COOLOOLA COAST

The Resilient Coast

GYMPIE REGIONAL COUNCIL

GYMPIE REGIONAL COUNCIL

Coastal Hazard Adaptation Strategy

Tin Can Inlet

FOREWORD

The Cooloola coast is a dynamic and varied landscape. Our coastal zone encompasses some of the highest dune systems in the world, pristine coastal wetlands, estuaries and inlets, extensive sandy beaches, and a diversity of cultural, economic and environmental values.

The Traditional Owners of the land, including the Kabi Kabi to the south and Butchulla to the north, have inhabited and cared for this ancient landscape for thousands of years.

The coast is highly valued by our Traditional Owners, local communities, residents of the broader Gympie Region, and visitors to the area. The coastal landscape and access to the coast underpins our economy.

Coastlines are dynamic, ever-changing with each tide and storm event. Erosion and storm tide inundation are natural processes that shape the coast over long timeframes. These processes are referred to as coastal hazards when they impact on how we use and enjoy the coast.

The Cooloola Coast is currently prone to coastal hazard impacts, driven by cyclones and storm events. Coastal hazard impacts are also predicted to increase with a changing climate.

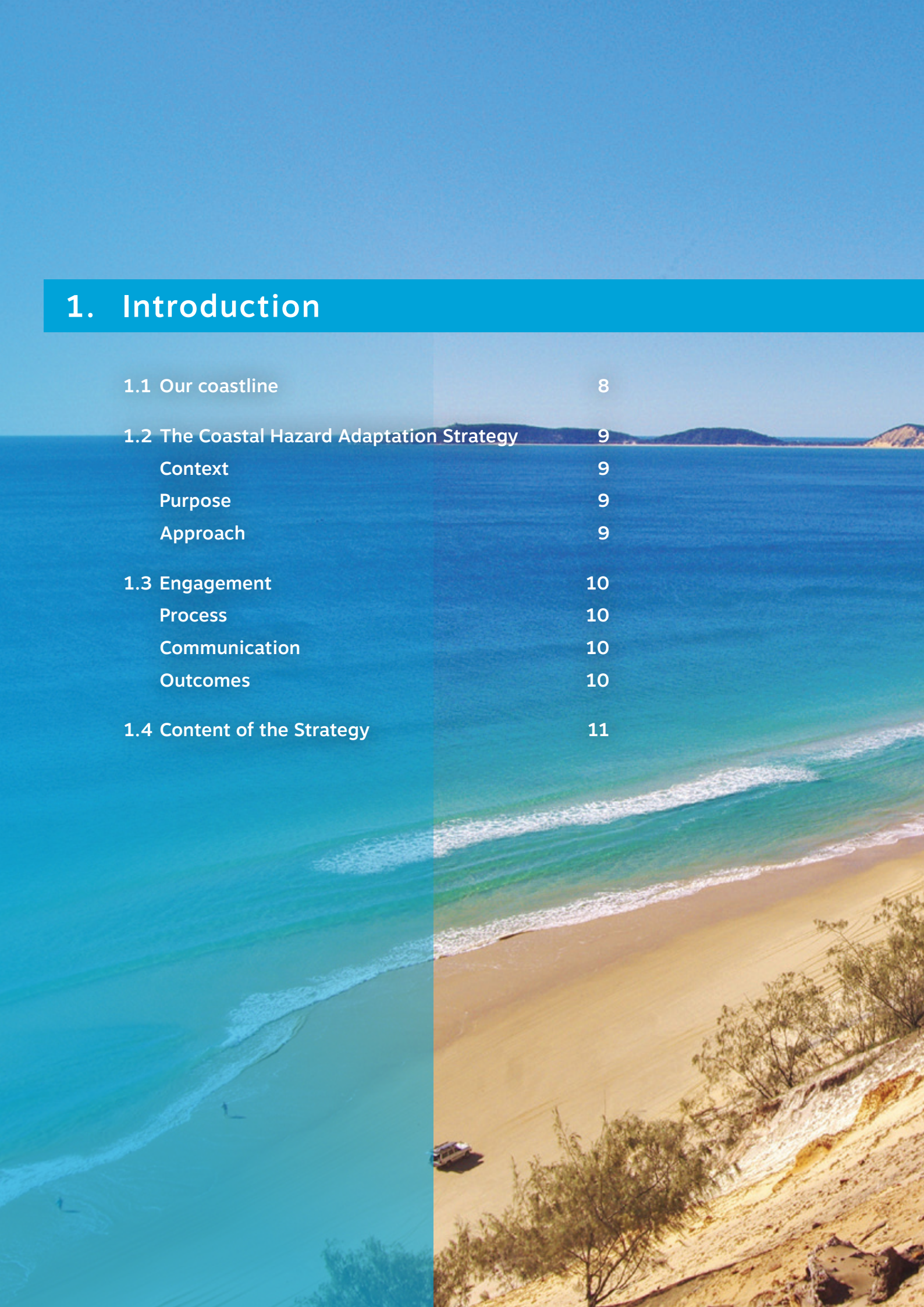
The State Government and Local Government Association of Queensland (LGAQ) provided funding to Queensland coastal Councils to develop a strategic approach to managing coastal hazards. With the funding awarded to Gympie Regional Council, we have been able to develop this Coastal Hazard Adaptation Strategy.

Our Coastal Hazard Adaptation Strategy enables us to be better prepared to reduce the impacts of coastal hazards on our communities, environment, cultural values, infrastructure, liveability and services, both now and into the future (to 2100).

CONTENTS

Tin Can Inlet

1. Introduction



1. Introduction

1.1 Our coastline

The Cooloola coastline of the Gympie Local Government Area (LGA) extends over 50 km from Cooloola Beach, around Double Island Point, along Rainbow beach, around Inskip Point then across Tin Can Bay (Figure 1).

The coastal zone has significant ecological value and includes parts of the UNESCO Great Sandy Biosphere Reserve, the Great Sandy National Park and the Ramsar-listed Great Sandy Strait, a sandy passage estuary between Fraser Island and the mainland.

The coastline is characterised by a unique combination of coastal landforms and ecosystems, including some of the highest parabolic dune systems in the world, a dynamic sandy barrier spit, and extensive coastal plains and wetlands around the bay, inlets, and estuaries.

The diversity of our landscape features support a range of land uses, including social, cultural, environmental and economic values.

The landscape has been shaped by coastal processes over many thousands of years. Erosion and accretion of the shoreline, and inundation of coastal areas, are part of these natural processes. However, these processes can become coastal hazards when they have the potential to impact on infrastructure, access, services, our lifestyle and the economy.

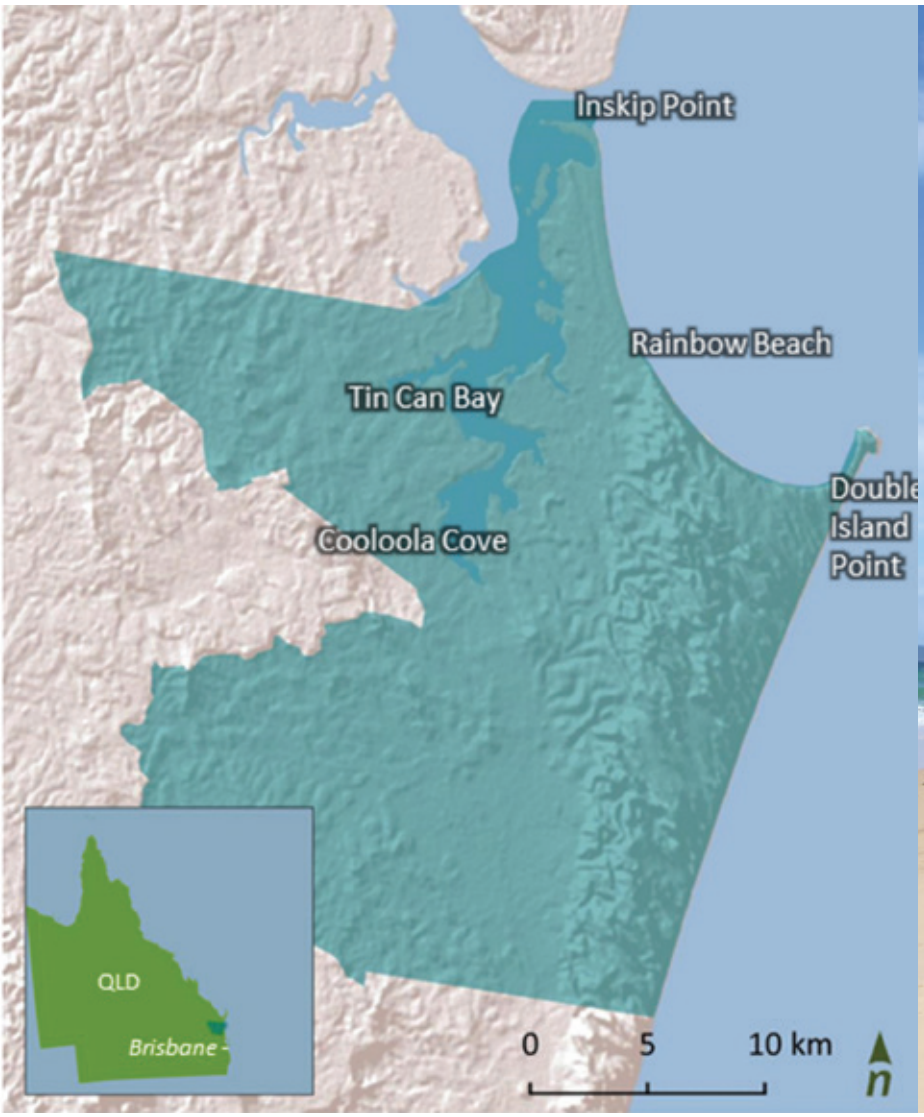


Figure 1. Cooloola coast (along the Gympie LGA)

1.2 The Coastal Hazard Adaptation Strategy

Context

The QCoast2100 program is a state-wide initiative of the Queensland Government and Local Government Association of Queensland (LGAQ), to help coastal councils proactively plan for managing coastal hazard impacts, from present day to 2100.

