Fraser Coast Coastal Hazard Adaptation Economic Analysis

Fraser Coast Council CHAS Phase 7

A confidential Final Report prepared for Fraser Coast Council

Friday 26 March 2021

AITHER

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Purpose of this report

This report and the associated analysis has been prepared as part of *Phase 7 - Socio-economic appraisal*, to inform the Fraser Coast Council Coastal Hazard Adaptation Strategy (CHAS) project.

In satisfying the QCoast2100 minimum standards and guidelines for Phase 7 - Socio-economic appraisal, this report is to be read in conjunction with the Fraser Coast CHAS Phase 6 - Adaptation options report (BMT Nov 2020).

Executive Summary

Overview

Many coastal communities in the Fraser Coast are already vulnerable to coastal erosion, permanent inundation due to sea level rise and storm tide inundation hazards, with risks increasing in the future. Aither was engaged, in partnership with BMT, to undertake a high-level socio-economic analysis of potential adaptation options at key locations throughout the Fraser Coast. The extent of coastal hazard impacts across the region are widespread, necessitating a high-level assessment of adaptation strategies to provide broad direction for Council's adaptation response.

The locations assessed include:

- the Hervey Bay Esplanade, including the suburbs of Point Vernon, Pialba, Scarness and Torquay and Urangan
- the Northern Beaches including Burrum Heads, Toogoom, Craignish, Dundowran Beach and emerging communities at Eli Waters
- the Great Sandy Strait Communities, including Maaroom, Boonooroo, Tuan, Poona and Tinnanbar
- Booral, River Heads and Susan River
- the Mary River.

Across these locations, there are highly valued beaches, parks, public infrastructure, and private properties that deliver benefits to Fraser Coast residents. Without appropriate future adaptation actions, there is a significant risk to these benefits and to the wellbeing of Fraser Coast residents.

This assessment focuses on the adaptation actions identified for further investigation through the Fraser Coast CHAS Phase 6 - Adaptation options report (BMT, 2020). For Hervey Bay Esplanade the material benefits and costs of the proposed options have been quantified, as there is sufficient data available to undertake a robust analysis. For the other locations there is limited data, and therefore the assessment is preliminary only and is limited to a high-level qualitative analysis of the proposed adaptation options.

Recommendations

This assessment has provided some clear priority recommendations for Council:

- Undertake beach nourishment in the short to medium-term along the Hervey Bay Esplanade. Council should also further investigate reconstruction or upgrades to seawalls to manage the risk of beach nourishment becoming unfeasible.
- For small, vulnerable communities where protection through engineered solutions is infeasible, focus on planned transition of assets most at risk by 2050, and provide practical support for the community.
- For areas where beach nourishment is a priority action, undertake detailed scoping studies of the capacity for beach nourishment and identify priority locations. This should include further investigation of how beach nourishment may be affected by proposed changes to zoning in the Great Sandy Marine Park.

- For areas with more significant tourist visitation, undertake a review of local tourist visitation and expenditure. This should include investigating tourists' reasons for visiting Fraser Coast. This would provide a better understanding of the visitor economy including whether tourists would visit other locations if local beach access was restricted by future coastal erosion and sea level rise. It would also help to prioritise adaptation responses.
- For areas where there is expected to be future development within current and future coastal hazard affected areas, undertake a review of the implications of the updated information for approved development. Council should also work with the developers to plan for a risk-responsive development outcome. This includes areas such as the Eli Waters/ Dundowran Emerging Community local plan area.
- For areas where roads, or other community infrastructure such as boat ramps, are at significant risk from coastal hazards, Council should investigate options for adapting or relocating. It should be noted that these assets may also be State-controlled in some locations and that Council is currently reviewing its service level provisions.

These actions will help support Council to understand the costs, benefits and risks of actions for these communities before undertaking more significant investments.

Summary of quantitative assessment for Hervey Bay Esplanade

The Hervey Bay Esplanade is an area of open coast from Point Vernon to Urangan. The area is highly urbanised, comprising of a mix of low to high density residential areas and tourism nodes incorporating high rise development and commercial activity centres. The area provides significant benefits to the local community and the wider region, including:


Benefits from the recreational use of the beaches.


Benefits to local businesses from profits from tourism.


Benefits to Fraser Coast residents from the existence of the beach.


Amenity and recreational benefits to residents from the parkland behind the beach.


Benefits to property owners from the use of private land and assets.


Benefits to the community from the use of public assets.

Ongoing investment in property development is expected in this area, with development of both vacant lots and single dwelling properties into apartment or unit complexes. Notably, these areas have significant capacity for growth and have not reached the development potential envisaged and encouraged by the land use planning policy and provisions currently in place. This will further increase the value of properties, support increased tourism and population growth, and therefore increase the value of the benefits to the local community.

The effects of coastal hazards at Hervey Bay Esplanade

Currently council undertakes limited and generally reactive actions to manage erosion along Hervey Bay Esplanade. Seawalls are also in place in some locations. If no additional actions are undertaken, coastal erosion, sea level rise and storm tide events are expected to progressively damage both natural and built assets in the area. The specific impacts from coastal hazards include:

- damage to the foreshore, parks and community coastal assets (jetties, piers etc.)
- damage to roads and other community assets
- damage to private commercial and residential properties
- reduced tourism value due to damage to foreshore and coastal assets, as well as disruption from inundation.

Options for protecting Hervey Bay Esplanade

Four adaptation options for Hervey Bay Esplanade which were identified in Phase 6 as requiring further investigation are described in Table 1. These options have been assessed against the base case of no additional actions over those already being undertaken. The development of options focused on providing protection from coastal erosion, however there will also be benefits from avoided inundation from sea level rise and storm tide events.

Table 1 Adaptation options for protecting Hervey Bay Esplanade and surrounding assets

Option	Description	Timing
Option 1 	Avoid development or redevelopment of lots within the coastal erosion hazard extents.	New development prevented from 2020.
Option 2 	Remove or relocate privately owned at-risk properties and relocate at-risk infrastructure.	Undertake relocation from 2050.
Option 3 	Reconstruction or upgrades to rock seawall along sections of the beach.	Reconstruction begins in 2050 with maintenance undertaken every 10 years.
Option 4 	Beach nourishment to maintain sufficient sand volume to accommodate storm bite.	Nourishment undertaken every 5 years from 2020 to 2050, and every 3 years from 2050 to 2100.

Costs and benefits of each option

The quantified costs and benefits for Fraser Coast LGA are identified and described in Table 2. It should be noted that all benefits arise from the protection of current values, rather than through generating new value to the community.

Table 2 Costs and benefits of options (all shown as present values using a 7% discount rate)

Option		Net present value*	Investment costs	Other costs to the community	Benefits
1	Avoid	**-$139.5 million**	Limited administrative costs associated with changes to planning regime	**-$140.4 million** Loss of benefits to those who could otherwise live or stay in properties developed along the Esplanade in future	**$0.9 million** Avoided inundation damage to properties that would otherwise have been developed
2	Transition/ retreat	-$38.9 m	Purchase of properties by Council (not a net cost to the community**)	**-$39.9 million** Loss of benefits to those who could otherwise live or stay in properties acquired by council	**$1.0 million** Avoided inundation damage that would have occurred if properties and public assets were not relocated.
3	Seawall	**$41.2 million**	**$8.7 million** • Construction of seawall • Ongoing maintenance	**-$16.7 million** Loss of beach over time leading to reduced recreational use and existence values, and reduced tourism	**$66.6 million** • Avoided erosion and inundation damage to properties ($45.3 million) • Avoided damage to parks and other community infrastructure ($21.3 million)
4	Beach nourishment	**$268.1 million**	**$8.4 million** Beach nourishment every 5 years to 2050, and every 3 years to 2100.	None quantified	**$268.1 million** • Avoided erosion and inundation damage to properties ($45.3 million) • Avoided damage to parks and other community infrastructure ($25.0 million) • Maintain tourism benefits ($144.3 million) and increase access to beach ($62 million)

Note: *Net present value is calculated as benefits minus costs ** This is not a net cost to the community as it represents a transfer of funding from the council to the property owners

Findings from the quantitative analysis

The results show that option 3 (seawall) and option 4 (beach nourishment) provide net benefits to the community between now and 2100. Beach nourishment provides the greatest net present value to the community due to:

- the maintenance of all highly valued tourism and park amenity benefits, as well as the protection of key coastal assets including jetties, piers and beach access
- reduced exposure to coastal erosion and inundation for public assets (e.g., roads) and private property
- no additional costs associated with the loss of the beach which occur under option 3.

The findings also demonstrate that combining beach nourishment in the short term with reconstruction of the seawall would also be expected to deliver net benefits to the community. This option would deliver reduced benefits and increased costs compared to only undertaking beach nourishment, however the risks would also be significantly reduced.

The council should investigate reconstruction or upgrades to seawalls to manage the risk of beach nourishment becoming unfeasible.

The analysis also demonstrates the importance of local parks and tourism benefits in delivering a positive net present value for coastal management. Better understanding of the effects of coastal hazards on tourism, and the value of local parks should be a key area of focus for the next stages of assessment.

Council's capacity to undertake beach nourishment is limited by the extensive marine park zoning along the coastline, which protects the unique marine environment but also restricts sand extraction activities. There is therefore significant uncertainty about the costs of beach nourishment. These costs should also be investigated further and identified as an action in the supporting implementation plan. However even if these costs are significantly higher, beach nourishment is still expected to be the most appropriate action to undertake in the short term.

