <li>— Environment</li> </ul>	Not effective 	Not effective long-term solution Isolates people and property. Sea level rise renders most land uses unusable due to salinization.	N/A  Ruled out
Land Use Planning	\$\$	Removes potential for increased intensification. Communicates risk through clear policy change. Change zoning patterns within Coastal Management District.	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only. Potential loss of land value for individuals. Required additional conversations with community.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping). Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix. Maintain a low-density settlement pattern and dominance of open space in all foreshore areas.	Now  Shortlisted
Resilient Infrastructure	\$\$	Increased service to the community. Necessary for the ongoing function of settlement. Minimises interruptions during events.	No environmental impacts. Short-term solution.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Effective against inundation. Not effective against erosion. Erosion or scour protection might have to be installed.	Now  Shortlisted
Intertidal reef inundation	No cost	Resilience of reef ecosystems.	No additional environmental impact.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Effective protection of high value reef ecosystems.	Now  Shortlisted
<b>Modify</b>							



Option	s	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Beach nourishment Dune (re-) construction	\$\$	Natural solution, creates additional buffer for erosion and inundation protection.	May impact tidal flushing of small creeks water quality and ecology. Scenic views. Potential for rapid sand displacement. Follow best practice. Ensure appropriate sand sourcing. Consider changed run off regime.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective	<p>Effective against erosion and inundation if built high enough, can also be effective against sea level rise. If no regular re-nourishment is undertaken the effectiveness will be reduced. Does not address inundation from the creeks and wetlands behind the dune. Dune planting increases effectiveness compared to beach nourishment alone. Prevents inundation if built high enough.</p>	0.8 m sea level rise	<p>To be assessed in MCA</p>
Seawalls /Rock wall / Buried Seawall	\$\$\$	Mitigates shore-front erosion and inundation, provides a hard line of defence (very limited residual risk for erosion to occur landwards of the seawall). Often constructed as buried seawalls with nourishment to provide amenity and satisfy state approval requirements.	Loss of beach in front of seawall. Create hard barrier to beach access. Can be built to current condition and retrofitted to account for SLR. Long beach compartment and therefore long seawall required. May adversely impact turtle nesting. May impact tidal flushing of small creeks water quality and ecology.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective	<p>Effective against erosion. Design options available that provide amenity. Does not address inundation from the creeks and wetlands behind the dune.</p>	0.8 m sea level rise	<p>To be assessed in MCA</p>
Artificial reef	\$\$\$	No visual impact on existing beach amenity.	Can accelerate erosion. Usual lifespan of 20 years, not designed for permanent inundation. Possible impact on existing natural reefs.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>✗ Economy</li> <li>✗ Settlements</li> <li>✗ Environment</li> </ul>	Not effective	<p>Only effective if there is sufficient sediment supply in the area, Not effective against sea level rise.</p>	0.8 m sea level rise	<p>Ruled out</p>
<b>Transform</b>								
Land Swap	\$\$\$\$\$	Complete removal of any residual coastal risk is possible. No environmental impacts.	Loss of community and community values (beach/coastal), however, the whole community can be potentially be moved as one. Limitation of available land outside of coastal hazard area and acceptance for the community. Perceived loss of home. Heavy burden on ratepayers	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Completely effective	<p>Not viable due to number of properties making this option cost prohibitive. Properties in highly desirable locations can be highly capitalised or zoned for intensification (with development rights). As time passes this may become more affordable as an option.</p>	0.8 m sea level rise	<p>Not preferred</p>



### 6.3.6 Elliott Heads

**Elliott Heads is the southern-most coastal growth centre, with public foreshore parks providing open space and recreation opportunities. It is provided with the full range of urban infrastructure.**

The risk profile for the settlement indicates that risk from both storm tide inundation and coastal erosion remains in the tolerable range under all sea level scenarios. That said, the risk present in the settlement is driven by economic impacts to residential buildings and associated infrastructure.

No physical interventions are proposed. The Tourist Park and Elliott Heads is at risk, although the reserve is large in this location and modification of operation might be the best solution to steer investment away from at-risk areas to higher ground.

There are a number of properties at Riverview which are at high risk of permanent inundation. The risk is exacerbated in a practical sense because of the access arrangement to these allotments. The analysis and optioneering does not consider access issues to private property.





TABLE 6-20 ADAPTION OPTIONS FOR ELLIOTT HEADS

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion. May lead to complacency in community or not all community engaged. May not achieve complete audience – selective hearing.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events. Minimises loss of life, livelihoods and damages.	Now Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Understand frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted. In many cases the community is unable to visualise solutions. Fear of loss.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Inform residents on the nature of the risk and natural behaviours, including the implications for isolation. Consider targeted engagement for specific at-risk properties. Risk is not able to be accommodated at some properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now Shortlisted
Building retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>— Economy</li> <li>✗ Settlements</li> <li>— Environment</li> </ul>	Not effective 	Not effective long-term solution Isolates people and property. Sea level rise renders most land uses unusable due to salinization.	N/A Ruled out
Land Use Planning	\$\$	Removes potential for increased intensification. Communicates risk through clear policy changes. Change zoning patterns within Coastal Management District.	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only. Potential loss of land value for individuals. Required additional conversations with community.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping). Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix. Maintain a low-density settlement pattern and dominance of open space in all foreshore areas.	Now Shortlisted
<b>Transform</b>							
Land use and tenure transition - Biggs Street	\$\$	Complete removal of any residual coastal risk is possible. No environmental impacts.	Loss of community and community values (beach/coastal), however, the whole community can be potentially be moved as one. Limitation of available land outside of coastal hazard area and acceptance for the community. Perceived loss of home. Heavy burden on ratepayers.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Completely effective 	Not viable due to number of properties making this option cost prohibitive (Biggs Street, 1 Mitchell Street and 2 & 4 McIntosh Avenue). These properties may also experience access difficulty. Properties in highly desirable location are highly capitalised. As time passes this may become more affordable as an option.	0.4 m sea level rise Not preferred





Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Land Swap - <i>Elliott Heads Tourist Park</i>	\$\$	The community can continue to enjoy holidays proximate to the coast at a safer location.	Does not remove hazards of sea level rise, inundation or erosion. Natural processes to continue.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Completely effective	 <p>In the medium term the Elliott Heads Tourist Park may consider modifying some operational practices with a long-term view of transforming or relocation. Completely effective i.e. risk to life and property is removed in preparation for the 0.8 m permanent inundation.</p>	0.4 m sea level rise	 Shortlisted



### 6.3.7 Coonarr

**Coonarr is a coastal character village which will retain its current form, preserving the distinctive character that reflects their connection with the landscape and the history of the region. Coonarr has no urban infrastructure.**

Coonarr has been identified as a priority area for consideration in Phase 6. The main issues at Coonarr relate to coastal erosion of the shorefront and permanent inundation causing isolation of the small community which is considered an intolerable risk. Coonarr Beach Road is likely to experience permanent inundation under a 0.2 m sea level rise scenario.









The settlement has the lowest economic exposure. A key issue is the lack of access at just 0.2 m sea level rise to the nine allotments. One is open space, two vacant lots and six dwellings. Risk can be mitigated by purchasing the vacant land to ensure not intensification of uses as low asset value supports the ability to transform. Allotments fully capitalised present a challenge for land use and tenure transition and can be reassessed at a later time.