Gympie Regional Council was awarded funding through QCoast2100 to undertake the Cooloola Coast – The Resilient Coast program and develop the Coastal Hazard Adaptation Strategy (CHAS).

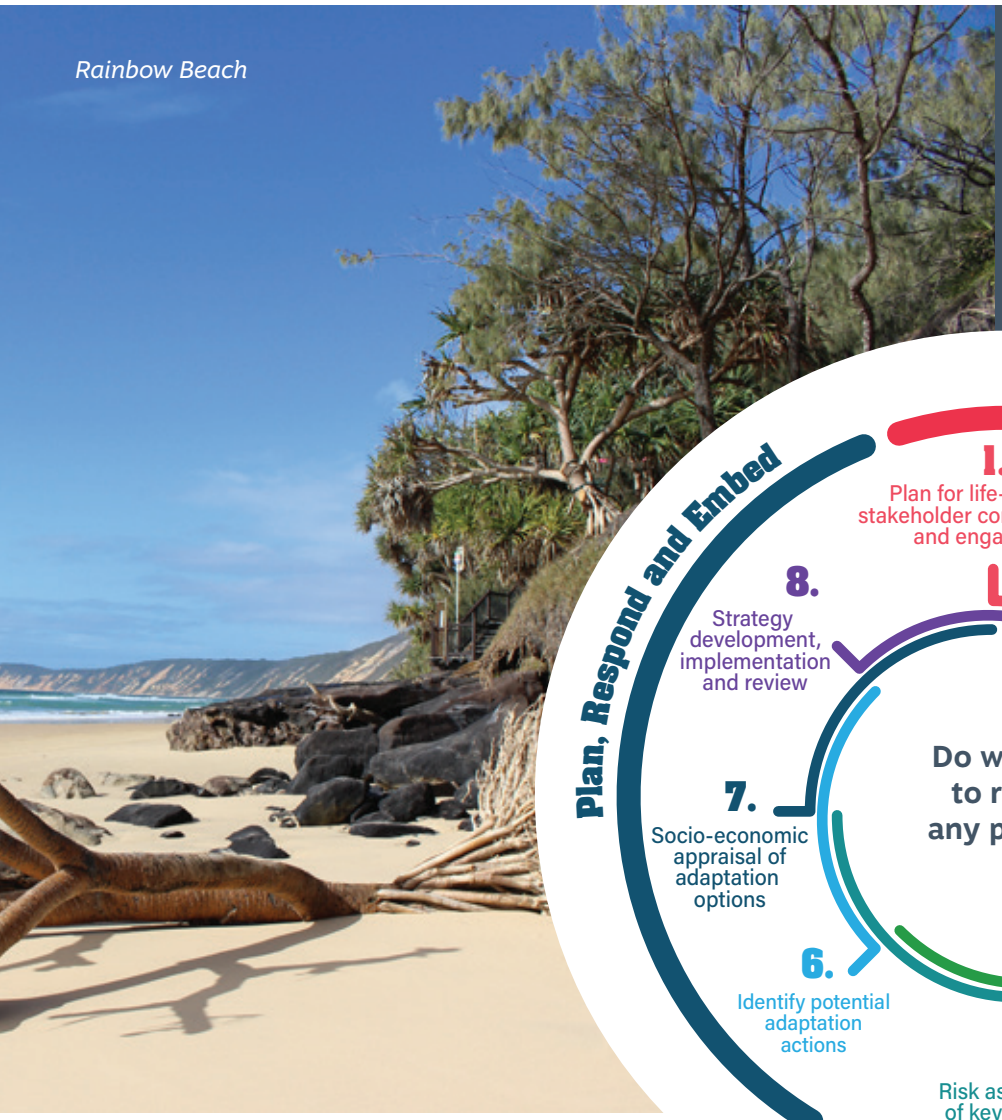
The Coastal Hazard Adaptation Strategy has been:

- Developed to proactively manage the impact of coastal hazards, now and into the future
- Developed in consultation with stakeholders and communities
- Tailored to include our full coastal landscape and communities.

Purpose

The purpose of The Strategy includes to:

- Inform future decisions regarding the protection and management of our coast and foreshore
- Inform future land use planning
- Guide the management of public utilities and facilities
- Guide the management of areas of environmental and cultural significance
- Foster collaboration and the shared care of our coastline.



Rainbow Beach

Approach

The Coastal Hazard Adaptation Strategy has been developed through an eight-phase process (Figure 2) as outlined in the QCoast2100 Minimum Standards & Guidelines (LGAQ and DEHP 2016).

Figure 2. QCoast2100 eight-phase process

The process has included a series of studies and activities that sought to:

- Identify coastal hazard areas
- Understand vulnerabilities and risks to assets
- Engage with the community to understand the preferred approaches to adaptation
- Determine adaptation actions, costs, priorities, and timeframes for implementation.

1.3 Engagement

Process

The Strategy development has been informed through consultation with key stakeholder groups and our Gympie Region communities.

Engagement events included:

- Community pop up events in April and May 2019, at multiple venues including Tin Can Bay, Rainbow Beach and Cooloola Cove.
- A community survey and online knowledge in early 2019 to inform an appreciation of coastal values and adaptation opportunities.
- A stakeholder workshop in August 2019 to help build awareness and prioritise important coastal values and assets. This included representatives across State Government, disaster management support, chamber of commerce, and coastcare.
- A four week public comment period in late 2020, including targeted briefings with stakeholders, on-site community pop-up sessions, and an online survey to assist with providing a submission/feedback on the draft.

Communication

During development of the Strategy, communication materials included project updates and a series of tailored fact sheets relevant to coastal hazard adaptation. The fact sheets are provided as Supplement A to this Strategy. The fact sheets include:

- Terminology
- Coastal landscapes
- Coastal hazards
- Coastal adaptation
- Cooloola coast - values and threats
- Adaptation framework
- Strategy summary.

Council's 'get involved' website was used for publicising the project, sharing information, and encouraging registration and participation.

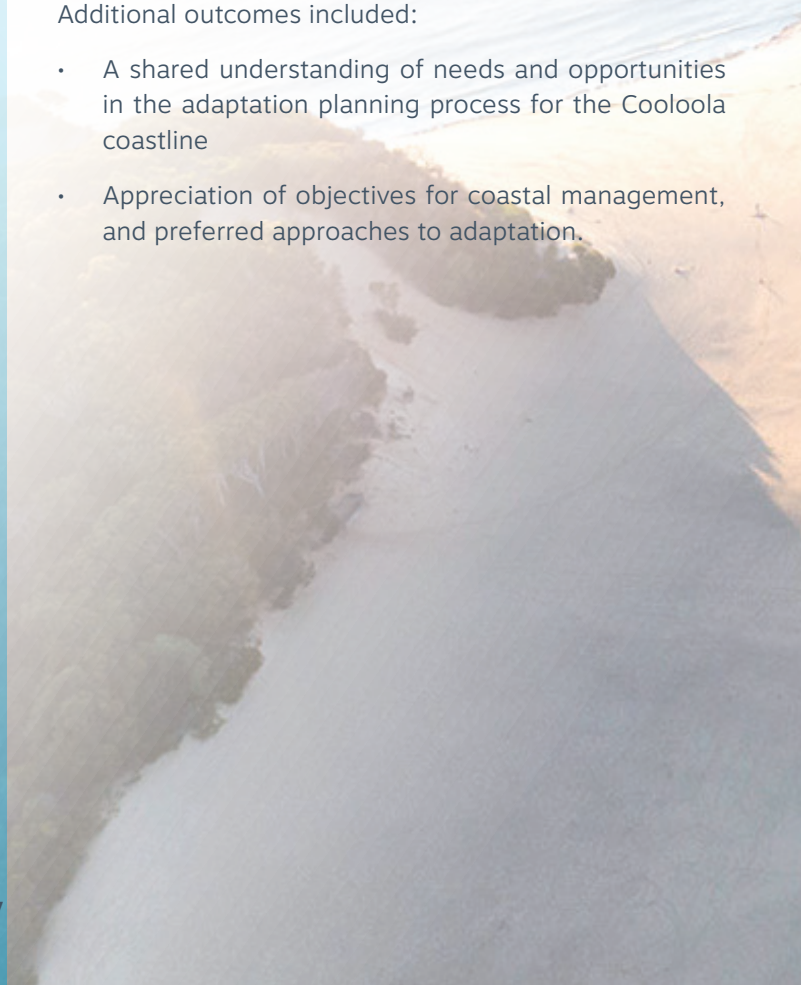
The engagement and communication process across all phases of the Strategy development was informed by planning undertaken in Phase 1 (GRC 2017), and specific action plans developed for Phases 5 – 8 (GRC 2020a – 2020d).

Outcomes

All input and feedback assisted to shape the direction of technical investigations underpinning the Strategy, and priority adaptation actions for the Cooloola coast.

Additional outcomes included:

- A shared understanding of needs and opportunities in the adaptation planning process for the Cooloola coastline
- Appreciation of objectives for coastal management, and preferred approaches to adaptation.