Summary of qualitative assessment for other locations

A qualitative assessment of the potential costs, benefits and risks of adaptation options was undertaken for the following locations:

- the Northern Beaches including Burrum Heads, Toogoom, Craignish, Dundowran Beach and emerging communities at Eli Waters
- the Great Sandy Strait Communities Maaroom, Boonooroo, Tuan, Poona and Tinnanbar
- Booral, River Heads and Susan River
- the Mary River.

A qualitative approach was undertaken due to limited data availability compared to the Hervey Bay Esplanade. The assessment at these locations is therefore more limited. The findings for these locations therefore focus on next steps for Council that should be undertaken to enable improved adaptation planning in future.

Overview of locations

Burrum Heads and surrounds

Burrum Heads and surrounds covers the northern coastal portion of the Fraser Coastal area, from Burrum River to Beelbi Creek and inland to Howard. Burrum Heads is a popular coastal holiday village with attractions including the beach, seaside caravan parks and holiday houses, recreational boating facilities and small businesses. The risk from coastal hazards in this location increases significantly between 2050 and 2100. The existing seawall lining the Burrum River and a small section of coastline provides some protection to private property and community assets that are at risk. However if no additional actions are undertaken, coastal erosion, sea level rise and storm tide events are expected to progressively damage both natural and built assets in the area.

Toogoom, Craignish, Dundowran Beach and Eli Waters

The area including Toogoom, Craignish, Dundowran Beach and Eli Waters is located between Burrum Heads to the north west, and Hervey Bay Esplanade to the south east. Toogoom is a coastal holiday village that includes residential properties, some seaside holiday accommodation and small commercial facilities. Craignish and Dundowran Beach and Eli Waters are mainly residential areas, and limited tourist accommodation. The eastern part of Dundowran Beach and the western section of Eli Waters have been identified as areas for future development, with approvals in place for a tourism node in the Eli Waters/ Dundowran Emerging Community local plan area.

The coastline from Toogoom to Eli Waters is at low risk from all coastal hazards. Inland from the coastline, a substantial section of Pialba Burrum Heads Road is currently at high risk from coastal hazards, with the expected risk to this section of road increasing under future climates. This road is a State-controlled road and an evacuation route that is a critical link for several communities between Burrum Heads and the main population and commercial centre of Hervey Bay.

Booral to Susan River

This location includes the coastline from Booral to Susan River and associated catchment areas. The settlement at River Heads is located between the water body of Hervey Bay and the confluence of the Mary and Susan Rivers. An important boating facility is used for recreational boating and for daily ferry and vehicular barge services to Fraser Island. Development at River Heads is predominantly rural residential or low-density residential. Most residential development in this location is well elevated.

Most of the River Heads community is not directly affected by coastal hazard areas, with only a small number of residential properties at risk by 2100. However, some areas zoned as emerging communities are at greater risk from sea level rise and erosion from 2050. The major assets affected by coastal hazards in this location are the barge ramp and boat ramp.

Great Sandy Strait Communities

This location includes the coastal settlements of Maaroom, Boonooroo, Tuan, Poona and Tinnanbar on the mainland shoreline of Great Sandy Strait, as well as the surrounding areas of Boonooroo Plains. This area includes extensive environmental assets and protected areas, including Great Sandy Conservation Park, Tuan State Forest and Poona National Park.

The small population centres are dispersed within these protected areas. Poona has the largest population and includes both permanent residences and holiday houses. Each settlement supports recreational activities such as boating and fishing, with a formal boat ramp at all settlements. Caravan

parks are located at Boonooroo, Poona and Maaroom. Commercial activities are limited with small stores located in Poona and Boonooroo. There are also small sandy beaches at each settlement.

Residential properties in Maaroom, Boonooroo Tuan, and Poona are at risk from coastal hazards under both current and future climates, with the risks increasing significantly between 2050 and 2100. Areas of the foreshore at Tuan, and Poona are also at risk from coastal hazards. There are limited risks to the settlement at Tinnanbar, with the main risk at the boat ramp site and the beach and foreshore reserve.

Mary River

The Mary River region is highly valued for the range of recreational opportunities it provides. The river system is popular among residents and visitors for boating and fishing. The parkland surrounding the river is also valued as an area for recreation, events and markets, and places to stay and eat. The main population centre for this location is Maryborough, on the Mary River. Maryborough includes several significant heritage sites, a central business district and key public facilities located close to the River. Maryborough and the surrounding localities of Maryborough West, Granville and Tinana all contain low density housing and associated facilities and services, as well as rural areas.

The risks from coastal hazards in this location are generally confined to the fringes of the river and its tributaries. The land extending across the riverbank has been identified as being at risk, although the number of properties directly affected is much lower. Specific impacts from coastal hazards include damage and disruption to roads and other community assets including parkland and damage to private commercial and residential properties.

Options and recommendations

As part of Phase 6, a range of coastal adaptation options were developed and assessed through a locality-based MCA. This process identified a set of options that should be investigated further through the Phase 7 assessment. The set of options for assessment varies by location, but overall includes the following types of actions:

- **Adapt:** build community resilience and build redundancy into the road network.
- **Protect:** maintain or refurbish existing seawalls in the near term and undertake upgrades to the existing seawall in future.
- **Enhance and protect:** undertake beach scraping and small-scale beach nourishment in the short term, with large scale beach nourishment after 2050.
- **Planned transition:** Commence planning for transition in the near term and retreat and relocate important infrastructure in future as required.
- **Avoid:** raise land levels and reduce intensity of development or implement coastal building lines and development setbacks.

These options were qualitatively assessed for the relevant locations using information from the Phase 6 assessment, economic data where available, and expert knowledge from Council. The assessment was used to develop recommendations, which focus on next steps for Council, to inform development of a robust adaptation strategy across the whole Fraser Coast. The priority recommendations have been summarised by location in Table 3. The recommendations focus on short-term priorities for each area based on the assessment, it is likely that in future different actions will be required in different locations as more detailed assessments are undertaken.

Table 3 Recommendations for Council by location

Council is recommended to prioritise the following actions for each area*	Burrum Heads	Toogoom, Craignish, Dundowran Beach, Eli Waters	Booral to Susan River	Great Sandy Strait Communities	Mary River
Scoping study of potential for beach nourishment	✓	✓			
Review of tourist visitation and expenditure	✓				
Survey of recreational use of the beach/foreshore	✓	✓			✓
Assessment of changes to planning policy, provisions and application requirements for new developments		✓			
Technical feasibility assessments for relocating or upgrading infrastructure such as roads or barge ramps		✓	✓		✓
Investment in pragmatic, practical solutions to support the local community to adapt to the current and future impacts of inundation and coastal erosion				✓	

Note *Some of these actions may also be relevant for all areas in future

1. Background, purpose, and scope

1.1. Background and purpose

Climate change is leading to sea-level rise and an increase in the frequency and severity of coastal hazards relative to the present day. Coastal hazards including storm tide inundation, coastal erosion and permanent inundation as a result of sea level rise pose a significant risk to the social, economic, and environmental values of communities along the Fraser Coast coastline and estuarine catchments.

The QCoast2100 Coastal Hazard Adaptation Program is a Queensland Government commitment to assist councils with coastal hazard adaptation strategies (CHAS) in response to these hazards. The CHAS includes the identification of strategic adaptation options to respond to the risks of coastal hazards. These options are evaluated based on their impacts on priority tangible and intangible assets in the Local Government Area, and the associated benefits and costs to the local community.

This analysis has been undertaken as part of Phase 7 – Socio-economic appraisal, to inform the Fraser Coast Council Coastal Hazard Adaptation Strategy (CHAS) project. In satisfying the QCoast2100 Minimum Standards and Guidelines, this report is to be read in conjunction with the Fraser Coast CHAS Phase 6 - Adaptation options report (BMT, 2020) which includes details of the preceding Multi-Criteria Analysis (MCA) and shortlisting of adaptation options at each locality.

1.2. Scope

A strategic economic assessment has been undertaken for key sites to inform Phase 7 of the CHAS process. This report presents the findings of the assessment which aim to:

- identify the social and economic merits of different adaptation options
- provide an evidence base for communicating the benefits and costs of adaptation options to stakeholders
- determine next steps for more detailed investigation.

The socio-economic analysis investigates the effects of coastal hazards between 2021 and 2100. Modelling undertaken by BMT in Phase 3 of the CHAS shows that sea level rise (relative to present day extents) will lead to increasing risk of inundation and erosion for the Fraser Coast. Phase 3 of the CHAS also identified the extent of storm tide inundation between 2021 and 2100. If management activities in these areas are not undertaken, the risk to assets at these locations is expected to progressively increase over time.

As part of Phase 6, a range of coastal adaptation options were developed in response to the coastal hazard risks identified through Phase 5. These options were further developed in consultation with Council's internal technical working group, external stakeholders, and the local community. The full range of potential options for all reporting areas for the CHAS project, were examined through a locality-based MCA (this process is illustrated in Figure 1).

Phase 6 involved the identification and broad review of forty-six (46) unique coastal adaptation options, summarised in the Phase 6 Adaptation Options Compendium (BMT, 2020).

All 46 adaptation options were then considered for each locality. Consideration was given to the community responses from the Adaptation Strategies survey undertaken in July/August 2020 (587 respondents). Then adaptation options were considered using a Multi Criteria Analysis which included economic, environmental and social considerations. A first pass review was undertaken by a qualified coastal engineer, then reviewed by Council's Technical Working Group. This group comprised of engineers, planners, economic, open space and environmental officers.