TABLE 6-21 ADAPTATION OPTIONS FOR COONARR

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion. May lead to complacency in community or not all community engaged. May not achieve complete audience– selective hearing.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events. Minimises loss of life, livelihoods and damages.	Now  Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Understand frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted In many cases the community is unable to visualise solutions. Fear of loss.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Inform residents on the nature of the risk and natural behaviours, including the implications for isolation. Consider targeted engagement for specific at-risk properties. Risk is not able to be accommodated at some properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now  Shortlisted
Building retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>— Economy</li> <li>✗ Settlements</li> <li>— Environment</li> </ul>	Not effective 	Not effective long-term solution Isolates people and property. Sea level rise renders most land uses unusable due to salinization.	N/A  Ruled out
Land Use Planning	\$\$	Removes potential for increased intensification. Communicates risk through clear policy changes. Change zoning patterns within Coastal Management District.	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only. Potential loss of land value for individuals. Required additional conversations with community.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Maintain the settlement pattern for limited growth and urban services are not extended. Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping). Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix.	Now  Shortlisted
Monitor Erosion	\$	Provides evidence for any future physical response to erosion.	Does not remove the coastal hazard. Short term solutions may be advised due to potential conflict with planning horizon for settlements.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Further site investigation and feasibility will be required.	Now  Shortlisted
<b>Modify</b>							






Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Beach nourishment / Dune (re-) construction	\$\$\$	Natural solution, creates additional buffer for erosion and inundation protection.	May impact tidal flushing of small creeks water quality and ecology. Scenic views. Potential for rapid sand displacement. Follow best practice Ensure appropriate sand sourcing Consider changed run off regime.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Partially effective 	Effective against erosion and inundation if built high enough, can also be effective against sea level rise. If no regular re-nourishment is undertaken the effectiveness will be reduced. Does not address inundation from the creeks and wetlands behind the dune. Dune planting increases effectiveness compared to beach nourishment alone. Prevents inundation if built high enough.	Now	 To be assessed in MCA
Seawalls / Rockwalls / Buried Seawalls	\$\$	Mitigates shore-front erosion and inundation, provides a hard line of defence (very limited residual risk for erosion to occur landwards of the seawall). Often constructed as buried seawalls with nourishment to provide amenity and satisfy state approval requirements.	Loss of beach in front of seawall. Create hard barrier to beach access. Can be built to current condition and retrofitted to account for SLR. Long beach compartment and therefore long seawall required. May adversely impact turtle nesting May impact tidal flushing of small creeks water quality and ecology.	✔ Society ✔ Economy ✔ Settlements ✗ Environment	Partially effective 	Effective against erosion. Design options available that provide amenity. Does not address inundation from the creeks and wetlands behind the dune.	0.2 m sea level rise	 To be assessed in MCA
Artificial reef	\$\$	No visual impact on existing beach amenity.	Can accelerate erosion. Usual lifespan of 20 years, not designed for permanent inundation. Possible impact on existing reefs.	✗ Society ✗ Economy ✗ Settlements ✗ Environment	Not effective 	Only effective if there is sufficient sediment supply in the area. Not effective against sea level rise.	0.2 m sea level rise	 Ruled out
Transform								
Change in land use over time by acquiring the land - of beach front properties	\$\$	Complete removal of any residual coastal risk is possible. No environmental impacts.	Loss of community and community values (beach/coastal), however, the whole community can be potentially be moved as one. Limitation of available land outside of coastal hazard area and acceptance for the community. Perceived loss of home. Heavv burden on ratepavers.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Completely effective 	Effective against inundation and erosion. Partial land use and tenure transition is appropriate now with reassessment at later date. Consider purchasing the two vacant allotments and rezoning to open space.	Now	 To be assessed in MCA



## RAISING KEY ACCESS ROADS

The following options are considered to address the isolation issue identified in Coonarr. Table 6-22 shows the key access roads for Coonarr discussed in the table below.

**TABLE 6-22 OPTIONS FOR RAISING ROADS IN COONARR**

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Raise Road Coonarr Beach Road (300 m)	\$\$	Prevents isolation of the settlement. Available as an evacuation route. Allow emergency services access and improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater, regular tidal ingress and egress to the estuarine wetlands to be maintained.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Completely effective	Built to the level of sea level rise. Will prevent isolation of community – recommend undertaking with other road upgrades elsewhere.	0.2 m sea level rise	 Shortlisted
Causeway (300 m)  Minimal road level increase, inclusion of concrete protected causeway, excludes new bridge construction.	\$\$	Reduces isolation of the settlement. Allow the road to be more frequently available as an evacuation route. Allow emergency services access for search/rescue operations in a greater number of storm events. Improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater flood waters.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Partially effective	Coonarr Beach Rd likely to be inundated permanently at 0.4 m sea level rise. Causeway will improve access / egress. Option not cost effective compared to raising road above level.	0.2 m sea level rise	 Not preferred
Maintaining Coonarr Road (300 m)	\$	Repair after inundation event to reduce cost.	Flooding of road and isolation of community still occurs.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>✗ Economy</li> <li>✓ Settlements</li> <li>✗ Environment</li> </ul>	Not effective	Inundation will still occur, passable and will need maintenance to recover from inundation event.	0.2 m sea level rise	 Not preferred



### 6.3.8 Woodgate Beach and Walkers Point

Woodgate Beach is a coastal township which will cater for modest growth reflecting and preserving character, identity and history of the relaxed coastal settlement. It supports facilities and services for local residents and visitors drawing its character and lifestyle from surrounding natural features.

Woodgate Beach and Walkers Point have been identified as a priority area for consideration in Phase 6. The main issues at Woodgate Beach relate to coastal erosion of the shorefront, permanent inundation causing isolation of communities and the associated social and economic impacts of coastal hazard causing an intolerable risk profile under a 0.4 m sea level rise scenario. The coastal settlement of Woodgate Beach and Walkers Point contain a large residential population and is expected to experience moderate growth into the future.

Options have been considered across three of the categories: maintain, modify and transform. The defensive option includes construction of a physical solution which will be effective against erosion but may have other impacts. Significant costs are incurred in accommodating the risk with relocation of underground services and addressing isolation risk. The risk characteristics for Woodgate are very similar to Moore Park Beach.















TABLE 6-23 ADAPTATION OPTIONS FOR WOODGATE BEACH AND WALKERS POINT

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion. May lead to complacency in community or not all community engaged. May not achieve complete audience – selective hearing.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events. Minimises loss of life, livelihoods and damages.	Now  Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Understand frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted. In many cases the community is unable to visualise solutions. Fear of loss.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Inform residents on the nature of the risk and natural behaviours, including the implications for isolation. Targeted engagement can be considered for specific at-risk properties. Risk is not able to be accommodated at some properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now  Shortlisted
Building retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>— Economy</li> <li>✗ Settlements</li> <li>— Environment</li> </ul>	Not effective 	Not effective long-term solution Isolates people and property. Sea level rise renders most land uses unusable due to salinization.	N/A  Ruled out
Land Use Planning	\$\$	Removes potential for increased intensification. Communicates risk through clear policy changes. Change zoning patterns within Coastal Management District.	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only. Potential loss of land value for individuals. Requires additional conversations with community.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Maintain a vision for low or no growth and the characteristics of a coastal township. Development capacity should not increase in future planning schemes. Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping). Consider informing residents on a more personal level such as letters to each household once the Bundaberg Coastal Hazard Adaptation strategy is released. Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix.	Now  Shortlisted
Resilient Infrastructure	\$\$	Increased service to the community, ensuring accessible evacuation routes.	No additional impact to environment.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective 	Effective against inundation. Not effective against erosion. Erosion or scour protection might have to be installed. Necessary for the ongoing function of settlement.	Now  Shortlisted
<b>Modify</b>							











Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Beach nourishment / Dune (re-) construction	\$\$\$	Natural solution, creates additional buffer for erosion and inundation protection.	May impact tidal flushing of small creeks water quality and ecology. Scenic views. Potential for rapid sand displacement. Ensure appropriate sand sourcing. Consider changed run off regime.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Partially effective 	Effective against erosion and inundation if built high enough, can also be effective against sea level rise. If no regular re-nourishment is undertaken the effectiveness will be reduced. Does not address inundation from the creeks and wetlands behind the dune. Dune planting increases effectiveness compared to beach nourishment alone. Prevents inundation if built high enough.	Now	 To be assessed in MCA
Seawalls / Rockwalls / Buried Seawalls	\$\$	Mitigates shore-front erosion and inundation, provides a hard line of defence (very limited residual risk for erosion to occur landwards of the seawall). Often constructed as buried seawalls with nourishment to provide amenity and satisfy state approval requirements.	Loss of beach in front of seawall. Create hard barrier to beach access. Can be built to current condition and retrofitted to account for SLR. Long beach compartment and therefore long seawall required. May adversely impact turtle nesting May impact tidal flushing of small creeks water quality and ecology.	✔ Society ✔ Economy ✔ Settlements ✗ Environment	Partially effective 	Effective against erosion. Design options available that provide amenity Does not address inundation from the creeks and wetlands behind the dune.	0.2 m sea level rise	 To be assessed in MCA
Groynes	\$\$\$\$	Increased amenity compared to seawall as a beach can be maintained. Can be effective in creating turtle habitat.	Only effective where sufficient long-shore sediment transport. Only effective against erosion if undertaken in combination with beach nourishment.  Not effective against inundation or SLR Impacts sedimentation patterns downdrift.	✗ Society ✔ Economy ✗ Settlements ✔ Environment	Partially effective 	Not a preferred option and as only effective in combination with beach nourishment	0.4 m sea level rise	 Not preferred
Artificial reef	\$\$	No visual impact on existing beach amenity.	Can accelerate erosion. Usual lifespan of 20 years, not designed for permanent inundation, initial costs can be high. Possible impact on existing reefs.	✗ Society ✗ Economy ✗ Settlements ✗ Environment	Not effective 	Only effective if there is sufficient sediment supply in the area. Not effective against sea level rise.	0.2 m sea level rise	 Ruled out
Transform								
Land use and tenure transition - <i>First Avenue, Theodolite Creek area properties</i>	\$\$\$\$	Consider strategic land use and tenure transition in the First Avenue area. Complete removal of any residual coastal risk is possible.	Loss of community and community values (beach/coastal), however, the whole community can be potentially be moved as one. Limitation of available land outside of coastal hazard area and acceptance for the community. Perceived loss of home. No additional impact to environment.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Completely effective 	Effective against inundation and erosion. To be assessed in conjunction with other 'physical options'.	Now	 Not preferred



## RAISING KEY ACCESS ROADS

The following options are considered to address the isolation issue identified in Woodgate Beach and Walkers Point. Table 6-24 shows the key access roads discussed in this table – Walkers Point Road, Acacia Street, Paperbark Court and First Avenue.







**TABLE 6-24 OPTIONS FOR RAISING ROADS IN WOODGATE BEACH**

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Raising Walkers Point Road								
Raising Walkers Point Rd (170 m, minor drainage)	\$\$	Prevents isolation of the settlement. Available as an evacuation route. Allow emergency services access and improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater, regular tidal ingress and egress to the estuarine wetlands to be maintained. The proposed works will not have a significant negative impact.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Completely effective 	Recommend raising Walkers Point Rad in conjunction with Acacia St due to alternative egress via Heidkes Rd (unsealed road).	0.8 m sea level rise	 Shortlisted
Causeway Walkers Rd	\$	Reduces isolation of the settlement. Allow the road to be more frequently available as an evacuation route. Allow emergency services access for search/rescue operations in a greater number of storm events. Improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater flood waters.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Partially effective 	Option to be considered for further discussion in conjunction with Acacia St due to alternative egress via Heidkes Rd (unsealed road). Not preferred. Causeway will improve access / egress. Lower cost than bridge option.	0.8 m sea level rise	 Not preferred
Maintenance (10yr Program)	\$	Repair after inundation event to reduce cost.	Flooding of road and isolation of community still occurs. No additional impact in environment.	✘ Society ✘ Economy ✔ Settlements ✘ Environment	Not effective 	Inundation will still occur, passable and will need maintenance to recover from inundation event.	0.8 m sea level rise	 Not preferred
Raising Acacia Street								
Raising Acacia Street (300 m)	\$\$	Prevents isolation of the settlement. Available as an evacuation route. Allow emergency services access and improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater, regular tidal ingress and egress to the estuarine wetlands to be maintained.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Completely effective 	Acacia St is likely to be inundated permanently at 0.4 m sea level rise. Will prevent isolation of community – recommend undertaking with other road upgrades elsewhere. Preferred Option as key access road for Woodgate Beach community	0.8 m sea level rise	 Shortlisted



Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Constructing causeway for Acacia Street (300 m, minor drainage)	\$\$	Reduces isolation of the settlement. Allow the road to be more frequently available as an evacuation route. Allow emergency services access for search/rescue operations in a greater number of storm events. Improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater flood waters.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective	Causeway will improve access / egress. Option not cost effective compared to raising road above level.	0.8 m sea level rise	 Not preferred
Maintenance (10yr Program)	\$	Repair after inundation event to reduce cost.	Flooding of road and isolation of community still occurs.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>✗ Economy</li> <li>✓ Settlement</li> <li>✗ Environment</li> </ul>	Not effective	Inundation will still occur, passable and will need maintenance to recover from inundation event.	0.8 m sea level rise	 Not preferred
<b>Raising Theodolite Creek Road</b>								
Raising Theodolite Creek Rd (300 m, minor drainage)	\$\$	Prevents isolation of the settlement. Available as an evacuation route. Allow emergency services access and improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater, regular tidal ingress and egress to the estuarine wetlands to be maintained.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Completely effective	Theodolite Creek likely to be inundated permanently at 0.4 m sea level rise. Built to the level of sea level rise. Will prevent isolation of community. Preferred Option as key access road for Properties along Theodolite Creek Road.	0.8 m sea level rise	 Shortlisted
Causeway Theodolite Creek Rd (300 m)	\$\$	Reduces isolation of the settlement. Allow the road to be more frequently available as an evacuation route. Allow emergency services access for search/rescue operations in a greater number of storm events. Improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater flood waters.	<ul style="list-style-type: none"> <li>✓ Society</li> <li>✓ Economy</li> <li>✓ Settlements</li> <li>✓ Environment</li> </ul>	Partially effective	Causeway will improve access / egress. Option not cost effective compared to raising road above level.	0.8 m sea level rise	 Not preferred
Maintenance (10yr Program)	\$	Repair after inundation event to reduce cost.	Flooding of road and isolation of community still occurs.	<ul style="list-style-type: none"> <li>✗ Society</li> <li>✗ Economy</li> <li>✓ Settlement</li> <li>✓ Environment</li> </ul>	Not effective	Inundation will still occur, passable and will need maintenance to recover from inundation event. Does not remove isolation risk.	0.8 m sea level rise	 Not preferred
<b>Raising Paperbark Court</b>								



Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)		Scenario	Screening
Raising Paperbark Court – First Ave (490 m)	\$\$	Prevents isolation of the settlement. Available as an evacuation route. Allow emergency services access and improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater, regular tidal ingress and egress to the estuarine wetlands to be maintained. The proposed works are in an area of mangroves and saltmarsh. The proposed works run roughly parallel to the drainage line and consequently would have less impact.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Completely effective 	Built to the level of SLR. (refer to Benefits). Will prevent isolation. Option to be considered for further discussion with consideration given to land use and tenure transition.	0.8 m sea level rise	 Shortlisted
Constructing causeway for Paperbark Court – First Ave (490 m, minor drainage)	\$\$	Reduces isolation of the settlement. Allow the road to be more frequently available as an evacuation route. Allow emergency services access for search/rescue operations in a greater number of storm events. Improve logistics during recovery.	Will need to include adequate drainage to allow passing of stormwater flood waters.	✔ Society ✔ Economy ✔ Settlements ✔ Environment	Partially effective 	Inundation will still occur, passable and will recover immediately from inundation event. Improve logistics in recovery. Isolation risk mitigated. Option to be considered for further discussion with consideration given to land use and tenure transition.	0.8 m sea level rise	 Shortlisted
Maintenance (10yr Program)	\$	Repair after inundation event to reduce cost.	Flooding of road and isolation of community still occurs.	✗ Society ✗ Economy ✔ Settlement ✗ Environment	Not effective 	Inundation will still occur, passable and will need maintenance to recover from inundation event. Option not cost effective compared to building causeway.	0.8 m sea level rise	 Not preferred





### 6.3.9 Buxton

**Buxton is a coastal character village which will retain its current form, preserving the distinctive character that reflects the connection with the landscape, especially lifestyle allotments on the Burrum River and the history of the region. Buxton has no urban infrastructure**

The coastal settlement of Buxton situated on the Burrum River, is considered to have a risk profile from both storm tide inundation and coastal erosion hazard that remains in the tolerable range under all sea level scenarios. That said, the risk present in the settlement is driven by economic impacts to residential buildings and associated infrastructure from coastal erosion. Existing coastal erosion issues in the settlement will require ongoing monitoring and investigation into possible mitigation measures required. Action will be required to ensure the risk profile within Buxton remains in the tolerable range under all future scenarios.