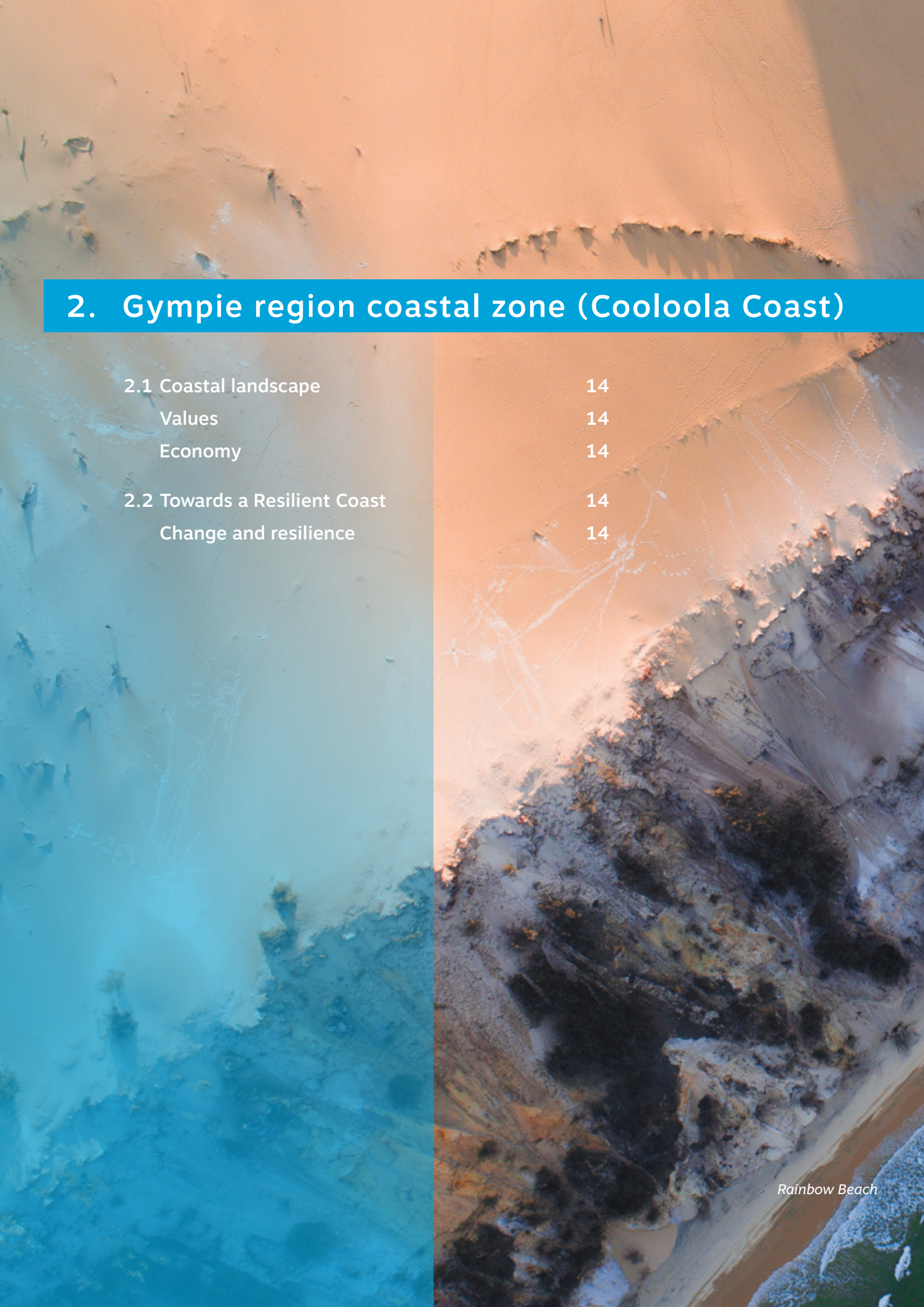
1.4 Content of the Strategy

The Strategy includes:

- **Section 2:** An overview of landscape features, values, history, and important elements of a resilient Cooloola coast
- **Section 3:** An overview of coastal hazards, including erosion and inundation, areas that may be exposed to coastal hazards, and the implications of exposure including potential economic costs.
- **Section 4:** Gympie Regional Council's approach to adaptation, including a framework for shared responsibilities, adaptation responses and options.
- **Section 5:** Priority adaptation actions across the Region.
- **Section 6:** Locality summaries with tailored adaptation actions for different communities.
- **Section 7:** The approach to implementation, including adaptative management and change management planning.

Rainbow Beach to Double Island Point

2. Gympie region coastal zone (Cooloola Coast)



Rainbow Beach

2.1 Coastal landscape

Values

The Gympie region is the traditional homeland of the Kabi Kabi people to the south and Butchulla people to the north. The coastal landscape has high cultural significance for Traditional Owners, who value the protection and sustainability of the land and sea (country).

Well known features of our Cooloola coastline include:

- The Ramsar listed Great Sand Straight (including Tin Can Bay and inlet)
- UNESCO Great Sandy Biosphere Reserve
- Great Sandy National Park
- Rainbow Beach and Double Island Point.

Key environmental values include:

- **Coastal landforms** – including extensive dune systems, tidal inlets, coastal plains and sandy beaches
- **Vegetation communities and ecosystems** – including the wetlands, mangroves and native dune vegetation
- **Significant and endangered species** – including both land and marine environments (e.g turtles, birds and fish).

Economy

The unique and beautiful coastal landscape of the Cooloola coast drives a strong tourism sector that is a significant contributor to the Gympie economy. Direct and indirect employment from the tourism and hospitality sector is estimated at 614 full-time equivalent jobs.

The region attracts over 500,000 tourists that stay a total of over 1 million guest nights per annum. The region also attracts significant levels of day visitors, particularly out of the Sunshine Coast (both tourists and regional residents).

Visitor surveys indicate that, in 2018-19 most visitors are domestic overnight visitors (61.4%), followed by domestic daytrips (30.2%) and international visitors (8.4%) (Tourism Research Australia, 2019). Holidays are the most common reason to visit the Gympie region across all visitor types.

The beach road along Rainbow Beach and Cooloola Beach is a significant asset, providing recreational values to locals and tourists alike. It is estimated that the annual willingness to pay for access to the beach road at Rainbow Beach is in the order of $35 million.

2.2 Towards a Resilient Coast

Change and resilience

The coastline is a dynamic and picturesque part of the landscape, where the land meets the sea. One of the more challenging aspects of the coastal landscape is that it experiences constant, and often rapid change.

Wind and waves continually work to move sediment and shape the shoreline, and extreme weather events can periodically result in substantial erosion and inundation of coastal land.

Rainbow Beach to Double Island Point

A resilient coast has social, economic and environmental systems in place to avoid, manage and mitigate the impact of hazardous events or disturbances (e.g. coastal hazards). Resilience also means the ability to respond or reorganise in ways that maintain the essential function, identity and values of a region, while also being able to proactively adapt to change.

For the Gympie region, coastal hazard adaptation options have been developed in keeping with the identity and values of our coastal communities.

During a number of discussions and engagement activities, the following elements were identified as important for a resilient Cooloola coast:

- Tourism values
- Environmental values
- Cultural values
- Recreation values
- Place based values
- Infrastructure
- Public safety.

GYMPIE REGION CHAS Survey #1 May 2019

The first survey for the CHAS program was completed in May 2019. The survey helped inform an understanding of key values, awareness of coastal hazards, and past experiences. Highlights from the survey findings include:

The top values are natural beauty and access:

The highest number of respondents identified that the most valued aspect of the coastal environment are the natural assets (64%). A high number of others identified beach driving in the Great Sandy Region and the area's unique coastal environment as important and valued aspects of the region's coastal areas.

There is good awareness of coastal hazards:

The community is aware of how vulnerable foreshore facilities are to coastal processes having experienced closure of parklands and walking tracks following storm-tide inundation and/or erosion.

There is strong community support for adaptation and planning:

The majority of the respondents have a strong connection to Rainbow Beach and Tin Can Bay and affirm the need for these areas to be protected for future generations.

3. Coastal hazards

3.1 Hazards

Coastal hazards include inundation of low-lying coastal land, and / or erosion of the shoreline.

Periodic inundation and erosion are natural processes and contribute to shaping the unique landforms of our coastal zone. However, when these processes have an adverse impact on communities, infrastructure and some natural assets, they are considered coastal hazards. In south-east Queensland, major coastal hazard impacts are typically associated with East Coast Lows and occasional Tropical Cyclones.

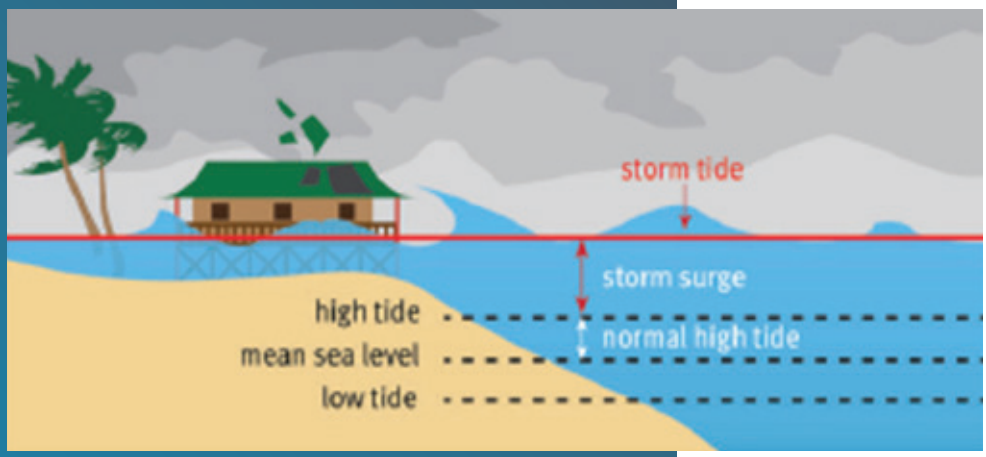


Figure 3. Components of storm tide

3.2 Storm tide inundation

Storm tide inundation is the flooding of low-lying coastal land from a locally elevated sea level (the 'storm tide'). The storm tide is a combination of the predicted tide, storm surge, and wave action (Figure 3). Storm surge is driven by the combined influence of low atmospheric pressure and high winds associated with events such as Tropical Cyclones.

Periodic inundation and erosion are natural processes and contribute to shaping the unique landforms of our coastal zone.

3.3 Coastal erosion

Coastlines naturally erode and accrete over time, driven by variations in sediment supply and climate patterns.

Short term erosion

Coastal erosion occurs when winds, waves and coastal currents act to shift sediment away from the shoreline. This can be a short-term shift, often associated with storm activity (termed storm bite), and the beach will then gradually rebuild (Figure 4).

When a beach is stable, all of the sand moved offshore during a storm eventually moves back onto the beach (over timeframes of months to years). In this case periodic beach erosion does not result in a long term landward movement of the shoreline.

Long term erosion

In other cases, due to changing sediment supply or climate conditions, the beach may not have sufficient capacity to rebuild between storm events. In the absence of intervention, long-term erosion (termed recession) may occur, which is the landward movement of the shoreline over a longer timeframes (decades).