- A 'traffic light' system was utilised to group the adaptation options to determine if they:
- should be ruled out for a particular locality (STOP)
- required further investigation through Phase 7 (SLOW), or
- are 'no regrets' options that should go ahead without any need for further review (GO).

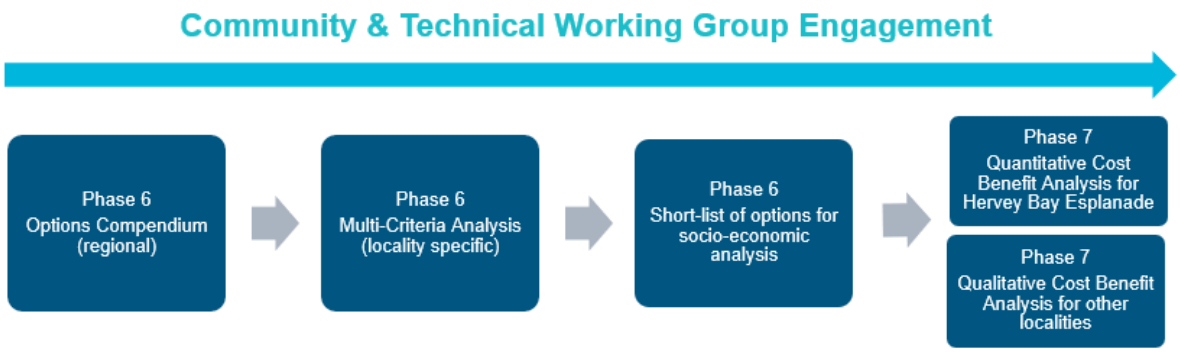
These results were outlined in the Phase 6 Adaptation Options report. Following guidance from LGAQ a detailed investigation of each possible option was not undertaken for this assessment, rather the analysis focused on a higher level grouping of options such as 'avoid', 'transition', 'protect'.

Based on the results of this process, the following locations are assessed in this report:

- the Hervey Bay Esplanade, including the suburbs of Point Vernon, Pialba, Scarness and Torquay and Urangan.
- the Northern Beaches including Burrum Heads, Toogoom, Craignish, Dundowran Beach and emerging communities at Eli Waters.
- the Great Sandy Strait Communities, Maaroom, Boonooroo, Tuan, Poona and Tinnanbar
- Booral, River Heads and Susan River
- the Mary River.

The Phase 6 report concluded that "Socio-economic analysis is needed to refine the preferred adaptation responses and pathways and is the focus of Phase 7 of the project". A quantitative Cost Benefit Analysis (CBA) analysis was possible for the Point Vernon to Urangan coastline (Zone 3). At other locations, there is insufficient data for a quantitative CBA and therefore a qualitative socio-economic analysis will be undertaken (BMT, 2020).

Therefore, for Hervey Bay Esplanade all the material benefits and costs of the proposed options have been quantified, as there is sufficient data available to undertake a robust analysis. For the other locations there is limited data, and therefore the assessment is preliminary only and is limited to a high-level qualitative analysis of the proposed adaptation options.



Source BMT

Figure 1 Workflow for shortlisting adaptation options

2. Hervey Bay Esplanade

2.1. Coastal hazard impacts

The Hervey Bay Esplanade is an area of open coast running from Point Vernon through Pialba, Scarness, Torquay and Urangan. This area is characterised by wide inter-tidal beaches backed by low dunes, beach ridge plains and extensive wetland areas. Urban development is exposed to erosion and inundation hazards under the present and future climates, particularly at Pialba, Scarness, Torquay and Urangan.

Currently council undertakes limited and reactive actions to manage erosion along Hervey Bay Esplanade. Seawalls are also in place in some locations. If no additional actions are undertaken coastal erosion, sea level rise and storm tide events are expected to progressively damage both natural and built assets in the area.

While the timing and magnitude of severe coastal erosion events are uncertain, the likelihood and severity of erosion is expected to increase over time due to climate change. Increasing sea levels are expected to lead to the gradual landward migration of the beach and dunes and reducing the storm buffer.

Community parkland, coastal assets including jetties and piers, parts of the road, and residential and commercial properties along the Esplanade are at risk from erosion and inundation. These risks increase significantly between 2050 and 2100 (BMT, 2020). Destruction of the parkland and coastal assets would greatly reduce the recreational and amenity values to locals and likely impact tourism activity in the Fraser Coast. The damage or loss of beachfront properties along the Esplanade would be a significant cost to property owners and impact local tourism. In addition, the area along the Esplanade is expected to be further developed in future, with expected development of vacant land and redevelopment of residential properties into multi-residence properties. If developed these new properties would also be at risk from erosion and inundation under future climate scenarios.

2.2. Coastal adaptation options

The Phase 6 report reviewed potential adaptation options in the context of effectiveness for both coastal erosion and storm tide inundation. For the Hervey Bay Esplanade, this process identified:

- adaptation options that were labelled 'no regrets' or low cost/high benefit options
- adaptation options that could immediately be ruled out
- adaptation options that required further investigation, which are those that have been subject to analysis below.

The options analysed for Hervey Bay Esplanade in this report are summarised in Table 1. A base case option is included to provide a basis for determining the benefits and costs of each option. The development of options focused on providing protection from coastal erosion, however there will also be benefits from avoided inundation from sea level rise and storm tide events. Further information for each option is provided in the following subsections. The development of options has focused on providing an understanding of the different types of actions and their associated costs and benefits,

rather than developing a specific adaptation pathway. For the future assessments it is likely that a more complex combination of options should be developed.

Table 4 Summary of coastal adaptation options assessed for Hervey Bay Esplanade

Option	Description
Base case	Limited and reactive actions to manage erosion along Hervey Bay Esplanade. Seawalls are also in place in some locations.
Option 1 - avoid	Avoid development or redevelopment occurring within the coastal erosion hazard extents from 2021 onwards.
Option 2 – transition / retreat	Relocate or remove privately owned at-risk properties and relocate at-risk infrastructure from 2050.
Option 3 – seawall	Reconstruction or upgrades to rock seawall along sections of the beach from 2050, with maintenance undertaken every 10 years.
Option 4 – Beach nourishment	Beach nourishment to maintain sufficient sand volume to accommodate storm bite. Nourishment undertaken every 5 years from 2020 to 2050, and every 3 years from 2050 to 2100.

2.2.1. Base case

The base case involves a reactive management strategy which includes beach scraping to maintain amenity following occasional storms. Annual maintenance of the existing seawall is also assumed to continue.

Without any additional management, it is assumed that the parkland, public assets, and private properties currently behind the beach will face progressively greater risk of destruction as the potential severity of future coastal erosion and inundation events increases.

2.2.2. Option 1 – avoid

Option 1 includes updates to planning provisions along the Hervey Bay Esplanade that prevent the development or redevelopment of land or properties within the erosion prone areas. This prevents these properties from being damaged under future coastal erosion or inundation events.

The updates to the planning provisions are assumed to occur from 2021, thereby preventing redevelopment from 2021 onwards. No other protection measures are undertaken.

2.2.3. Option 2 – transition / retreat

Option 2 includes all relocation of all properties within the 2050 erosion prone areas. The properties are assumed to removed or relocated in 2050. No assumptions are made about the properties being leased or converted into other use in order to provide a conservative estimate of the impacts on the community.

No other protection measures are undertaken.

2.2.4. Option 3 - seawall

Option 3 includes reconstructions and upgrades to the existing seawall in this location. The seawall upgrades are undertaken in 2050. The seawall is repaired and maintained every 10 years. The area of

dunes reinstated following severe storms is assumed to always remain at 100 per cent of the current area (4.2 hectares).

The seawall would protect most of the natural and built assets at risk from erosion, including the parkland, public assets, and private properties. The seawall would not protect boat ramps and jetties. Access to the beach is expected to decline compared to the base case, resulting in a loss of recreational beach.

2.2.5. Option 4 – beach nourishment

Option 4 includes large-scale beach nourishment to mitigate sea level rise and maintain all tide access beach (i.e. maintain the 2020 condition). The volume of sand required will progressively increase over time to accommodate loss due to sea level rise and long-term losses. Nourishment is undertaken from 2021 for every five years until 2050 and every three years after 2050.

This high level of nourishment would maintain access to the beach and is assumed to completely protect all natural and built assets at risk from erosion. There will be no long-term loss of recreational beach over the next 80 years.

2.3. Benefits and costs

The costs and benefits for each option have been identified through the previous stages of the CHAS and confirmed through consultation with Council and BMT. The costs of coastal adaptation measures were obtained from BMT. The benefits have been quantified through desktop research and previous coastal adaptation economic analysis conducted by BMT and Aither. The following section describes the costs and benefits under each option.

2.3.1. Management costs

The total discounted capital and ongoing costs under each option are summarised in Table 5. This information has been provided by BMT and is based on high-level assessments of the potential costs of undertaking the different management actions included in the analysis. Detailed unit costs are outlined in Appendix A.

Table 5 Discounted capital and ongoing costs, 2021 to 2101, Hervey Bay Esplanade

	Discounted capital costs relative to the base case	Ongoing costs relative to the base case
Option 1 – Avoid	Administrative costs not estimated	Administrative costs not estimated
Option 2 – Transition / retreat*	Administrative costs of property purchase not estimated	Administrative costs of property purchase not estimated
Option 3 - Seawall	$8.3 million	$0.4 million
Option 4 – Beach nourishment		$8.4 million

Source Aither analysis based on information provided by BMT. Costs discounted to 2021 values.