There are some low asset value allotments which supports the ability to transform. No physical intervention is proposed.





TABLE 6-25 ADAPTATION OPTIONS FOR BUXTON

Option	Costs	Benefits	Adverse Impacts / Challenges	Alignment to Principles	Assessment of Effectiveness (SLR)	Scenario	Screening
<b>Maintain</b>							
Disaster Management	\$	Builds resilience through communication and messaging. Coordinates preparation to disasters. No environmental impacts.	Does not remove hazards of sea level rise, inundation or erosion. May lead to complacency in community or not all community engaged. May not achieve complete audience – selective hearing.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Strengthens community disaster preparedness and coordinates systematic responses to potential coast hazard events. Helps convey clear risk, overcome fear and understanding communications during events. Minimises loss of life, livelihoods and damages.	Now  Shortlisted
Education and Awareness Campaigns	\$	Enhanced understanding of coastal processes, adaptation options and implications for specific neighbourhoods. Understand frequency of events into the future. Mutual capacity building.	Does not remove hazards of sea level rise, inundation or erosion. Communicating 'wicked problems' is complex, how to engage audience? Community values are interrupted. In many cases the community is unable to visualise solutions. Fear of loss.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Inform residents on the nature of the risk and natural behaviours, including the implications for isolation. Targeted engagement can be considered for specific at-risk properties. Risk is not able to be accommodated at some properties. Cannot be totally effective as engagement with total community is not guaranteed.	Now  Shortlisted
Building retrofitting	Private Cost	More economical than reconstruction or lifting, however depending on construction methods and materials suitable to withstand inundation, may add notable cost.	Does not remove hazards of sea level rise, inundation or erosion. Access roads might still be impacted, causing interruption of services and isolation. Natural processes to continue.	✗ Society — Economy ✗ Settlements — Environment	Not effective 	Not effective long-term solution Isolates people and property. Sea level rise renders most land uses unusable due to salinization.	N/A  Ruled out
Land Use Planning	\$\$	Removes potential for increased intensification. Communicates risk through clear policy changes. Change zoning patterns within Coastal Management District.	Does not hazards of sea level rise, inundation or erosion. Applicable to new development only Potential loss of land value for individuals. Required additional conversations with community.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Consider incorporating the SPP storm tide inundation mapping into the planning scheme (alternatively incorporate the CHAS mapping). Consider a range of more detailed options and review of land use planning discussed in the Technical Appendix.	Now  Shortlisted
Monitor Erosion	\$	Provides the evidence for any future physical response to erosion.	Does not remove hazards of sea level rise, inundation or erosion. Short-term solutions may be advised due to potential conflict with planning horizon for settlements.	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Partially effective 	Further site investigation and feasibility will be required. Council is currently monitoring erosion in Buxton and will implement ongoing baseline surveys.	Now  Shortlisted
<b>Transform</b>							
Land use and tenure transition - Wharf St	\$\$\$	Complete removal of any residual coastal risk is possible.	Loss of community and community values (beach/coastal), Limitation of available land outside of coastal hazard area and acceptance for the community. Perceived loss of home	✓ Society ✓ Economy ✓ Settlements ✓ Environment	Completely effective 	Consideration given to expanding the open space area on Wharf Street with strategic purchase of vacant properties.	Now  Shortlisted



## 6.4 Council Wide Recommendations

The following recommendations apply across the Bundaberg Region. These recommendations fall into the category of land use planning and land use and tenure transition. Specific planning scheme recommendations are also documented in the Technical Appendix.

### 6.4.1 Land use and tenure transition

Land use and tenure transition is the only completely effective mitigation option because the risk to life and property is removed from the hazard. However, this is complex because of community values and highly capitalised assets on the foreshore making this option cost prohibitive in most cases. This will be explored further in Phase 7 for some settlements. Over time, depend on the natural process, the property values may dictate that this option and the opportunity to reclaim land as open space becomes a realistic option.

In the meantime, Council can move to purchase vacant land and strategic properties without significant public intervention and there are a number of vacant allotments which fit the criteria of low capital improvement and opportunity to enhance public access to the foreshore or add to valuable recreational land or public open space.

**Recommendation:** that Council considers formally adopting the policy position governing the environmental levy expenditure, that the use of a proportion of the environmental levy is used for strategic transition of intolerable risk properties where there is a community benefit.

### 6.4.2 Planning Scheme Amendments

The existing overlays, local area plans or the tables of assessment maintain low levels of assessment for development on existing allotments, therefore planning scheme does not offer explicit resistance to development on existing subdivided and zoned land. While this may not achieve a significant mitigation of risk on existing allotments it is a first step in providing the correct messages for risk-aware development to all stakeholders, planners included.

The scheme is constructed in a similar fashion to the SPP in that it assumes that once land has been created, development can proceed with little involvement from Council. This is to be applauded as a development facilitating scheme. However as new data comes to light in some circumstances this may not always be appropriate.

#### **Recommendations:**

- consider incorporating either the SPP storm tide inundation mapping or the future Bundaberg Coastal Hazard Adaptation Strategy mapping, whichever has greater utility into the planning scheme;
- review the risk exposure of some settlements in the context of accepted development and determine whether greater levels of assessment are required for development generally in the coastal zones and within the mapped overlay area.

The Technical Appendix Report provides more detailed information on planning analysis and recommendations.



## 7 SUMMARY AND NEXT STEPS








Phase 6 is the identification and refinement of adaptation options to reduce or eliminate intolerable or maintain tolerable coastal hazard risks. The minimum requirements include identification and workshoping options with stakeholders and the community before applying a high-level screening process to refine the long list for appraisal in Phase 7 and the CHAS implementation strategy in Phase 8.

- Adaptation options are provided in *The Compendium* reference document which provides guidance on coastal adaptation options for coastal ecosystems and the built environment. The Bundaberg Region CHAS has also considered disaster management and community awareness measures as an effective method of reducing risk from coastal hazards now and into the future.
- The process of screening the long list of options has been guided by the first principles of the Bundaberg Region CHAS and 'Settlement Visioning' which have been developed through discussion with the community and stakeholders and through analysis of the planning scheme document.
- Phase 6 shows there are a range of adaptation pathways available to each settlement, commensurate to the changing risk profile associated with future sea level rise scenarios.