Both short term and long-term erosion processes may impact on coastal assets, depending on how close to the fore-dune assets are located.

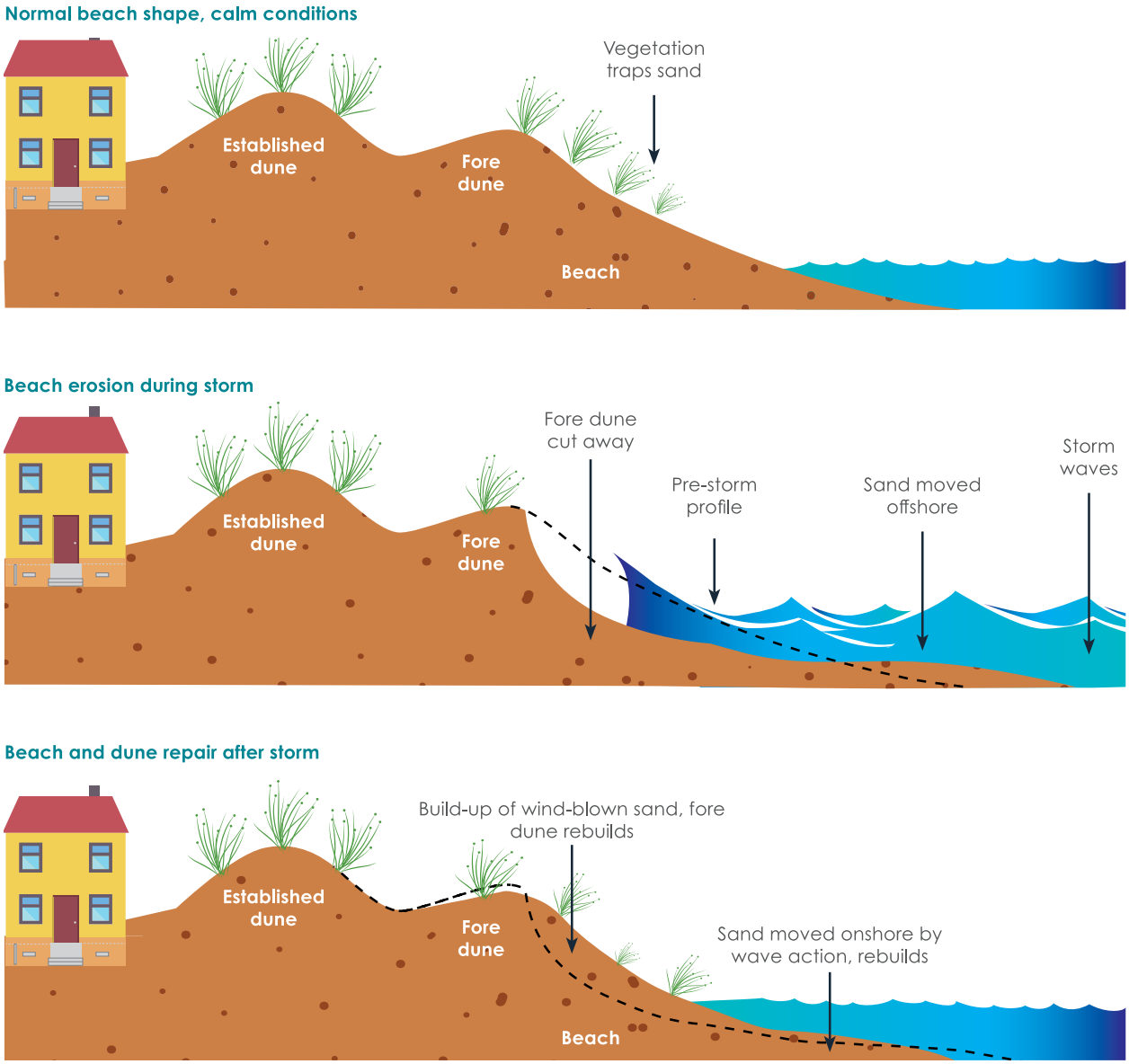


Figure 4. Natural short term erosion and dune rebuilding process

3.4 Tidal inundation due to sea level rise

Tidal inundation is regular inundation from the tidal cycle, including up to the Highest Astronomical Tide. Areas of low-lying coastal land will be prone to an increased extent of tidal inundation with sea level rise. A 0.8 m sea level rise by 2100 is currently planned for by the Queensland State Government.

3.5 Current and future exposure

Updated mapping

The Cooloola coast is prone to cyclone and storm events, and coastal hazard impacts are predicted to increase with a changing climate.

As part of the Cooloola Coast – The Resilient Coast program, the existing mapping for Erosion Prone Areas and predicted storm tide inundation zones have been updated for the full coastline. These updates have been based on the best available technical data, and have included:

- New modelling of open coast erosion[1]
- Application of the State Government approach to defining Erosion Prone Areas, tailored to the Gympie region in consultation with State and LGAQ[2]
- Updated mapping of storm tide inundation zones based on previous study outputs[3] and additional modelling.

Based on the state-wide approach to mapping, the Erosion Prone Area includes components of:

- Open coast erosion: A calculated component of open coast erosion potential, informed by erosion modelling
- Tidal areas: the combined area inundated by the Highest Astronomical Tide plus a defined horizonal buffer, plus any additional area inundated due to sea level rise.

As required by State Government, a sea level rise of 0.8 m by 2100 has been adopted for the Coastal Hazard Adaptation Strategy (with 0.2 m by 2040 and 0.5 by 2070).

As part of the Cooloola Coast – The Resilient Coast program, the existing mapping for Erosion Prone Areas and predicted storm tide inundation zones have been updated for the full coastline.

[1] Refer Phase 3 summary report (GRC, 2019a)
[2] Refer Phase 3 summary report (GRC 2019a)
[3] Refer Phase 3 summary report (GRC 2019a)

Rainbow Beach

Planning horizons

Mapping for both erosion and storm tide inundation includes multiple planning horizons and event likelihoods[4] (Table 1).

Table 1. Likelihood of occurrence scenarios

Likelihood of occurrence	Hazard AEP	Planning horizons
Likely	10%	Present-day, 2040, 2070, 2100
Possible	1%	Present-day, 2040, 2070, 2100
Rare	0.2%	Present-day, 2040, 2070, 2100

Maps of the 2100 1% AEP are provided in Supplement B to the Strategy.

Erosion Prone Areas and storm tide inundation zones do not represent a predicted loss of coastal land. The maps provide an indication of areas that may be exposed to erosion or inundation processes (now or in the future), and in many cases the impacts can be avoided, mitigated or managed through adaptation planning.

Additional detail on the mapped components and the approach is provided in the Phase 3 summary report (GRC 2019a).

Exposure

Planning scheme zones associated with residential areas, open space, community purposes, rural, sport and recreation and marine industry are likely to experience significantly increased exposure to erosion and inundation by 2100. For these zones, there is typically an increase of over 100% in total area exposed to coastal hazards by 2100[5].

The area of residential land exposed to coastal hazards may increase by up to a factor of six by 2100, increasing from 1% of total area exposed at the present day, to 13% by 2100 (primarily in Tin Can Bay).

Environmental areas including high ecological value wetlands and national parks may experience a small increase in area exposed to coastal hazards (in the order of 2%) by 2100. Additional information on exposure is provided in the Phase 4 summary report (GRC 2019b).

[4] 1%AEP only for Erosion Prone Area, all AEPs for storm tide inundation

[5] Refer Phase 4 summary repot (GRC 2019b)

FUTURE COASTAL HAZARDS

Projected sea level rise and an increase in cyclone intensity for the Queensland coastline is anticipated to increase the extent and impact of coastal hazards.

Coastal erosion:

- Increased water levels will accelerate coastal erosion
- Sediment transport patterns may be altered by shifts in wave direction, triggering changes to the form and location of shorelines
- Low-lying land may be permanently inundated
- Increased cyclone and storm activity will escalate the severity of coastal erosion events

Storm tide inundation:

- Sea level rise will increase the apparent severity and frequency of storm tide inundation and will cause inundation to occur further inland
- Increased cyclone and storm intensity will add to the magnitude of storm tide events and the extent of inundation

Source: Coastal Hazard Technical Guideline (DEHP 2013)

3.6 Potential impacts

Approach

Coastal hazards have the potential to have adverse impacts on Gympie coastal communities, services and lifestyle, in both the present day and by 2100.

As part of the *Cooloola Coast – The Resilient Coast program*, new technical assessments have been undertaken to review coastal hazard risk for a range of assets across the region. The risk assessment has included analysis of:

- Data on infrastructure assets (drainage, sewerage, water, roads, marine, beach and foreshore)
- The Gympie Regional Council planning scheme land parcels
- New information collated on dwellings (building locations, types)
- Environmental overlays.

Risk is assessed based on the likelihood of an asset being exposed to a coastal hazard, combined with the consequence of that exposure (Table 2).

A tailored approach to assessing consequence was developed, based on stakeholder and community feedback on the important elements for the coastal zone (property and infrastructure, economy and growth, public safety, environmental values, Traditional Owner values, community services and lifestyle) (Table 3).

To complete the risk assessment:

- The likelihood of exposure (likely, possible, rare) was determined for each asset / land parcel, separately for erosion and inundation
- The consequence of exposure (insignificant, minor, moderate, major, catastrophic) was determined for each asset / land parcel, separately for erosion and inundation
- Coastal hazard risk was assessed (low, medium, high, very high), based on the likelihood and consequence for each asset / land parcel, separately for erosion and inundation.

Risk is assessed based on the likelihood of an asset being exposed to a coastal hazard, combined with the consequence of that exposure.

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Likely 10% AEP	Low	Medium	High	Very high	Very high
	Possible 1% AEP	Low	Medium	Medium	High	Very high
	Rare 0.2% AEP	Low	Medium	Medium	Medium	High

Table 2. Risk matrix.