Note * Costs to purchase property not included as these represent a transfer rather than a net cost.

2.3.2. The benefits of coastal adaptation for Hervey Bay Esplanade

The benefits quantified for the cost benefit analysis of coastal adaptation options at Hervey Bay Esplanade include:

- Beach recreational use benefits – the benefits to Fraser Coast residents from passive or active uses of the beach such as walking, swimming, and sunbathing.
- Beach non-use benefits – the benefits to Fraser Coast residents from the existence of the beach, even if they never visit the beach themselves.
- Park amenity benefits – the use and non-use benefits to local residents provided by the community parkland.
- Private property benefits – the benefits to property owners from living in, or renting out, the private land and assets.
- Public asset benefits – the benefits to the community from using public assets.
- Tourism benefits – the benefits from business profits from tourism.

Each of these benefits are further described in the following sections. Detailed assumptions are provided in Appendix A.

Beach recreational use benefits

Beach users receive recreational benefits from passive or active use of the beach. These benefits are calculated based on the people visiting the beach each year and the value they place on recreational beach use. A narrower beach, or loss of access due to tides, is assumed to negatively affect visitation, and the recreational use value per visit. For this analysis, the average value per recreational use for Fraser Coast residents were taken from a study by Raybould et al. (2011).

Recreational benefits are relevant under options 3 and 4, which change the expected use of the beach relative to the base case. Under option 3 there is a greater loss of beach width and access and therefore a loss of recreational value, so these values are included in the analysis as a loss. Under

option 4 there is increased beach width and access and therefore increased recreational value, so these values are included as a benefit for this option. The losses or benefits from recreational use are incurred by all recreational users of the beach.

Beach non-use benefits

As well as providing individuals with recreational use benefits, the beach is likely to provide significant non-use values to Fraser Coast residents. The non-use values of the beach includes the value of its existence and the potential for use for future generations. An individual may receive these non-use values even if they never use or visit the beach themselves.

Non-use benefits are quantified based on the average non-use value per household (Pascoe et al., 2016), the number of households and the area of beach in the future under each option. Non-use benefits are assumed to only accrue to the residents of Fraser Coast households.

Under option 3 there is a slight loss of non-use benefits due to the gradual loss of beach width over time. Under option 4 there is an increase in non-use benefits due to the protection of the beach. Under options 1 and 2 there is no difference from the base case.

Park amenity benefits

The community parkland situated along the Esplanade provides amenity benefits to nearby residents. These include the tangible benefits from recreational use and non-tangible benefits such as aesthetic appreciation. Under the base case there is an extreme risk of the parkland being destroyed or damaged. Both options 3 and 4 provide protection of the parkland, avoiding the permanent reduction in amenity benefits that would otherwise occur following severe storms.

Park amenity benefits have been quantified based on the average yearly household willingness to pay for public open space (Ambrey and Fleming, 2014), and the area of park that is protected. To avoid potential double counting with the use and non-use benefits of the beach, park amenity benefits are assumed to only accrue to the population who live nearby the parkland.

Private property protection

The protection of private property delivers significant benefits to property owners. The benefits are not limited to the protection of the buildings structure and contents, but also include the benefits received from being able to live in or run businesses from these properties. In contrast, where adaptation requires avoided property development, or removal of properties from at risk locations, there are losses to the community from no longer being able to live in or run businesses from these properties.

Any property falling within the extent of a coastal erosion event is assumed to be permanently destroyed, and all future value that would have otherwise been received is lost. Where a property is affected by inundation, damage costs are estimated based on annual damage cost curves which provide an estimate of the damage related to flood depths. The annual benefits for protecting each property were calculated based on recent market prices for beachfront properties at Hervey Bay Esplanade.

In addition to the current properties located within the erosion prone area, there is also expected to be potentially significant development along the Esplanade in future under the base case. This would increase the number of properties at risk from coastal erosion and inundation. The actual rate of redevelopment is highly uncertain, however it is assumed that all vacant lots with the high and

medium density residential zones are redeveloped into multi-residence properties. This assumption is tested through the sensitivity analysis.

The identified property benefits accrue to the owners of a property, with negligible benefits flowing to the broader public. While some property owners may reside outside the Fraser Coast, ownership records were not available to identify the benefits accrued to these individuals.

Public asset protection

The protection of public assets at risk from coastal erosion can provide a broad range of benefits to the local community and tourists visiting Hervey Bay Esplanade. For this analysis, this is limited to the roads, built assets in the parkland, and coastal assets such as jetties and piers. While there are also potable water and storm water infrastructure at risk, their values were not quantified due to insufficient information being available.

The annual benefits of protecting these assets were quantified by using indicative asset replacement costs. This is a necessary simplification which likely underestimates value that individuals get from the services provided by these assets. The benefits from protection of these assets are assumed to accrue equally to all residents nearby.

Tourism benefits

Tourism visitation to the Fraser Coast provides substantial benefits to the local economy. The level of tourism activity in the Fraser Coast, and therefore tourism benefits are assumed to be affected by both the presence of the beach, other coastal assets and occurrence of inundation events.

Under the base case and options 1 and 2 the reduction in beach access, damage to boat ramps, jetties and piers, and risk of inundation is expected to reduce tourist visitation and therefore profits from tourism activity. This leads to a reduction in profits to local businesses from tourism, and a loss of tourism benefits. However, this assumption is highly uncertain as there is limited evidence on the response of tourists to coastal hazards. This assumption has therefore been tested through sensitivity analysis.

Under option 3 there is a further decline in recreational use of the beach, and there is limited additional protection of coastal assets such as jetties and piers, which is assumed to lead to a further reduction in tourism to the Fraser Coast. Under option 4 protection of the beach and coastal assets and reduced risk of inundation is expected to reduce the risk of reduced tourist visitation and therefore tourism benefits are higher than under the base case.

The future redevelopment of the Esplanade is also expected to affect future rates of tourism, although this has not been directly included in the modelling due to the uncertainties over the proposed rate of development, and the proportion of developments which would be used for tourist accommodation.

The benefits under each option are determined based on the level of tourism activity over time, the typical expenditure per tourist day and profit per dollar of tourism expenditure.

Benefits not considered

There are several benefits not considered in the assessment of coastal adaptation options for Hervey Bay Esplanade, including:

- the of avoided negative physical and mental health effects that may result directly or indirectly from inundation events.

- the avoided costs of response and recovery following inundation events.

2.4. Results

The benefits and costs of each adaptation option were assessed over an 80-year period from 2021 to 2101, using a real discount rate of 7 per cent. This section reports the benefits and costs for each option.

The results show that options 3 and 4 provide net benefits to the community between now and 2100. However, option 4 provides the greatest net present value to the community. Key features driving benefits for option 4 include:

- The maintenance of all tourism and park amenity benefits, as well as the protection of key coastal assets including jetties, piers and beach access
- reduced exposure to coastal erosion and inundation for public assets (e.g., roads) and private property
- no additional costs associated with the loss of the beach which occur under option 3.

The findings also demonstrate that combining beach nourishment in the short term with reconstruction of the seawall would also be expected to deliver net benefits to the community. This option would deliver reduced benefits and increased costs compared to only undertaking beach nourishment, however the risks would also be significantly reduced.

Options 1 (avoid) and 2 (transition) would lead to net costs to the community. For option 1 this is driven by the loss of benefits to those who could otherwise live or stay in properties developed along the Esplanade in future. The loss is particularly high for those properties which would only be affected by coastal erosion by 2100. For option 2 the net costs are driven by the loss of benefits to those who could otherwise live or stay in properties relocated or removed in 2050. If transition did not happen, benefits from using properties in the 2100 erosion prone area could continue for 50 years before the major impacts of coastal erosion occur. This is a very conservative assumption however, and a transition strategy could be developed that reduced these costs by allowing continued access to properties. Neither of these options provide protection to other important assets such as parklands, recreational areas, or beach access.

Table 6 summarises the benefits and costs likely to be received by residents of the Fraser Coast.

Table 6 Cost and benefits for each option relative to the base case, Hervey Bay Esplanade ($ millions)

Metrics/Benefits/Costs	Option 1 – Avoid	Option 2 – transition / retreat	Option 3 – seawall	Option 4 – beach nourishment
Net Present Value (NPV)	-$139.5	-$38.9	$41.2	$268.1
Investment costs				
Capital and maintenance costs	$0.0	$0.0	$8.7	$8.4
Property costs*	$140.4	$39.9	$0	$0
Benefits **				
Recreational beach use	$0.0	$0.0	-$1.9	$12.7
Existence values (beach)	$0.0	$0.0	-$14.2	$49.2
Park amenity benefits	$0.0	$0.0	$21.2	$21.2
Property protection benefits	$0.9	$0.9	$45.3	$45.3
Public asset benefits	$0.0	$0.1	$0.1	$3.8
Tourism benefits	$0.0	$0.0	-$0.6	$144.3

Note *Property costs are the costs to private owners from the loss of value when properties are prevented from being developed, or when they are removed from at risk locations ** Where benefits are shown as negative, it implies a loss to the community. This does not affect the NPV which is the preferred metric for ranking project options. All benefits and costs are expressed in real (2020-21) terms and are calculated over an 80-year time horizon from 2022 to 2101, with a 7 per cent real discount rate.