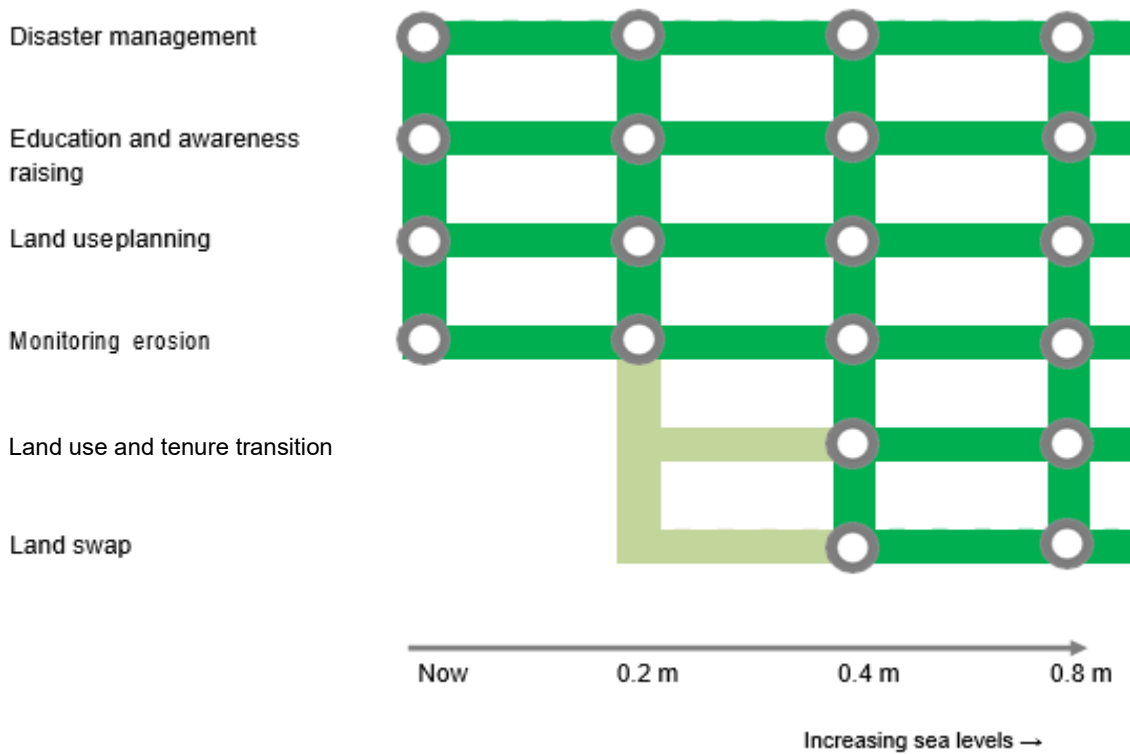
### 7.1 Adaptation Pathways

The adaptation pathway diagrams present the options available for each settlement based on the high-level screening process. Potential adaptation options are listed down the left-hand side of the pathway diagram and the following table explains the symbology for each option.

**TABLE 7-1 EXPLANATION OF PATHWAYS MAP**

Symbol	Interpretation
	Circles indicate decision points, that is, points in time when a decision needs to be made between alternate adaptation options. The timing of decision points has been set to coincide with present day conditions (now) and sea level rise scenarios of 0.2 m, 0.4 m and 0.8 m.
	Planning or investigation commences for a shortlisted option
	Indicates when a shortlisted option would likely be implemented.
	Indicates when planning or investigation would likely commence for a non-preferred option.
	Indicates when a non-preferred option would likely be implemented.
	Indicates when planning or investigation would likely commence for a ruled-out option.
	Indicates when a ruled-out option would likely be implemented.

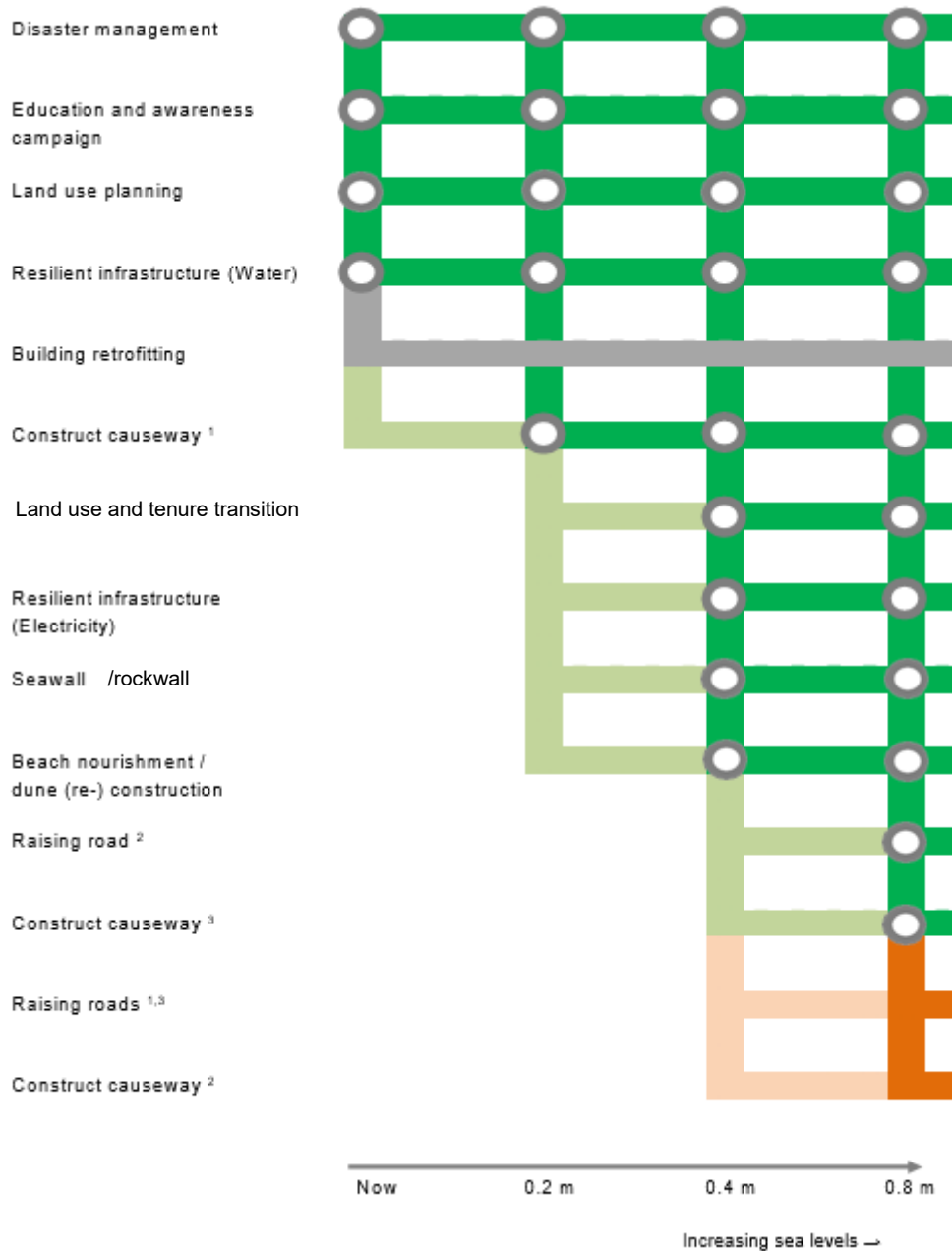
### 7.1.1 Miara, Winfield and Norval Park



**FIGURE 7-1 ADAPTATION PATHWAYS – MIARA, WINFIELD AND NORVAL PARK**

Adaptation for the coastal settlement of Miara, Winfield and Norval Park will require a focus on disaster management, education and awareness campaigns. Monitoring the rate erosion in Colonial Cove over time may lead to the implementation of a SEMP in this location. Modification of operations at the Holiday Park may be required in the short- term.