	PLACE AND PLANNING AND SUSTAINABILITY		
CONSEQUENCE	**Property and infrastructure**	**Economy and growth**	**Public safety**
Catastrophic	Widespread major damage or loss of property or infrastructure with total value >$25 million. Full recovery/repair may take many years.	Regional economic decline, widespread business failure and impacts on state economy.	Loss of lives and/or permanent disabilities.
Major	Major damage or loss of property or infrastructure with total value >$10 million. Full recovery/repair may take several years.	Lasting downturn of local economy with isolated business failures and major impacts on regional economy.	Widespread serious injuries/ illnesses.
Moderate	Moderate - major damage to property or infrastructure with total value >$1 million. Full recovery may take less than 1 year.	Significant impacts on local economy and minor impacts on regional economy.	Isolated serious injuries/ illnesses and/or multiple minor injuries/ illnesses.
Minor	Minor damage to properties or infrastructure with total value >$200,000.	Individually significant but isolated impacts on local economy.	Minor and isolated injuries and illnesses.
Insignificant	Minimal damage to properties or infrastructure with total value >$50,000.	Minor short-term impact on local economy.	Negligible injuries or illnesses.

COMMUNITY AND LIFESTYLE		ENVIRONMENT	
Lifestyle	**Traditional Owner values**	**Environmental values**	**CONSEQUENCE**
Widespread semi-permanent impact (~1year) to highly utilised community services, wellbeing, or culture of the community with no suitable alternatives.	Severe and widespread, permanent impact on multiple sites of indigenous significance, including loss of land, connection to land, and ability to continue traditional practices. Recovery unlikely.	Severe and widespread, permanent impact on multiple regionally or nationally significant ecosystem services and natural features of the region. Recovery unlikely.	**Catastrophic**
Major widespread long-term (~1 month) disruption to well-utilised services, wellbeing, or culture of the community with very few alternatives available.	Severe and widespread semi-permanent impact on one or more sites of indigenous significance, including loss of land, connection to land, and ability to continue traditional practices.	Severe and widespread semi-permanent impact on one or more regionally or nationally significant ecosystem services and natural features of the region. Full recovery may take many years.	**Major**
Minor medium-to long-term (~1 week) or major short-term disruption to moderately utilised services, wellbeing, or culture of the community with limited alternatives.	Substantial impact on one or more sites of local indigenous significance. Full recovery may take several years.	Substantial impact on one or more locally significant ecosystem services and natural features of the region. Full recovery may take several years.	**Moderate**
Small to medium short-term disruption (~1 day) to moderately utilised services, wellbeing, finances, or culture of the community with some alternatives available, or more lengthy disruption of infrequently	Small, contained and reversible short-term impact on sites of indigenous significance. Full recovery may take less than 1 year.	Small, contained and reversible short-term impact on isolated ecosystem services and natural features of the region. Full recovery may take less than 1 year.	**Minor**
Very small short-term disruption (~1 hour) to services, wellbeing, finances, or culture of the community with numerous alternatives available.	Little to no impact to sites of indigenous significance.	Little to no environmental impact.	**Insignificant**

Assets at risk

Outputs from the risk analysis were mapped for all localities across the region[6], to review the distribution of assets / land at risk from coastal hazards. At risk assets is inclusive of any assets with a medium to very high risk of adverse impacts from coastal hazards[7].

For infrastructure in the Cooloola coastal area, up to 10% of roads are currently at risk from coastal hazards, increasing to 12% by 2100 (Table 4). Sewerage, drainage and water reticulation assets currently have a relatively low risk (<2% of assets at risk), increasing to 4% of assets at risk by 2100.

For our planning scheme zones, open space, limited development (constrained land), and waterfront and marine industry areas are the main zones at risk from coastal hazards in the present day (with 7% – 50% of land at risk), and increasing by 2100 (with up to 38% of open space land and 100% of marine industry zones at risk) (Table 5).

Coastal hazard risk will increase notably by 2100 for residential zones. At present <5% of the area of these zones are exposed to coastal hazards, which may increase to 10-23% of the total area at risk by 2100.

Coastal hazard risk for residential dwellings at the present day is in the order of 20 dwellings across the whole region. By 2100, this may increase to over 100 dwellings in the at-risk zone for coastal hazards.

Additional detail on the asset and risk assessment, and associated mapping, is provided in the Phase 5 and 6 summary reports (GRC 2020a and 2020b).

Table 4. Infrastructure assets at risk

	EROSION PROCESSES (EPA- ALL COMPONENTS)				STORM TIDE INUNDATION (1%AEP)			
% infrastructure assets at risk from coastal hazards	**Present day**	**2040**	**2070**	**2100**	**Present day**	**2040**	**2070**	**2100**
Sewerage	0.6	1	2	4	-	-	-	-
Water	0.3	1	2	3	-	-	-	-
Stormwater	1	2	4	4	-	-	-	-
Pathways	7	12	18	20	7	9	11	14
Roads	10	11	12	12	9	9	10	11

[6] Refer Phase 5 Summary report (GRC 2020a)

[7] Relative to all assets in the coastal zone

Table 5. Areas of planning scheme zones at risk

	EROSION PROCESSES (EPA- ALL COMPONENTS)				STORM TIDE INUNDATION (1%AEP)			
% infrastructure assets at risk from coastal hazards	Present day	2040	2070	2100	Present day	2040	2070	2100
Community Purposes	2	3	5	6	3	4	6	8
District Centre	-	-	-	-	-	-	-	-
Environmental Management And Conservation	2	2	3	4	1	2	3	3.
Limited Development (constrained Land)	8	11	18	20	-	-	-	-
Low Impact Industry	-	-	-	-	-	-	-	-
Medium Impact Industry	-	-	-	-	-	-	-	-
Open Space	18	24	34	37	-	-	-	-
Residential Choice	1	3	8	11	5	11	15	23
Residential Living	-	0.1	0.3	0.4	0.1	0.6	1	2
Rural	1	2	3	3	-	-	-	-
Rural Residential	-	-	-	-	-	-	-	-
Sport And Recreation	3	5	6	8	5	6	8	10
Tourist Accommodation	-	-	-	-	-	-	-	-
Waterfront And Marine Industry	54	74	96	99	-	-	-	-

Communities

Our understanding of coastal hazard risk for assets and land across our region, provides a basis to begin targeting our adaptation response and actions. All three of our Cooloola communities are included in this Strategy, with the adaptation effort, response and actions tailored to the location specific needs.

Table 6. Communities and adaptation needs

Communities	Implications for adaption
Rainbow Beach	- Adaption actions associated with mitigating open coast erosion risk
Tin Can Bay, Cooloola Cove	- Adaption actions focused on mitigating expanding tidal area inundation and storm tide inundation risk

In the absence of intervention / adaptation, there are economic costs associated with coastal hazards.

Rock wall at Tin Can Bay

Economic costs (base case)

In the absence of intervention / adaptation, there are economic costs associated with coastal hazards.

Economic analysis is important for determining the best approach to coastal hazard adaptation for different localities. Economics is used in several ways including to:

- Value assets and key industries
- Define a base case (cost of no action)
- Assess adaptation options.

After assigning values to key infrastructure and natural assets[8], the foundational step of an economic assessment in coastal hazard adaptation is to define a base case (Figure 5). This means determining the potential economic costs or losses associated with coastal hazards (and no additional adaptation/intervention, i.e. business as usual). This becomes the baseline for a cost-benefit assessment of implementing adaptation options.

The base case for the Cooloola coast has been determined by examining the likelihood and consequence ($ damage) of coastal hazard impacts on assets, and at different timeframes (e.g. present day, 2040, 2070 and 2100).

For the Cooloola coast, five key components of damages / losses have been considered for the base case:

1. **Damage to buildings and facilities** –Public and private buildings, and structures such as marinas and swimming pools, among others. This is the financial cost of repairing or replacing these assets.
2. **Damage to other infrastructure and facilities** – Such as electricity, sewerage, drainage, and water supply infrastructure.
3. **Damage to transport infrastructure** – Including roads, pathways, and bridges. This is the financial cost of repairing or replacing the assets and can also trigger other economic losses where access to key sites is lost.
4. **Losses of land, environmental and cultural assets** – Such as wetlands, national park, and habitats for threatened species. This is the lost value from a reduction of these assets.