2.5. Limitations

The analysis of adaptation options for Hervey Bay Esplanade has been undertaken using the data and evidence available within the scope and timeframes of this project. However, there are several assumptions based on expert opinion, and limited accuracy for various data sources.

The key limitations not addressed in this analysis are shown in Table 6. Sensitivity analysis surrounding the magnitude of costs, discount rates, property and parkland values, and the likelihood of erosion events is presented in the following section.

Table 7 Key limitations of the analysis of options for Hervey Bay Esplanade

Limitation	Description
Uncertainty of coastal erosion event extents and severity	The consequence of coastal erosion events is uncertain. Some of assets assumed to be destroyed could have far less damage, and others that were not considered impacted severely damaged.
Uncertainty in sand supply and cost for beach nourishment	The current analysis does not fully reflect the uncertainty of costs for this option. There is significant uncertainty about the availability and viability of local sand sources, and the costs to acquire and transport sand.
Existence values of the beach	Non-use values for environmental goods are challenging to quantify, and can be overvalued if there are other substitute areas readily available, or if quantification methodologies have not been used appropriately. Although the values used for the analysis have been taken from high-quality studies undertaken in Australia they may still overestimate or underestimate the value of the beach.
Extent of property redevelopment	The actual future increase in the number of properties along the Esplanade is highly uncertain, including the timing of development. A greater potential increase in properties increases the value of protect options, but increases the costs of avoid or transition.
Value of parkland to the community	The value of the parkland to the community is not well understood and was based on transfer of values from previous studies. It is possible that the parkland delivers greater benefits to Fraser Coast residents than estimated.
Impacts of beach width on recreational use	The changes in the recreational use of the beach were based on previous studies and assumption. There could be a larger decline in recreational use of the beach than assumed. This would lead to a larger loss of recreational values under option 3.
Impacts on Fraser Coast tourism visitation	The changes in tourism activity under different states of the beach and nearby assets are not well understood. It is likely that a loss of tourism activity would be avoided by maintaining the community parkland and built assets behind the beach. However, the magnitude of this avoided loss is unknown.
Combination of options is the likely outcome (rather than a 'one option' approach)	The approach of this analysis was to broadly assess each type of option available, given the early stage of the assessment. In future it is likely that a combination of options should be developed into an adaptation pathway approach.
Storm tide inundation impacts	Although the effects of storm tide inundation have been included in the costs and benefits for different options, options to specifically address storm tide inundation have not been developed.

2.6. Sensitivity analysis

Sensitivity analysis has been undertaken by testing the effect of the key risks and uncertainties and the major input assumptions on the net present value (NPV). Standard sensitivities around discount rate and capital cost estimates have been included. In addition the sensitivity analysis has focused on using the most conservative input assumptions to test the lower bounds of the benefits of each option.

Sensitivity analysis has been undertaken on the following input assumptions:

- Changes in tourist visitation – sensitivities have been tested where tourist visitation decreases by 10 or 50 per cent, instead of 25 per cent. This is tested for options 3 and 4 which see changes in tourist visitation compared to the base case.
- Increased recreational beach use – there is limited data on the actual number of visitors to the beaches along the Esplanade so currently the analysis uses assumptions based on tourist numbers and some beach surveys, which has been tested with the Council. To further test this assumption a sensitivity of +/- 20 per cent increase in beach visitation is included here.
- Changes in redevelopment along the Esplanade – in the central analysis it is assumed that all vacant lots in high and medium density residential zones will be redeveloped before 2050. The actual rate of redevelopment is highly uncertain, so sensitivities have been included where only 10 per cent of vacant lots have been redeveloped, and where all vacant lots plus all residential lots larger than 1000 m2 are redeveloped.

The results of the sensitivity analysis are shown in Table 8, compared to the central results. The results show that the sensitivity analysis does not affect the preferred options.

Table 8 Sensitivity analysis (NPV, $million)

Sensitivity	Option 1	Option 2	Option 3	Option 4
Central results	-$139.5 m	-$38.9 m	$41.2 m	$268.1 m
Discount rate sensitivities (central = 7%)				
4% discount rate	-$316.3 m	-$172.4 m	$80.0 m	$591.7 m
10% discount rate	-$75.6 m	-$10.3 m	$23.8 m	$158.7 m
Capital cost sensitivities				
Capital costs +20%	-$139.5 m	-$38.9 m	$37.3 m	$264.4 m
Capital costs -20%)	-$139.5 m	-$38.9 m	$44.3 m	$271.1 m
Recreational beach use				
Recreational beach use +20%	-$139.5 m	-$38.9 m	$41.1 m	$183.6 m
Recreational beach use -20%	-$139.5 m	-$38.9 m	$41.4 m	$423.3 m
Tourism impacts (central = 25%)				
10% decrease in tourism	-$139.5 m	-$38.9 m	$38.2 m	$278.8 m
50% decrease in tourism	-$139.5 m	-$38.9 m	$44.1 m	$257.4 m
Redevelopment (central = all vacant lots in high and medium density residential zones)				
20% of vacant lots developed	-$48.5 m	-$26.0 m	$20.3 m	$247.2 m
Vacant lots and residential lots greater than 1000m2	-$281.1 m	-$60.4 m	$403.0 m	$629.9 m

2.7. Findings and recommendations

The cost benefit analysis shows that a major benefit for Fraser Coast Council comes from protecting open space recreational areas, beach access and other coastal assets. These benefits are greatest under option 4 (beach nourishment) which prevents erosion from increasing beyond current day extents. However, each adaptation option also has significant risks and uncertainties which are summarised in Table 9. In particular there is significant uncertainty in the supply and price of sand for future beach nourishment activities, which may increase the costs or reduce the effectiveness of this option.

Based on the assessment of the costs, benefits and risks of each option, Fraser Coast Council should plan to undertake beach nourishment in the short to medium-term along the Hervey Bay Esplanade. The council should also further investigate reconstruction or upgrades to seawalls to manage the risk of beach nourishment becoming unfeasible. The trigger point for constructing the seawall may need to be associated with both storm impacts, shoreline position, or availability and costs of sand. Delaying expenditure on the seawall while undertaking beach nourishment would delay the costs of construction, as well as delaying any loss of access to the beach. This would reduce the costs to the local community.

The analysis also demonstrates the importance of beaches, local parks and tourism benefits in delivering a positive net present value for coastal management. Better understanding of the effects of coastal hazards on tourism, the existence value of the beach, and the value of local parks should be a key area of focus for the next stages of assessment. Significant uncertainty of the costs of beach nourishment suggests that these costs should also be investigated further in the next stages of the assessment and identified as an action in the supporting implementation plan. However even if these costs are significantly higher, beach nourishment is still expected to be the most appropriate action to undertake in the short term.

Table 9 Identified advantages, disadvantages and risks for each option

Option	Advantages	Disadvantages	Risks or uncertainties
Option 1: Avoid	• Avoids development of properties and subsequent damage costs from erosion and inundation	• Does not provide any additional protection to other natural or built assets from erosion or inundation	• The total number and value of properties expected to be developed between 2020 and 2100 is unknown.
Option 2: Transition/ retreat	• Avoids damage to properties from erosion and inundation between 2050 and 2100	• Does not provide any additional protection to other natural or built assets • Provides a transfer from the rest of the community to private property owners in erosion prone areas	• There is significant uncertainty in the number of properties that would be affected in future due to potential development along the Esplanade.
Option 3: Seawall	• Protects built assets including private property and community infrastructure from the effects of erosion and inundation	• Loss of beach access due to seawall • Some potential loss of tourism associated with reduced beach access	• The upfront costs of building the seawall are uncertain. Higher costs may be incurred due to limited feasible rock supply and increased build and cost times
Option 4: Beach nourishment	• Protects built assets including private property and community infrastructure • Prevents loss of tourism associated with inundation • Prevents loss of beach access	• Requires ongoing management and supply of sand	• The current analysis does not fully reflect the uncertainty of costs for this option. There is significant uncertainty about the availability and viability of local sand sources, and the costs to acquire and transport sand.

3. Burrum Heads and Surrounds

Burrum Heads and Surrounds covers the northern coastal portion of the FCRC area, from Burrum River to Beelbi Creek and inland to Howard. The area includes the settlements of Burrum Heads, Howard, and Torbanlea. Burrum Heads is popular coastal holiday village with attractions including the beach, seaside caravan parks and holiday houses, recreational boating facilities and small businesses.

The area provides significant benefits to the local community including:

Benefits from the use and existence of the beaches and boating facilities.

Benefits to local businesses from business profits from tourism.

Benefits to the community from the use of public assets.

Benefits to local businesses from business profits from tourism.

Benefits from the use and existence of the National Park, bushland and river.

Benefits to property owners from the use of private land and assets.

3.1. The effects of coastal hazards

For Burrum Heads and surrounds the risk from coastal hazards increases significantly between 2050 and 2100. The maintained, the existing seawall lining the Burrum River and a small section of coastline provides some protection to private property and community assets that are at risk. If no additional actions are undertaken coastal erosion, sea level rise and storm tide events are expected to progressively damage both natural and built assets in the area.

The specific impacts from coastal hazards in this location include:

- damage to community coastal assets including the seawall and boat ramps
- loss of foreshore areas and damage to the National Park
- damage to roads and other community assets
- damage to private commercial and residential properties
- reduced tourism value due to damage to foreshore and coastal assets and disruption from inundation.