## 7.1.2 Moore Park Beach



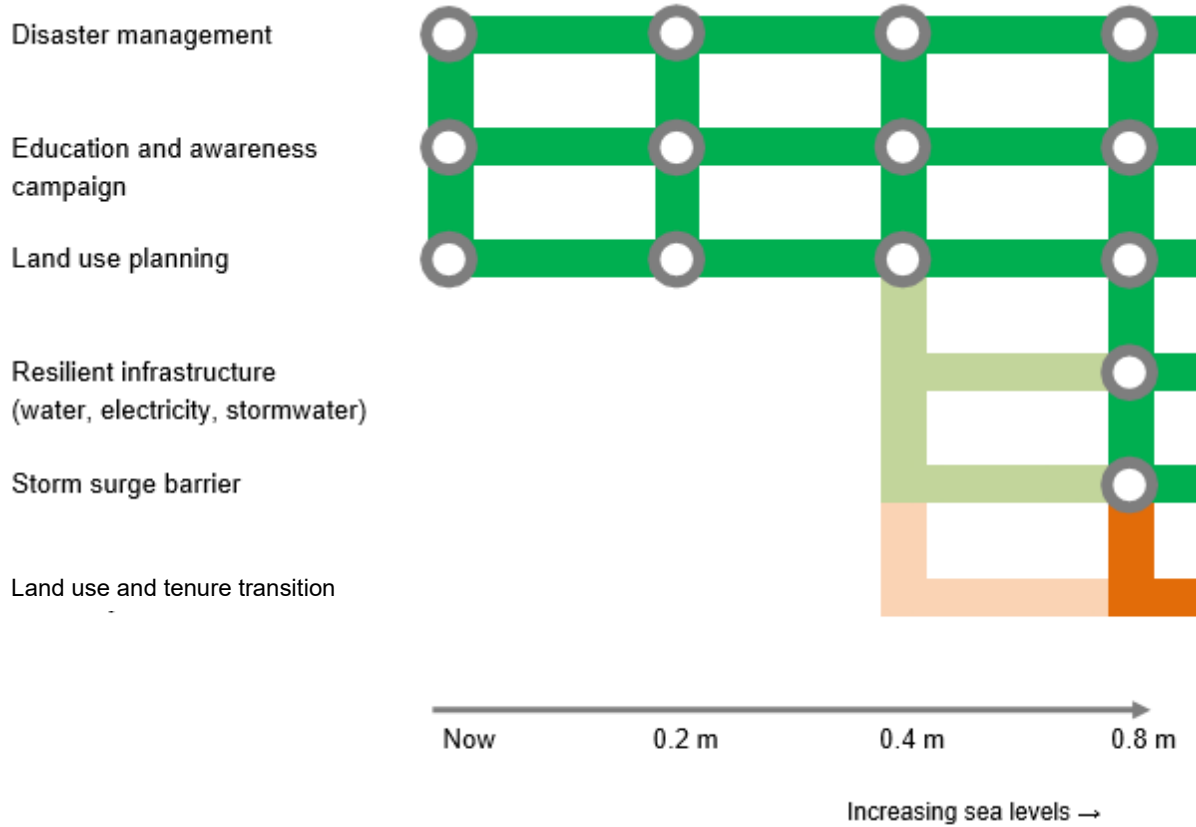
**FIGURE 7-2 ADAPTATION PATHWAYS – MOORE PARK BEACH**

Adaptation for the coastal settlement of Moore Park Beach will require an immediate focus on disaster management, education and awareness campaigns. Planning for physical interventions against coastal erosion may commence at 0.2 m; and isolation risk by raising Murdochs Linking Road at 0.4 m of sea level rise.

1 - Moore Park Road, 2 - Murdochs Linking Road, 3 - Malvern Drive.



### 7.1.3 Burnett Heads



**FIGURE 7-3 ADAPTATION PATHWAYS – BURNETT HEADS**

Adaptation for the coastal settlement of Burnett Heads will require appropriate land use planning and development controls to ensure new development is not subject to intolerable risks and contributes to risk mitigation. Maintaining resilience by implementing disaster management and education and awareness campaigns; investigating the construction of a storm surge barrier may occur after 0.4 m of sea level rise.



#### 7.1.4 Bargara

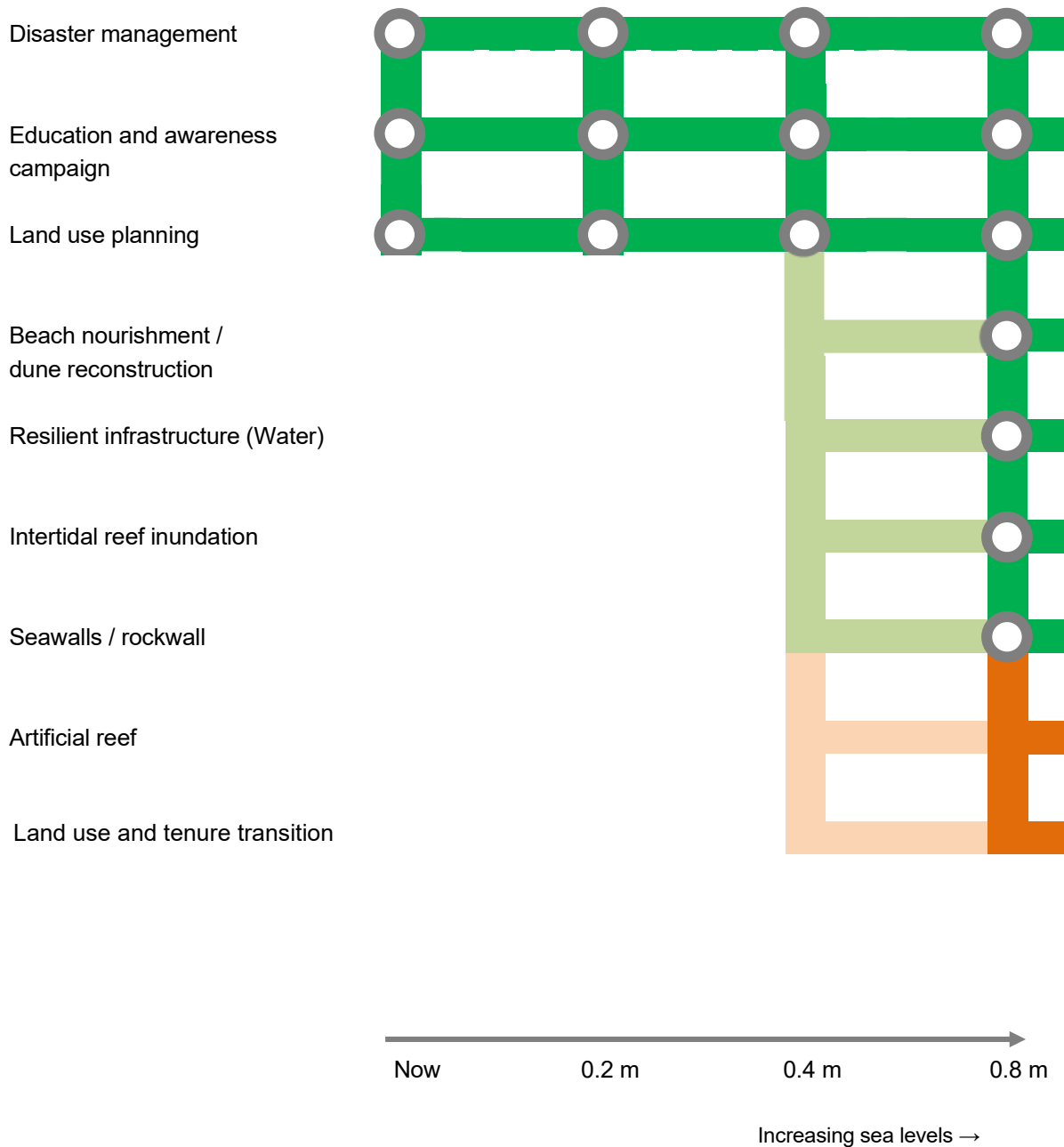


**FIGURE 7-4 ADAPTATION PATHWAYS - BARGARA**

Adaptation for the coastal settlement of Bargara will require appropriate land use planning and development controls to ensure new development is not subject to intolerable risks. Maintaining resilience by implementing disaster management and education and awareness campaigns. Monitoring the rate erosion in Nielsen's Beach and the Bargara foreshore over time may lead to the implementation of a SEMP in these locations. Investigating the construction of a seawall may occur after 0.4 m of sea level rise.