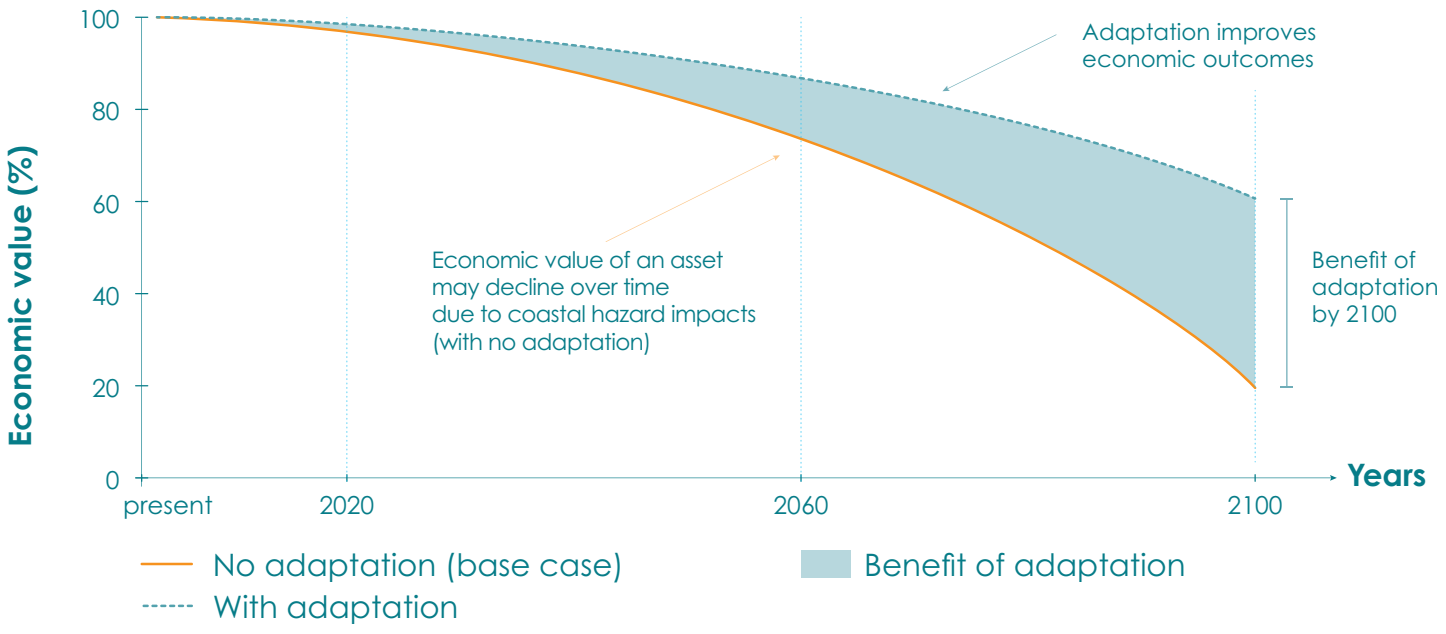


Figure 5. Economic base case and benefit of adaptation

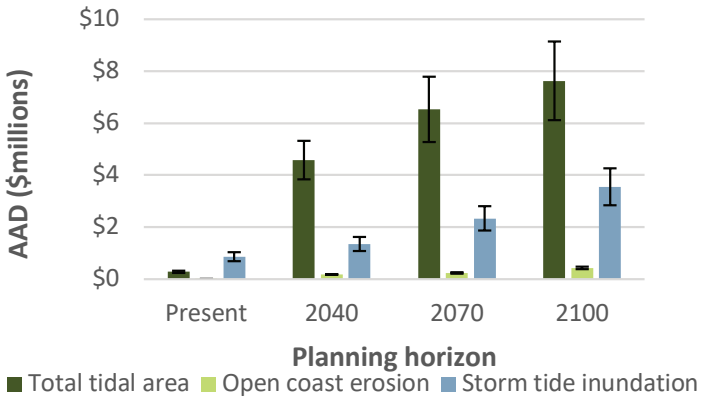
[8] Refer to Phase 7 summary report (GRC 2020c)

Mangroves at Norman Point

5. Damage to beach and foreshore assets – Such as lifesaving towers, pontoons, jetties, playgrounds, shelters, and other beachside facilities.

For the Coolooa coast, the present day average annual damages (AAD) associated with combined coastal hazard impacts on infrastructure assets is estimated to be in excess of $1 million dollars (Figure 6.)

In the absence of adaptation, this is likely to increase up to $6 million dollars (AAD) by 2040, $9 million dollars (AAD) by 2070 and over $11 million dollars (AAD) by 2100. The predicted increase in tidal areas linked to sea level rise is the main driver of the increase. The majority of damages are linked to buildings and facilities and transport infrastructure.



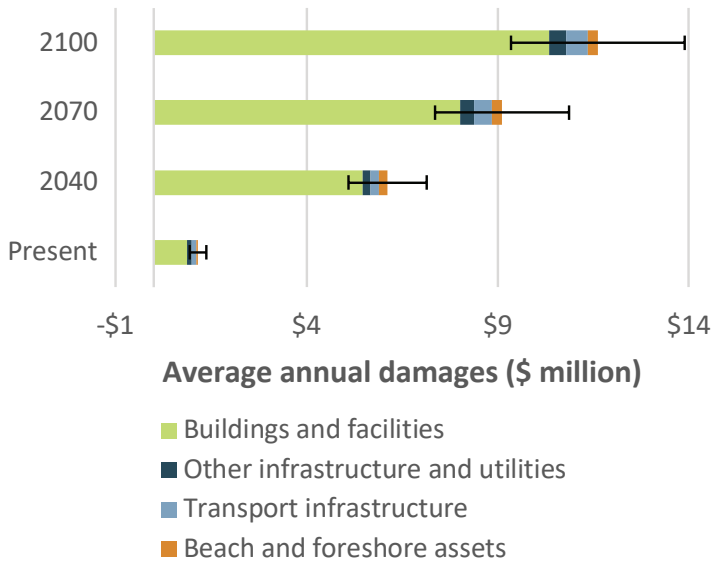


Figure 6. Potential average annual damages from coastal hazards for infrastructure assets (base case)

An annual willingness to pay for the 4WD beach road access of almost $35 million

Losses of natural assets has been considered separately to infrastructure assets. Estimating these damages/losses carries significant uncertainty, however does provide a means of assessing potential damages associated with coastal hazard impacts on natural assets over time. Potential coastal hazard impacts for natural assets may be in the order of $3.5M in average annual damages by 2100.

The estimated damages are largely linked to high ecological significance wetlands and High Ecological Value Waters-wetlands (primarily the Great Sandy Strait Ramsar internationally important wetland that encompasses the Tin Can Inlet).

Coastal hazards may also have potential to impact on 4WD access to Rainbow Beach, with potential flow on impacts for the economy.

Rainbow Beach is a very popular 4WD location for commuting south, or for local 4WD recreation activities. Present day high tides and storm events frequently restrict 4WD access along the coast from Rainbow Beach to Double Island Point. These impacts are expected to increase with sea level rise and a changing climate.

The estimated number of 4WD trips/visits each year is in the order of 300,000, with the total running costs coming to just under $14 million. This, in combination with the permit expenditure indicates an annual willingness to pay for the 4WD beach road access of almost $35 million, coming from recreational users. This highlights the importance of the beach road for the region.

Recent beach road closures have lasted several days.[9] The potential economic impact on the local community from 2 week closure of the beach road is estimated to be in the order of $2M – 3.5M, which is a substantial economic impact for the community.

Strategic adaptation can assist to avoid, mitigate and manage the impacts and potential economic damage associated with coastal hazards.

The potential economic impact on the local community from 2 week closure of the beach road is estimated to be in the order of $2M – 3.5M, which is a substantial economic impact for the community.

Implementing the adaptation approach and actions in the Coastal Hazard Adaptation Strategy will contribute to avoiding potential economic costs to the Region of up to:

- **PRESENT DAY: $1 million dollars** per annum
- **By 2040: $6 million dollars** per annum
- **By 2070: $9 million dollars** per annum
- **BY 2100: $11 million dollars** per annum

[9] An erosion event in 2015 restricted beach road access for a period of around two to three weeks. See https://www.adventurecentre.com.au/2015/03/29/2015327beach-driving/ for more details.

Rock wall at Inskip Point Spit

4. Approach to adaptation

4.1 Framework

Council's role

Gympie Regional Council recognise a shared responsibility for the management of coastal hazard risk; shared by Council, other land managers and private land owners. Council's primary responsibility is the maintenance and protection of Council land and assets, and to inform statutory planning.

Council's role in adaptation varies depending on the type and ownership of different assets. Council's role includes to:

- Inform – Council will make available to all stakeholders (including public and private land and asset owners) the outcomes of relevant Council-led investigations on coastal hazard risk, planning and adaptation options.
- Observe – Council will actively observe / monitor coastal hazard risk for Council owned land and assets. For land and assets owned or managed by others, Gympie Regional Council may, as part of everyday activities, observe a risk from coastal hazards and will notify the relevant land owner/manager.
- Plan – Council will develop strategic planning measures to mitigate the risk of coastal hazard impacts on Council owned land and assets, and to inform appropriate land use planning across the region.
- Act – Council will implement strategic planning measure to mitigate the risk of coastal hazard impacts on Council owned land and assets, and to inform appropriate land use planning across the region.

Initiatives in the Coastal Hazard Adaptation Strategy also seek to foster and enable other stakeholders to proactively manage coastal hazard impacts on their own/land assets in accord with the Strategy and in consultation with Council.

Gympie Regional Council recognise a shared responsibility for the management of coastal hazard risk; shared by Council, other land managers and private land owners.

A strategic approach

Across Australia and internationally, coastal land managers are taking a strategic approach to managing the risk of coastal hazards, and enhancing the resilience of our coastal zones.

Common elements of this strategic approach include:

- Assigning a strategic **adaptation response** to different localities, to guide decision making with a pathways approach across present day, intermediate and 2100 planning horizons
- Assessing the range of **adaptation options** suitable in different locations to help avoid, mitigate, and manage the risk of coastal hazards
- Developing a strategy for coastal adaptation, with prioritised actions over a 5—10 year timeframe.

A tailored approach has been developed to guide decision making on adaptation response and options across the Cooloola coast.

		Land or asset type		
		Council owned	**Managed by other authorities**	**Privately owned**
Council's role	Inform	✓	✓	✓
	Observe	✓	✗	✗
	Plan	✓	✗	✗
	Act	✓	✗	✗

Table 7. Council's role in coastal hazard adaptation

Adaptation objectives

The purpose of clarifying adaption objectives is to help guide an appropriate adaptation response, and to screen adaptation options, across different localities.

Objectives for our Cooloola coast, as informed by consultation with stakeholders and the community, include to:

- Retain the natural beauty of the coast
- Limit adverse impacts on scenic amenity
- Protect important ecosystems
- Protected freshwater and tidal waterways and wetland habitats that support our special and diverse wildlife such as dolphins, dugongs and migratory shorebirds
- Maintain access to the region (including 4WD beach access)
- Minimise potential impacts on tourism
- Protect significant, protected and sensitive areas (environment and biodiversity)
- Retain sandy beaches
- Maintain access to beach and assets
- Limit impact on assets and infrastructure (including new developments) within hazard zone.

These objectives provide a reference for considering the suitability of different coastal hazard adaptation options across the Gympie Region.

Adaptation response

The tailored framework includes four adaptation responses – Avoid, Monitor, Mitigate, and Transition (Table 8).

Avoid

The general first principle is to avoid placing new development or assets in coastal hazard areas. The preference is to ensure land use in coastal hazard areas is one that is low risk for coastal hazard impacts, while also being a use that maximises economic, social, and environmental value to region.

Any new development / infrastructure that is placed in coastal hazard areas will need to be in accord with State planning policy and approvals requirements and include necessary migration measures.

Monitor

At localities where the coastal hazard risk profile is low, Council will continue to monitor risk and undertake existing maintenance / asset management activities. If, over time, the risk profile is observed to increase (as indicated by local trigger levels), then the adaptation response may shift to mitigate.