3.2. Options for managing coastal hazards

For Burrum Heads and surrounds the general approach to adaptation identified through the previous CHAS assessments included both hard and soft protection measures, as well as planning for transition. The recommended options included:

- **Adapt and protect:** build community resilience, maintain or refurbish existing seawalls in the near term and undertake upgrades to the existing seawall in future.
- **Enhance and protect:** undertake beach scraping and small-scale beach nourishment in the short term, with large scale beach nourishment and installation of groynes after 2050.
- **Planned transition:** Commence planning for transition in the near term and retreat and relocate important infrastructure in future as required.

3.3. Assessment of options

A qualitative assessment of the costs and benefits for each of the identified options has been undertaken. This has drawn on available data from previous phases of assessment, as well as expert insight from Council and the findings of the cost benefit analysis. The assessment is provided in Table 10.

Table 10 Qualitative assessment for Burrum Heads

	Adapt and protect	Enhance and protect	Planned transition
Investment costs	**Medium costs** associated with maintaining and upgrading existing seawalls	**Medium – High costs** associated with undertaking large scale beach nourishment	**Medium – High costs** associated with building redundancy into road network and relocating community assets
Private property benefits	**Medium benefits** – seawall protects half of the properties affected by coastal erosion, provides limited protection from inundation	**High benefits** – beach nourishment protects the majority of properties including those outside of Burrum Heads	**Low benefits** –future damage is avoided but future benefits of living or staying in properties prior to damage occurring are also lost
Environmental benefits	**Low benefit** – seawall only provides protection for built assets and may lead to increased erosion of beach	**High benefits** – protects national park and other environmental assets and beach extent	**Medium benefits** – no additional protection for National park and environmental assets but minimal interference with natural processes
Recreational use benefits	**Low benefit** – may reduce recreational use of beach and associated benefits	**High benefits** – maintains recreational use of beach and boat ramps	**Low – medium benefits** – maintain access through upgrading the road network, no protection for other coastal infrastructure
Tourism benefits	**Low - medium benefit** – protects some tourist assets but may also reduce attractiveness of location	**High benefits** – protects tourist assets and attractiveness of location	**Low – medium benefits** – maintain access through upgrading the road network, no protection for other coastal infrastructure
Public asset protection benefits	**Medium to high benefit** – protects key public assets in the Burrum Heads locality, does not protect other locations	**High benefits** – protects parks and community facilities	**Medium benefits** – public assets relocated

3.4. Findings and recommendations

This area has a larger population than many other coastal towns in the Fraser Coast, and a higher rate of tourist visitation. The beach, foreshore and national park are all used and valued by residents and will be negatively affected by coastal hazards into the future. A significant number of private properties are also affected as well as some key community infrastructure.

These factors suggest that there is scope for a relatively large-scale investment in beach nourishment, with the community benefits expected to outweigh the costs at this location. However given the proximity to the Great Sandy Marine Park, and the declared Fish Habitat Area at the Burrum River, the viability of beach nourishment at this location is highly uncertain. Undertaking targeted upgrades and refurbishment to the existing seawall is also expected to deliver net benefits, although undertaking an expansion of the existing seawall on public land is not feasible in this location[1]. Preparing for transition of specific community infrastructure should still be undertaken in case other options become unviable.

Given the findings for this location, the next steps for Fraser Coast Council should include:

- Undertaking a detailed scoping study of potential for beach nourishment in this location including further investigation of how beach nourishment may be affected by proposed changes to zoning in the Great Sandy Marine Park.
- Undertaking a review of tourist visitation and expenditure, in particular understanding their reason for visiting, whether they would visit other areas of the Fraser Coast, and whether they would be likely to visit after coastal erosion or inundation events.
- Undertaking a survey of recreational use of the beach and foreshore.

This will provide a clearer understanding of the potential costs, benefits and viability of undertaking large-scale beach nourishment in this location.

[1] Individual properties may be able to manage seawalls on their own land in some locations at Burrum Heads, however further south properties may have limited areas for construction of seawalls on private property.

4. Toogoom, Craignish, Dundowran Beach and Eli Waters

The area including Toogoom, Craignish, Dundowran Beach and Eli Waters is located between Burrum Heads to the north west, and Hervey Bay Esplanade to the south east. Toogoom is a coastal holiday village that includes residential properties, some seaside holiday accommodation and small commercial facilities. Craignish and Dundowran Beach and Eli Waters are mainly residential areas supported by retail and occasional tourist accommodation. The eastern part of Dundowran and the western section of Eli Waters have been identified as areas for future development, with approvals in place for a tourism node at Eli Waters.

The benefits to the local community from this location include:

Benefits from the recreational use of the beaches and coastal environment

Benefits to property owners from the use of private land and assets.

Benefits to the community from the use of public assets.

Benefits from the use and existence of the wetlands, mangroves and coastal dunes.

The redevelopment at Eli Waters may also lead to future benefits from increased property values and tourist expenditure in the area.

4.1. The effects of coastal hazards

The coastline in this location is at low risk from coastal hazards. Inland from the coastline, a substantial section of Pialba Burrum Heads Road is currently at high risk from coastal hazards, with the expected risk to this section of road increasing under future climates.

This road is a State-controlled road and an evacuation route that is a critical link for several communities between Burrum Heads and the main population and commercial centre of Hervey Bay.

The specific impacts from coastal hazards at this location include:

- damage to community coastal assets (in particular the seawall, and boat ramps)
- some loss of foreshore areas and impacts on environmental assets
- damage to roads and other community assets
- damage to private commercial and residential properties including those built in future within the emerging community zones.

4.2. Options for managing coastal hazards

For this location the general approach to adaptation identified through the previous CHAS assessments included both hard and soft protection measures, as well as planning for transition. The recommended options included:

- **Adapt and protect:** build community resilience, maintain or refurbish existing seawalls in the near term and undertake upgrades to the existing seawall in future (Toogoom only).
- **Enhance and protect:** undertake beach scraping and small-scale beach nourishment in the short term, with large scale beach nourishment after 2050.
- **Planned transition:** Commence planning for transition in the near term and retreat and relocate important infrastructure in future as required.
- **Avoid:** raise land levels and reduce intensity of development (emerging communities only)

Toogoom currently has sections of rock revetment in place to protect some residential properties from erosion. However, these provide limited benefits to the broader community, largely due to the relatively low number of residential properties and community assets at high or extreme risk from erosion. The seawalls also provide limited protection from sea-level rise and storm tide inundation and cannot provide protection from erosion impacts from Beelbi Creek. The presence of the seawall may also be causing increased erosion of the adjacent beaches.

4.3. Assessment of options

A qualitative assessment of the costs and benefits for each of the identified options has been undertaken. This has drawn on available data from previous phases of assessment, as well as expert insight from Council and the findings of the cost benefit analysis. The assessment is provided in Table 11.

Table 11 Qualitative assessment for Dundowran, Toogoom and Eli Waters

	Adapt and protect (Toogoom)	Enhance and protect	Planned transition	Avoid
Investment costs	**Medium costs** associated with maintaining and upgrading existing seawalls	**Medium – High costs** associated with undertaking large scale beach nourishment	**Low - medium costs** associated with building redundancy into road network	**Low costs** associated with changes to planning provisions
Private property benefits	**Medium benefits** – protects properties in Toogoom from erosion. No protection for inundation or for other areas.	**High benefits** – beach nourishment protects the majority of properties	**Low benefits** – property is protected from future hazards but current value is lost	**Low - Medium benefits** – developed or redeveloped properties are protected from future damage
Environmental benefits	**Low benefit** – seawall only provides protection for built assets and may lead to increased erosion of beach	**High benefit** – protects environmental assets and beach extent	**Low – medium benefits** – no additional protection for environmental assets but minimal interference with natural processes	**Low – medium benefits** – no additional protection for environmental assets but minimal interference with natural processes
Recreational use benefits	**Low benefit** – may reduce recreational use of beach and associated benefits	**High benefit** – maintains recreational use of beach and boat ramps	**Low benefits** – maintain access through upgrading the road network. no other protection	**Low benefits** – maintain access through upgrading the road network. no other protection
Tourism benefits	**Low benefit** – protects some tourist assets, may also reduce attractiveness of location	**Medium benefit** – protects tourist assets and attractiveness of location	**Low benefits** – maintain access through upgrading the road network. no other protection	**Low benefits** – maintain access through upgrading the road network. no other protection
Public asset protection benefits	**Low benefit** – protects public assets in the Toogoom locality, does not protect other locations including important roads	**High benefits** – protects parks and community facilities and road infrastructure	**High benefits** – public assets relocated or protected through upgrades	**Low benefits** – public assets not protected

4.4. Findings and recommendations

This location is largely a residential area, with relatively dense population and some emerging communities. There is recreational use of the beach and foreshore, and some important environmental assets but more limited tourist visitation. The key assets affected by coastal hazards are roads, including those providing access to Burrum Heads.

Significant investment in beach nourishment may deliver net benefits at this location through protection the road network and coastal assets, including protecting future property development. However, this is highly dependent on sand supply and costs. Given potentially greater benefits from beach nourishment in other locations undertaking planned transition, in particular raising of roads and avoiding development may be more appropriate at this location. Seawalls are not expected to be feasible in this location due to the length of the open coast, and the potential increased erosion of the beach.

The potential risks associated with beach nourishment and the limited feasibility of building new seawalls, may require changes to planning provisions to protect new developments. Increasing development setbacks or requiring additional adaptation measures for any new developments may therefore be appropriate in this location.