### 7.1.5 Innes Park and Coral Cove



**FIGURE 7-5 ADAPTATION PATHWAYS – INNES PARK AND CORAL COVE**

Adaptation for the coastal settlement of Innes Park and Coral Cove will require disaster management, land use planning, implementing beach nourishment and dune reconstruction. Planning for the replacement of infrastructure and investigating the construction of a seawall may occur after 0.4 m of sea level rise.



### 7.1.6 Elliott Heads

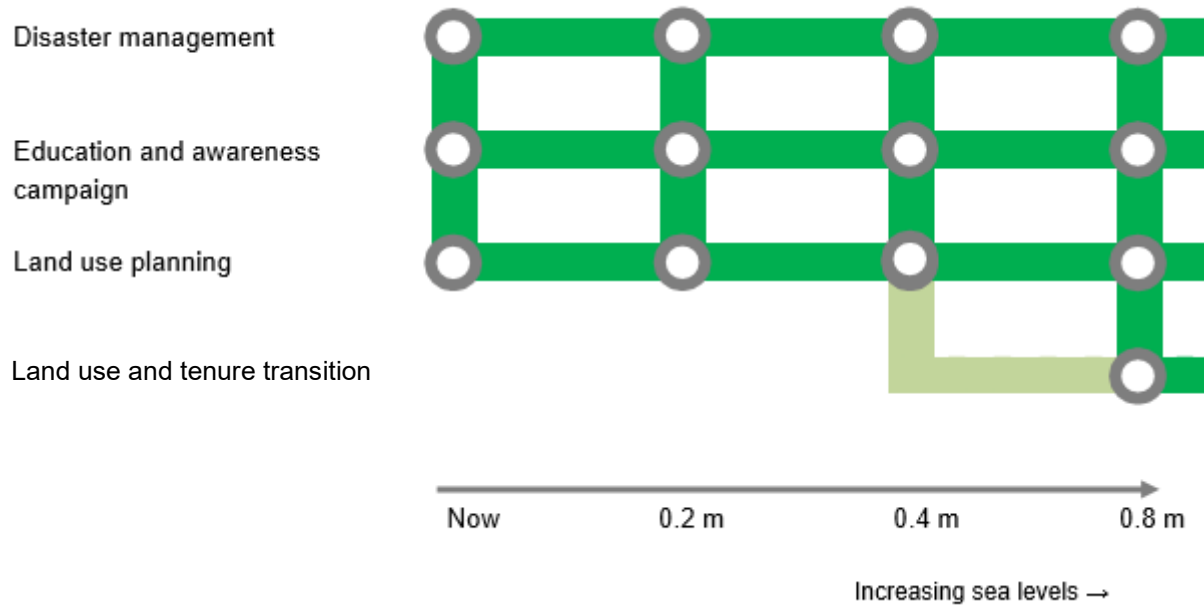
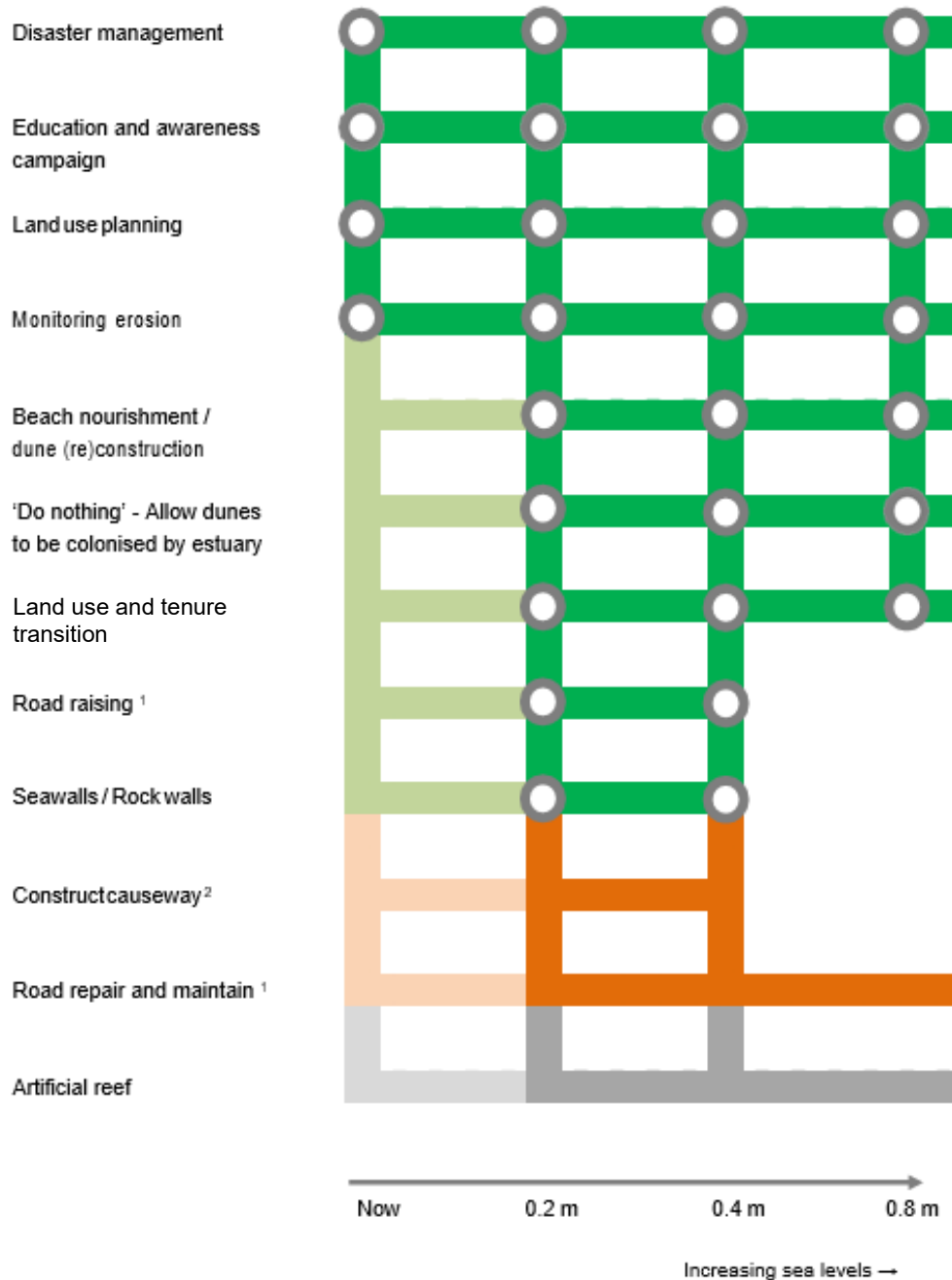


FIGURE 7-6 ADAPTATION PATHWAYS – ELLIOTT HEADS

Adaptation for the coastal settlement of Elliott Heads will require continued land use planning, education and awareness, disaster management and land use and tenure transition, which may occur after 0.4 m of sea level rise.