Mitigate

At localities where coastal hazard risks have been identified, Council will actively manage the risk through implementing a range of adaptation options.

Mitigation will be tailored to each locality, incorporating site-specific processes, community input, and statutory planning considerations. If, over time, the risk profile is observed to increase (as indicated by local trigger levels), and mitigation becomes infeasible (due to economic or other factors), then the adaptation response may shift to transition.

Transition

In some specific areas within a locality, if the coastal hazard risk profile is very high, and/or mitigation becomes infeasible (due to economic or other factors), Council may make a strategic decision to transition to an alternative land use. Transition is likely to be a gradual process over time, where mitigating hazards for a period is part of the transition process.

	Coastal hazard adaptation			
	Avoid	Monitor	Mitigate	Transition
Adaptation response	Avoid placing new development or assets in coastal hazard areas.	Monitor the risk of coastal hazards. Monitor until local trigger levels are reached to initiate mitigation.	Actively mitigate the risk of coastal hazards through a range of adaptation options. Mitigate until local trigger levels are reached to initiate transition.	A strategic decision to transition to an alternative land use in some areas. Mitigation may be part of the transition process.
Adaptation options		Monitoring and initiatives to enhance adaptive capacity	Full range of adaptation options	

Table 8. Adaptation response

Adaptation options

Four themes of adaptation options have been defined for the Strategy, with a range of options that relate to avoiding, mitigating and managing the risk of coastal hazards. The themes are:

1. Capacity building initiatives
2. Planning updates
3. Modifying infrastructure
4. Coastal management and engineering.

The range of common adaptation options across these themes are described in Table 9 . More detailed descriptions of the options are provided in Supplement C to the Strategy, along with preliminary screening of the relevance of options to different localities.

Rock wall at Norman Point

Theme	Adaptation options	Description	Supplement C summary sheet number
Capacity building initiatives	Community stewardship	Developing programs and partnerships to enhance stewardship of the coastline	Sheet 1
	Knowledge sharing	Facilitating knowledge sharing and education on hazards and adaptation	Sheet 2
	Monitoring	Monitoring changes in coastal hazard risk and effectiveness of adaptation	Sheet 3
Planning updates	Land use planning	Informing statutory planning and strategic plans Includes consideration of land purchase or land swap/relocation	Sheet 4
	Disaster management	Updating emergency response planning	
Modifying infrastructure	Increase infrastructure resilience	• Modifying critical infrastructure (e.g. raising floor levels) • Modifying drainage networks • Building resilient homes	Sheet 5
	Relocate infrastructure	• Relocating critical infrastructure	
Coastal management and engineering	Dune protection and maintenance	Minimising dune disturbance, maintaining vegetation	Sheet 6
	Beach nourishment	Beach scraping and / or importing additional sand to the beach	Sheet 7
	Structures to assist with sand retention	Using structures (groynes, artificial headlands or similar) to help retain sand	Sheet 8
	Structures to dissipate wave energy	Constructing offshore breakwaters or artificial reefs to dissipate wave energy (submerged or exposed)	Sheet 9
	Last line of defence structures	Constructing seawalls / revetments	Sheet 10
	Structures to minimise inundation	Constructing levees / dykes	Sheet 11

*Note: An additional option – offshore breakwaters or artificial reefs to dissipate wave energy (submerged or exposed) are not considered a feasible option for the Gympie region due to the proximity of the Great Sandy Marine Park and protected / sensitive marine areas. Therefore, this option was excluded from the adaptation options in the Phase 6 screening.

Table 9. Adaptation options by theme

4.2 Adaptation response by locality

Adaptation response has been assigned for a series of key localities across the region. The adaptation response takes into consideration what is at risk (land and assets), and how the risk is changing over time – the emerging risk profile (present day, 2040, 2070, and 2100)[10] (Table 10).

By 2070 there are some limited areas within Tin Can Bay and Rainbow Beach where transition to an alternative land use may be appropriate (due to increasing coastal hazard risk), subject to the outcome of initial priority adaptation actions for these locations.

Transition planning from present day is required at Inskip Point Spit. The spit is a highly dynamic coastal feature that is vulnerable to major change at any point in time. Land use and adaptation, including emergency works at Inskip Point will need to be undertaken in the context of long-term transition planning.

Table 10. Adaptation response for each locality

	Adaptation response			
	Present day	**2040**	**2070**	**2100**
Cooloola (Estuarine frontage)	Avoid/Monitor	Avoid/Monitor	Avoid/Monitor	Avoid/Monitor
Cooloola (Ocean frontage)	Monitor	Mitigate	Mitigate	Mitigate
Cooloola Cove	Avoid/Monitor	Avoid/Monitor	Avoid/Monitor	Avoid/Monitor
Inskip Point South	Mitigate	Mitigate	Mitigate	Transition*
Inskip Point Spit	Transition*	Transition*	Transition*	Transition*
Rainbow Beach (Estuarine frontage)	Monitor	Mitigate	Mitigate	Transition*
Rainbow Beach (Ocean frontage)	Monitor	Mitigate	Mitigate	Transition*
Tin Can Bay	Monitor	Mitigate	Transition*	Transition*

*A transition response may be appropriate for limited areas within the locality.

[10] As per technical investigations in the Phase 5 and 6 summary reports (GRC 2020a, 2020b)

Emergency works at Inskip Point Spit

4.3 Determining adaptation actions

A range of adaptation actions have been defined to enable a strategic approach to coastal hazard adaptation across the Cooloola coast. A suite of priority actions across the four themes (Table 9) have been defined at:

- The regional scale (outlined in Section 5)
- The locality scale as part of the adaptation response pathway (outlined in Section 6).

The program of priority actions has been informed by the initial screening of options, as well as a detailed cost-benefit analysis for tailored coastal engineering options for Rainbow Beach and Tin Can Bay[11].

There is not currently a strong economic case for major engineering or infrastructure-based interventions to manage coastal hazard risk.

Baseline actions of dune protection and maintenance, and mangrove protection and enhancement, will be critical for enhancing resilience.

Actions across capacity building, land use planning and modifying infrastructure are the core focus for most localities, combined with some site-specific targeted investigations to inform future updates to the adaptation pathways.

Results may also change over time and should be the subject of future Strategy updates.

[11] Refer Phase 7 summary report (GRC 2020c)

Rainbow Beach Surf club

Coast Guard at Tin Can Bay

5. Region-wide actions summary

Crab Creek

The Coastal Hazard Adaptation Strategy priority actions across the region include a range of actions relevant to the four themes identified for the Strategy:

1. Capacity building initiatives
2. Planning updates
3. Modifying infrastructure
4. Coastal management and engineering

Priority 5 – 10 year actions to each of these themes are summarised in Table 11, with some additional information / guidance in Supplement C to the Strategy.

Adaptation response and actions specific to different localities across the region are provided in the location summaries (Section 6).

Table 11. Region wide actions

Theme	Strategic action no.	Description	2020 Priority strategic actions (completed within 5 – 10 years)
1. Capacity building initiatives	1.1. Community stewardship program	Develop programs and partnerships to enhance stewardship of the coastline.	1.1.1 Establish program / officer role 1.1.2 Establish and dune protection and maintenance, and mangrove protection and enhancement program utilising a mix of Council and volunteers' time 1.1.3 Seek co-funding / resources for further initiatives through grants and stakeholder partnerships.
	1.2. Knowledge sharing	Facilitate knowledge sharing and education on hazards and adaptation. Knowledge sharing includes collaborative partnerships.	1.2.1 Identify networks / forums for knowledge sharing (internal and external) 1.2.2 Establishing a collaborative partnership with Traditional Owners 1.2.3 Facilitate training / education workshops / events 1.2.4 Promote cross-sector partnerships and initiatives to enhance resilience and strategic adaptation for tourism
	1.3. Monitoring	Monitor changes in coastal hazard risk and effectiveness of adaptation	1.3.1 Establish photo point monitoring system (coast snap or similar) at key areas 1.3.2 Establish a beach condition monitoring system.

Theme	Strategic action no.	Description	2020 Priority strategic actions (completed within 5 – 10 years)
2. Planning updates	2.1. Land use planning	Use the outcomes of the Strategy to inform statutory planning and other strategic plans.	2.1.1 All planning matters undertaken by Council to incorporate and have regard to the new coastal hazard information presented in the Coastal Hazard Adaptation Strategy 2.1.2 Consider implications (within Council) of the Strategy for future development approvals and conditions including: - approval conditions for lots of un-developed land with existing approvals - implications for future development approvals and conditions. 2.1.3 For the next scheduled Planning Scheme update, use the updated Erosion Prone Area and outcomes of the Strategy to inform decisions on development areas and strategic land use planning.
	2.2. Disaster management	Update emergency response planning	2.2.1 Use the updated Erosion Prone Area and storm tide mapping, risk assessment and economic implications to update the Gympie Regional Council Local Disaster Management Plan.
	2.3. Transition planning	plan for management in a long term transition context	2.3.1 Develop a transition plan for Inskip Point Spit. Planning needs to consider physical mechanisms of erosion (e.g. open coast erosion and sinkholes) as well as site specific economic analysis on the value of maintaining barge access to Fraser Island, value to tourism, and alternate locations for barge access. 2.3.2 Develop a long-term transition plan for Tin Can Bay Peninsula (by 2070). Plan will consider road raising, buildings resilient/suitable for marine environment, potential reduced level of service to the area, and potential relocation / change to infrastructure around the point (linked to action 3.2.1)
3. Modifying	3. 1. Build resilience	Upgrading infrastructure. Building resilient homes.	3.1.1 Review at risk infrastructure (from the Strategy data outputs) and embed risks into current asset management plans. This could include 'betterment' at critical asset refurbishment/ renewals points. 3.1.2 Review of access road renewals and upgrades (prioritisation) 3.1.3 Promote resilient homes within the community and building sector (link in with knowledge sharing initiatives) 3.1.4 Consult with utility providers on future services and upgrades and implications of coastal hazard areas