Given the findings and key drivers for this location, the next steps for council should include:

- Undertaking a detailed scoping study of potential for beach nourishment in this location including further investigation of the total sand availability for the Fraser Coast region.
- Identify potential changes to planning policy, provisions and application requirements for new developments to reduce the effects of coastal hazards on any new developments and reduce the need for beach nourishment.
- Undertake a detailed shoreline erosion management plan and further investigate the drivers of erosion along Toogoom Spit and the challenges with maintaining existing infrastructure and community values.
- Undertaking a study of recreational use of the beach and foreshore to better understand the potential benefits of investment in this location.
- Identify other options to ensure that the presence of an evacuation route for communities, if beach nourishment is not feasible.

5. Booral to Susan River

This location includes the coastline from Booral to Susan River and associated catchment areas. The settlement at River Heads is located between the water body of Hervey Bay and the confluence of the Mary and Susan Rivers. An important boating facility is used for recreational boating and for daily ferry and vehicular barge services to Fraser Island. Development at River Heads is predominantly rural residential or low-density residential. The majority of residential development in this location is well elevated. The area provides significant benefits to the local community including:

Benefits from the recreational use and existence of the river, foreshore and other environmental assets

Benefits to property owners and businesses from the use of private land and assets.

Benefits to the community from the use of public assets.

Benefits to local businesses from business profits from tourism.

5.1. The effects of coastal hazards

Most of the River Heads community is not directly affected by coastal hazard areas, with only a small number of residential properties at risk by 2100. However, some areas zoned as emerging communities are at greater risk from sea level rise and erosion from 2050. The major assets affected by coastal hazards in this location are the barge ramp and boat ramp. The specific impacts from coastal hazards include:

- damage to community coastal assets including the boat and barge ramps
- loss of foreshore areas and impacts on environmental assets
- limited damage to roads and other community assets
- damage to private commercial and residential properties including future developments
- reduced tourism value due to damage to tourism infrastructure.

5.2. Options for managing coastal hazards

For River Heads the general approach to adaptation identified through the previous CHAS assessments included maintaining current seawalls, as well preventing development in erosion prone areas and planning for transition. The recommended options included:

- **Adapt and protect:** build community resilience, maintain or refurbish existing seawalls.
- **Avoid:** implement coastal building lines and development setbacks.

- **Planned transition:** Commence planning for transition in the near term and retreat and relocate important infrastructure in future as required.

5.3. Assessment of options

A qualitative assessment of the costs and benefits for the identified options has been provided in Table 12. This has drawn on available data from previous phases of assessment, as well as expert insight from Council and the findings of the cost benefit analysis.

5.4. Findings and recommendations

For this location the major asset affected is the barge and boat ramps providing access to Fraser Island, for both locals and tourists. Given the moderate population, and limited damage to other assets adaptation should be focused on highly targeted protection and adaptation for the barge and boat ramps. Investigation of the feasibility of relocating the access point to Fraser Island to another boat harbour such as Urangan, should also be considered given the limited other requirements for investment in this location. Updates to planning provisions should also be considered to prevent development in areas affected by coastal hazards. Planned transition should focus on upgrading or removing assets in line with end-of-life upgrades to minimise costs in this location.

Next steps for this location should include undertaking a technical investigation into options for protecting or adapting the barge and boat ramps, and the feasibility of relocation (noting the Queensland State Government is a key stakeholder). This assessment should be used to inform any future upgrades to the existing infrastructure.

Table 12 Qualitative assessment for River Heads

	Adapt and protect	Avoid	Planned transition
Investment costs	**Medium – high costs** associated with building community resilience, maintaining existing seawalls, and adapting infrastructure	**Low costs** associated with changes to planning provisions	**Medium – High costs** associated with building redundancy into road network and relocating community assets
Private property benefits	**Medium benefits** – seawall protects half of the properties affected by coastal erosion and inundation	**Low - Medium benefits** – developed or redeveloped properties are protected from future damage	**Low benefits** – property is protected from future hazards but current value is lost
Environmental benefits	**Low benefit** – seawall only provides protection for built assets and may lead to additional changes to environmental including increased erosion of beach	**Low – medium benefits** – no additional protection for National park and environmental assets but minimal interference with natural processes	**Low – medium benefits** – no additional protection for National park and environmental assets but minimal interference with natural processes
Recreational use benefits	**Low benefit** – may reduce recreational use of beach and associated benefits	**Low – medium benefits** – maintain access through upgrading the road network, no protection for other coastal infrastructure	**Low – medium benefits** – maintain access through upgrading the road network, no protection for other coastal infrastructure
Tourism benefits	**Low - medium benefit** – protects some tourist assets but may also reduce attractiveness of location	**Low benefits** – maintain access through upgrading the road network, no protection for other coastal infrastructure	**Low – medium benefits** – maintain access through upgrading the road network, no protection for other coastal infrastructure
Public asset protection benefits	**Medium to high benefit** – protects key public assets in the Burrum Heads locality, does not protect other locations	**Low benefits** – public assets not protected	**Medium benefits** – public assets relocated

6. Great Sandy Strait Communities

This location includes the coastal settlements of Maaroom, Boonooroo, Tuan, Poona and Tinnanbar on the mainland shoreline of Great Sandy Strait, as well as the surrounding areas of Boonooroo Plains. This area includes extensive environmental assets and protected areas, including Great Sandy Conservation Park, Tuan State Forest and Poona National Park.

The small population centres are dispersed within these protected areas. Poona has the largest population and includes both permanent residences and holiday houses. Each settlement supports recreational activities such as boating and fishing, with a formal boat ramp at all settlements. Caravan parks are located at Boonooroo, Poona and Maaroom and Tinnanbar. Commercial activities are limited with small convenience stores located in Poona and Boonooroo. There are also small sandy beaches at each settlement.

The area provides the following benefits to the local community:

Benefits from the existence and use of the beaches, foreshore, and strait.

Benefits to property owners and businesses from the use of private land and assets.

Benefits to the community from the use of public assets including boat ramps.

Benefits from the existence of environmental assets.

6.1. The effects of coastal hazards

Residential properties in Maaroom, Boonooroo Tuan, and Poona are at risk from coastal hazards under both current and future climates, with the risks increasing significantly between 2050 and 2100. Areas of the foreshore at Tuan, and Poona are also at risk from coastal hazards. There are limited risks to the settlement at Tinnanbar, with the main risk at the boat ramp site and the beach and foreshore reserve.

Specific impacts from coastal hazards include:

- damage to community coastal assets (including boat ramps)
- loss of foreshore areas
- damage and disruption to roads and other community assets
- damage to private properties
- damage to ecosystems.

6.2. Options for managing coastal hazards

For the Great Sandy Strait Communities, the general approach to adaptation considered through the previous CHAS assessments included maintaining or constructing seawalls (noting that most existing structures are not approved and the design standard is uncertain),, as well preventing development in erosion prone areas and planning for transition. The recommended options included:

- **Adapt:** build community resilience and build redundancy into the road network
- **Protect:** maintain and enhance natural ecosystems (Poona only)
- **Avoid:** implement coastal building lines and development setbacks.
- **Planned transition:** Commence planning for transition in the near term and retreat and relocate important infrastructure in future as required.

6.3. Assessment of options

A qualitative assessment of the costs and benefits for each of the identified options has been undertaken. This has drawn on available data from previous phases of assessment, as well as expert insight from Council and the findings of the cost benefit analysis. The assessment is provided in Table 13.

Table 13 Qualitative assessment for Great Sandy Strait Communities

	Adapt	Avoid	Protect	Planned transition
Investment costs	**Low - Medium costs** to build redundancy into road network and supporting community resilience	**Low costs** associated with changes to planning provisions	**High costs** associated with seawalls in this location	**Medium costs** to relocate community assets and at risk properties
Private property benefits	**Low – medium benefits** – private owners supported to manage own property protection	**Low - Medium benefits** – developed or redeveloped properties are protected from future damage	**Low benefits** – seawalls cannot fully protect properties in this location given complexity of creek systems	**Low – medium benefits** – property is protected from future hazards but current value is lost
Environmental benefits	**Low – medium benefits** – no additional protection for environmental assets but minimal interference with natural processes	**Low – medium benefits** – no additional protection for environmental assets but minimal interference with natural processes	**Low benefit** – protects national park and other environmental assets and beach extent	**Low – medium benefits** – no additional protection for environmental assets but minimal interference with natural processes
Recreational use benefits	**Medium benefit** – maintains recreational use of beach and boat ramps	**Low benefits** – no specific actions to protect recreational use	**Low benefit** – does not provide protection to beaches or coastal infrastructure	**Low – medium benefits** – maintain access through upgrading the road network, no protection for other coastal infrastructure
Tourism benefits	**Low benefit** – protects some tourism but value in this area is limited	**Low benefits** – value of tourism in this area is limited	**Low benefits** – value of tourism in this area is limited	**Low benefits** – value of tourism in this area is limited
Public asset protection benefits	**Medium benefit** – protects road network maintaining community access	**Low benefits** – public assets not protected	**Low benefits** – does not protect road network	**Medium benefits** – public assets relocated

6.4. Findings and recommendations

The very small and dispersed populations in this location makes it unlikely that the public benefits of any 'protect' options would outweigh the costs. The majority of the impacts in these locations are expected to be related to private property damage, or disruption in access to private properties, and therefore investment in protection is not expected to deliver significant public benefits. Even options such as maintaining road access or relocating community infrastructure may have greater costs than benefits in these locations. The local communities in these locations are already experiencing flooding and other impacts from coastal hazards and therefore need actions that can be implemented quickly and efficiently.