### 7.1.7 Coonarr

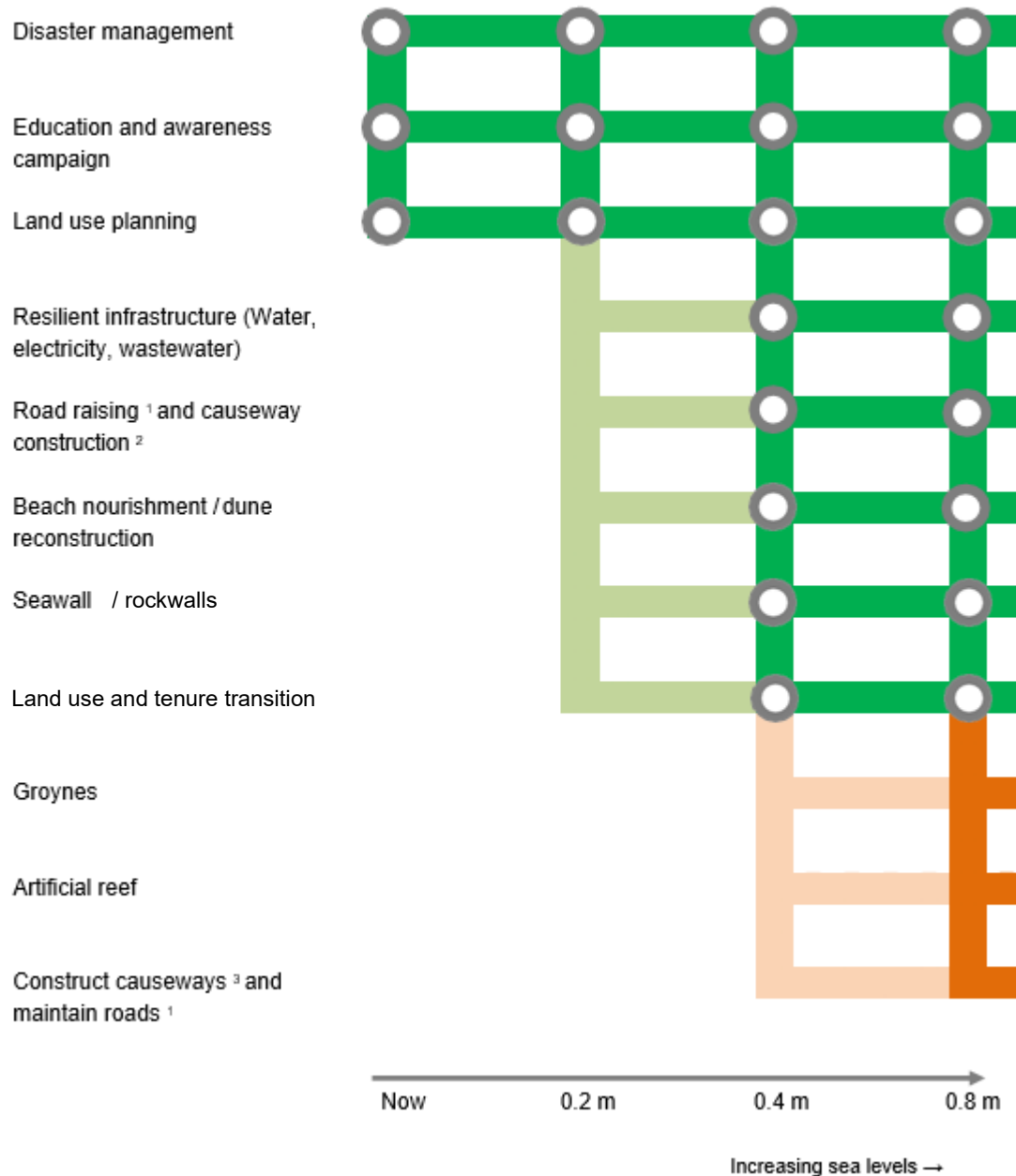


**FIGURE 7-7 ADAPTATION PATHWAYS - COONARR**

Adaptation for the coastal settlement of Coonarr will require immediate investigation of raising Coonarr Beach Road to prevent isolation to the community. Potential land use and tenure transition may occur after 0.2 m of sea level rise.

1 - Coonarr Road, 2 - Coonarr Beach Road

### 7.1.8 Woodgate Beach and Walkers Point



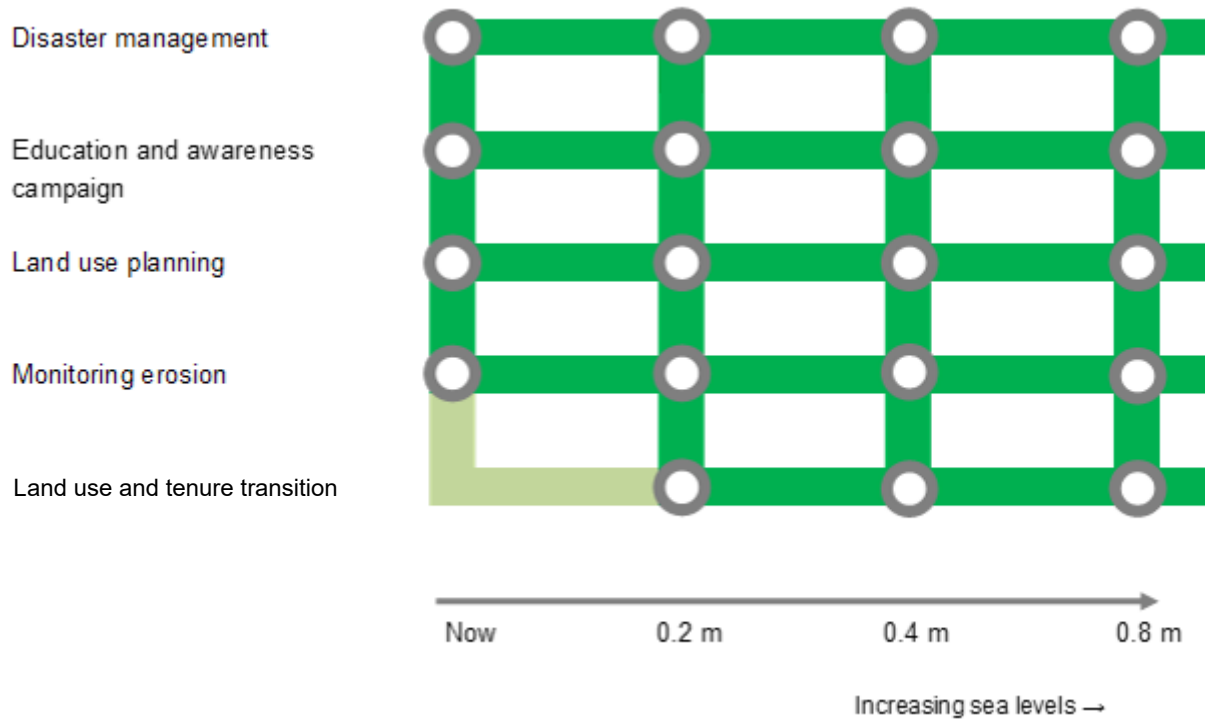
**FIGURE 7-8 ADAPTATION PATHWAYS – WOODGATE BEACH AND WALKERS POINT**

Adaptation for the coastal settlement of Woodgate Beach and Walkers Point will require disaster management, education and awareness campaign to maintain resilience. Planning for the implementation of seawall, beach nourishment, replacing infrastructure and raising key access roads to prevent isolation may occur after 0.2 m sea level rise.

1 – Walkers Point Rd, Acacia Street, Theodolite Creek, Paperbark Court – First Avenue, 2 – Paperbark Court – First Avenue, 3 – Walkers Point Rd, Acacia Street, Theodolite Creek



### 7.1.9 Buxton



**FIGURE 7-9 ADAPTATION PATHWAYS - BUXTON**

Adaptation for the coastal settlement of Buxton will require disaster management, land use planning and education and awareness campaigns. Planning for potential land use and tenure transition may require immediate investigation after 0.4 m of sea level rise.





## 7.2 Next Steps

The adaptation pathways provide a preliminary format for appreciation of how the final strategy will be informed. The pathways will undergo further refinement once the multi criteria analysis is complete in Phase 7.

Whilst the CHAS has identified a range of adaptation options and trigger points for implementation, there are a suite of measures that require further appraisal and cost benefit analysis for Council to choose a 'preferred pathway' in Phase 7 and 8. This will be undertaken using a MCA approach, where each option is assessed against the range of evaluation criteria. Because criteria are not all equally important, they will be given a weight. The MCA will undertake the following process:

- Select evaluation criteria based on minimum guidance, community surveys output and stakeholder consultation
- Weighting for criteria will be applied in consultation with Council and key stakeholders and the 15 pre-selected options will be compared against each other to rank them from 1 to 15.

Phase 8 of the CHAS involves the drafting of the Strategy and Implementation Plan linked to resilience improvements coupled with development of monitoring and evaluation processes.



## 8 REFERENCES

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