Indicative cost estimates suggest that construction of seawalls to protect each of the population centres in the Great Sandy Strait communities would cost close to $50 million by 2100. Even if there was available funding for implementation and the environmental constraints could be overcome, seawalls are unlikely to assist these communities in all instances. Coastal inundation would still occur via the creeks and there would be issues with drainage during rainfall events.

In this location, investment in pragmatic, practical solutions to support the local community to adapt to the current and future impacts of inundation and coastal erosion may be the most appropriate action that can be undertaken in the short term, as well as preventing any additional development in these locations. Other environmental management actions may also be appropriate.

Next steps for this location should include development of a plan to support the local community, in particular to prepare for increasing risks of inundation, and identify appropriate options for planned transition for those assets most at risk by 2050.

7. Mary River

The Mary River region is highly valued for the range of recreational opportunities it provides. The river system is popular among residents and visitors for boating and fishing. The parkland surrounding the river is also valued as an area for recreation, events and markets, and places to stay and eat. The main population centre for this location is Maryborough, on the Mary River. Maryborough includes several significant heritage sites, a central business district and key public facilities located close to the River. Maryborough and surrounding areas contain low-density housing and facilities and services. The area provides significant benefits to the local community including:

Benefits from the recreational use of the river and parkland

Benefits to property owners and businesses from the use of private land and assets.

Benefits to the community from the use of public assets including roads, boat ramps and jetties and other infrastructure.

Benefits to local businesses from business profits from tourism.

7.1. The effects of coastal hazards

The risks from coastal hazards in this location are generally confined to the fringes of the river and its tributaries. The land extending across the riverbank has been identified as being at risk, although the number of properties directly affected is much lower. Specific impacts from coastal hazards include:

- damage and disruption to roads and other community assets including parkland
- damage to private commercial and residential properties
- disruption to tourism and local businesses.

In this location catchment flooding is expected to be a much larger issue for the community.

7.2. Options for managing coastal hazards

The general approach to adaptation identified through the previous assessments included maintaining existing riverbank protection, as well building redundancy into the road network and planning for transition. The recommended options included:

- **Adapt:** build community resilience and build redundancy into the road network
- **Protect:** maintain or refurbish existing riverbank protection
- **Planned transition:** Commence planning for transition in the near term and retreat and relocate important infrastructure in future as required.

7.3. Assessment of options

A qualitative assessment of the costs and benefits for each of the identified options has been undertaken. This has drawn on available data from previous phases of assessment, as well as expert insight from Council and the findings of the cost benefit analysis. The assessment is provided in Table 14.

Table 14 Qualitative assessment for Mary River

	Adapt	Protect	Planned transition
Investment costs	**Medium costs** associated with building community resilience and building redundancy into road network	**Medium costs** associated with maintaining or rebuilding existing protection	**Medium – High costs** associated with relocating infrastructure and properties
Private property benefits	**Low - medium benefits** – community undertakes individual action to protect properties	**Medium benefits** – increased protection for some riverfront properties	**Low benefits** – property is protected from future hazards but current value is lost
Environmental benefits	**Low benefits** – no protection for environmental assets	**Low - medium benefit** – some protection of environmental assets along riverbank	**Low – medium benefits** – no additional protection environmental assets but minimal interference with natural processes
Recreational use benefits	**High benefit** – maintains access to high value recreational areas	**High benefit** – maintains recreational use of river and parkland	**Low benefits** – does not protect recreational use of high value assets
Tourism benefits	High benefit – maintains access for tourist visitation	**High benefit** – protects tourist assets and attractiveness of location	**Low benefits** – does not protect tourist assets and attractiveness of location
Public asset protection benefits	**Medium benefit** – protection of roads but limited other public asset protection	**High benefits** – protects parks and community facilities	**Medium benefits** – public assets relocated

7.4. Findings and recommendations

For this location the key costs to the community are driven by inundation and erosion damaging community assets and disrupting road access, including for some State-controlled roads. Given the relatively large population, the importance of tourist visitation, and range of public benefits from adaptation at this location, investment in adaptation is expected to deliver net benefits. Actions should be focused on protecting high value community assets and enabling continued recreational use and access.

The implications of coastal hazards in this location are complicated by the effects of catchment flooding which is also expected to cause increasing hazards in this location. However the adaptation options proposed are not expected to negatively affect the management of catchment flooding.

For Council the next steps in assessment for this location should include:

- Undertake a coordinated assessment of the connections between coastal hazards and catchment flooding to better understand the likely implications for adaptation.
- Undertaking a technical investigation into options for maintaining road access for council managed roads, including relocating the road or building redundancy into the road network.
- Undertaking a survey of recreational use of the river and foreshore.
- Undertaking a survey of tourist visitation and expenditure, in particular understanding their reason for visiting, whether they would visit other areas of the Fraser Coast, and whether they would be likely to visit after coastal erosion or inundation events.

Appendix A – Data

This appendix provides a summary of all key data and their sources used in the analysis.

Physical data

Data on built and natural assets, modelled erosion extents and inundation depth for each asset were provided by BMT, and are provided in the Phase 5 report.

Adaptation option data

The costs for all management actions undertaken across all locations, and the timing and scale for certain options are summarised in the following tables. Identification of relevant options is provided in the Phase 6 report.

Management action costs

Table 15 Assumed costs

Cost	Value	Description
Beach nourishment variable cost per nourishment (2021-2051)	$1,300,000	Total cost per nourishment activity, undertaken every 5 years
Beach nourishment variable cost per nourishment (2021-2051)	$1,300,000	Total cost per nourishment activity, undertaken every 5 years
Seawall construction	$58,000,000	Cost of seawall for entire length of shoreline
Seawall maintenance	$3,000,000	Maintenance cost per year, undertaken every 10 years
Seawall reconstruction	$29,000,000	Cost to reconstruct seawall at end of 50-year design life

Source BMT

Economic data

Table 16 Economic parameters for Hervey Bay Esplanade

Parameter	Value	Unit	Source
General			
Discount rate (real)	7	%	PAF Guidelines
Analysis price year	2020-21	year	
Time horizon	2022 to 2101	year	
Demographics			
Fraser Coast LGA households	101,504	no	ABS (2016)
Fraser Coast LGA household growth	1.2	%/year	ABS (2016, 2001)
Population nearby community parkland	358	no	ABS (2016, 2001)
Parkland region population growth	1.2	%/year	ABS (2016)
Beach recreation use			
Current beach use	1021500	no/year	Fraser Coast Council (2020)
Annual beach use growth	1.85	%/year	ABS (2016)
Proportion of use by Fraser Coast LGA residents	0.1	proportion	Assumption
Use value for local (Fraser Coast LGA) residents	10.44	$/visit (2008 AUD)	Raybould, M., et al. (2013)
Use value annual growth	1.04	%/year	World Bank and OECD (2019)
Use value for non-residents	11.86	$/use	Blackwell, B. (2007)
Beach non-use value			
Non-use value for protection of sandy beach	0.45	$/ha/quarter/household (2016 AUD)	Pascoe, S., et al. (2016)
Park amenity			

Willingness to pay for a 1% increase in open greenspace	469	$/% increase in open greenspace/year/person	Ambrey, C. and Fleming, C., 2014
Current area of open space in SA1 regions which contain the community parkland at risk	120	ha	Google maps (2020)
Amenity value	391	$/ha/year/person	Aither analysis
Tourism			
Tourism days (day trips)	776,000	days	Tourism Research Australia (2019)
Tourism days (domestic overnight)	696,000	days	Tourism Research Australia (2019)
Tourism days (international overnight)	137,000	days	Tourism Research Australia (2019)
Tourism expenditure (day trips)	108	$/day (2019 AUD)	Tourism Research Australia (2019)
Tourism expenditure (domestic overnight)	128	$/day (2019 AUD)	Tourism Research Australia (2019)
Tourism expenditure (international overnight)	65	$/day (2019 AUD)	Tourism Research Australia (2019)
Tourism expenditure annual growth	1.04	%/year	World Bank and OECD (2019)
Profit per dollar of tourism expenditure	0.17	$profit/$expenditure	Dwyer et al. (2014)
Reduction in tourism without the beach	25	%	Assumption that 25% of tourist beach users would not visit Fraser Coast if Hervey Bay suffered beach loss, loss of jetties and piers and inundation.
Public assets			
Road replacement cost	1,500	$/m (2020 AUD)	BMT
Other asset replacement cost	Varied	$ (2011 AUD)	BMT/ Fraser Coast - Phase 5 assessment

Private properties			
Market value of units	$409,509	$ (2020 AUD)	Fraser Coast Council from real estate data
Market value of houses	$780,680	$ (2020 AUD)	Fraser Coast Council from real estate data
Property owners discount rate	5	%	Assumption
Property market price growth	1.2	%	ABS (2020a)
Redevelopment assumptions			
Average unit size	100	m2	Average size of existing units in Esplanade
Proportion of lot built on	75%	%	Assumption
High density residential zone building height	6	Storeys	Fraser Coast Council
Medium density residential zone building height	3	Storeys	Fraser Coast Council
Tourism node building height	8	Storeys	Fraser Coast Council
Private property protection			
Commercial building replacement cost	$2,179,750	$/building (2017 AUD)	Median Fraser Coast structure value for commercial buildings in the Fraser Coast, Geoscience Australia (2017)
Residential building depreciation	35	%	Bureau of Transport Economics (2001)
Commercial building depreciation	25	%	Bureau of Transport Economics (2001)

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