Theme	Strategic action no.	Description	2020 Priority strategic actions (completed within 5 – 10 years)
	3.2. Relocate infrastructure	Relocate critical infrastructure	3.2.1 When updating asset management plans, consider the long term (2100) coastal hazard risk, and consider options for relocation if needed.
4. Coastal management and engineering	4.1. Dune protection and maintenance	Minimise dune disturbance, maintain vegetation.	4.1.1. Pilot the dune protection and maintenance program at Inskip Point and Rainbow Beach (linked to action 1.1.2) 4.1.2 Extend the dune protection and maintenance program to all relevant locations
	4.2 Energy dissipation approach - Mangrove protection and enhancement	Protect and enhance mangroves communities that are providing shoreline protection	4.2.1 Pilot the mangrove protection and enhancement program at Tin Can Bay.
	4.3 Targeted investigations	Location specific studies to better inform decision making	4.3.1 Undertake a geotechnical study of beach and dune system at Rainbow Beach (Ocean frontage) to confirm underlying geology and implications for erosion vulnerability. 4.3.2 Undertake a geomorphic study of beach and dune system for Cooloola (Ocean frontage) and Rainbow Beach (Ocean frontage), to assess the long-term expectation for the beach and dune response to sea level rise, and implications for use of the Beach road. 4.3.3 Develop a long-term 4WD planning strategy for the beach roads in the region. This should include likely beach access constraints into the future, guidance for 4WD users to protect dune systems, and the addition of safe 'pull out' locations along with possible alternative routes.
	4.4 Additional open coast erosion mitigation works (if required)	Structures to minimise erosion	4.4.1 Investigate appropriate rock including type and sizing for emergency works at Inskip Point, to ensure any emergency work construction is suitable to be left long term, and in the context of transition planning. 4.4.2 Maintain stockpile of rock for emergency works at Inskip Point.
	4.5 Additional protection from tidal and storm tide inundation (if required		4.3.1 Investigate options to prevent tidal inundation of Tin Can Bay pool – feasibility study and concept options (also in the context of transition planning).

Dunes at Rainbow Beach

6. Location summaries

Inskip Point Spit

Cooloola coast localties as deifned for the Strategy are shown in Figure 7.

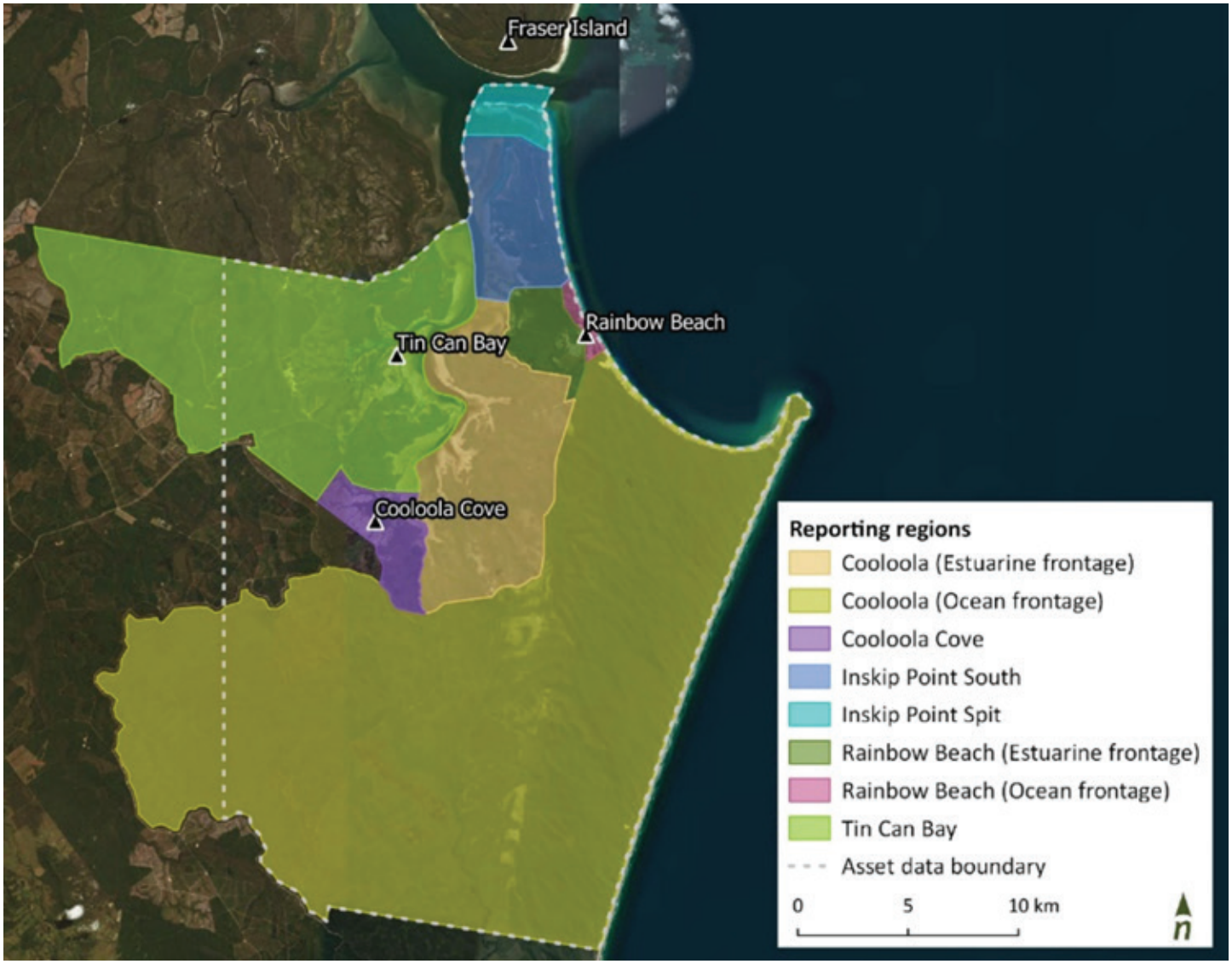


Figure 7. Cooloola coast localities

6.1 Cooloola (Estuarine frontage)

Landscape

The Cooloola estuarine frontage area covers the south eastern shoreline of Tin Can Inlet between Carlo Creek and Cooloola Cove (Figure 8). The landscape is relatively low-lying predominately supporting palustrine wetlands, open forest and woodlands on dunes and sandy plains.

This locality is situated entirely within the Great Sandy National Park. It contains large areas wildlife habitat and wetlands of high ecological significance. Habitat supports a variety of threatened flora and fauna.

Figure 8. Cooloola (Estuarine frontage)

Coastal hazards exposure and implications

The Cooloola estuarine frontage has a relatively high natural resilience and the coastal erosion and inundation risk is relatively low from present day to 2100.

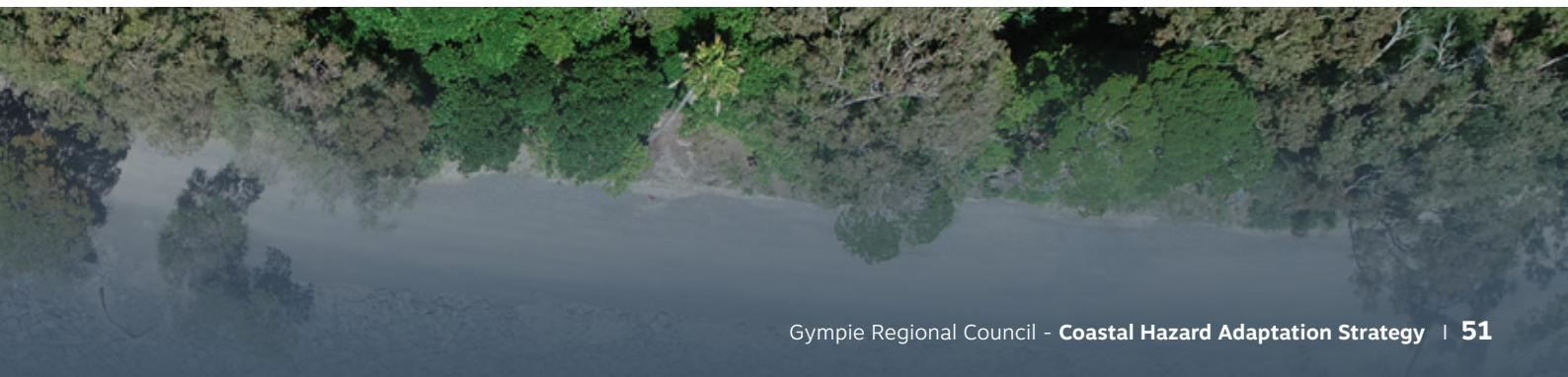
The main overhead power supply network runs across the inlet and through the National Park. While the lines themselves are elevated, some of the tower infrastructure may be within coastal hazard areas. However infrastructure design is likely to be resilient, and some towers sit within the Inlet itself.

There is likely to be a significant increase in inundation of environmental management and conservation areas, ecosystems, and ecologically significant wetlands by 2100. Depending on the specific dynamics of natural processes in the coastal zone, areas such as wetlands and mangroves can migrate and re-establish themselves as sea levels rise, particularly where there is sufficient room for these assets to naturally adapt. The entire locality is currently under environmental management and this will assist to facilitate natural system adaptation into the future.

The ongoing adaptation response for Cooloola estuarine frontage is to avoid/monitor (present day through to 2100) (Table 12).

	Present day	2040	2070	2100
Cooloola (Estuarine frontage)	Avoid/Monitor	Avoid/Monitor	Avoid/Monitor	Avoid/Monitor
1. Capacity building	As per region-wide actions			
2. Planning updates	As per region-wide actions			

Table 12. Cooloola (Estuarine frontage) adaptation pathway



6.2 Cooloola (Ocean frontage)

Landscape

The Cooloola ocean frontage covers are large expanse of open sandy beaches, rocky headland (Double Island Point) and large parabolic dune systems between the Rainbow Beach township and the local government boundary with Noosa Shire (Figure 9).

The land all sits within the Great Sandy National Park and is zoned as environmental management and conservation, or open space.

The foreshore is undeveloped and the beach is used as a popular 4WD vehicle access route along Cooloola Beach, past Double Island Point, and to Rainbow Beach.

Coastal hazards exposure and implications

This section of the coast will primarily be impacted by open coast erosion and sea level rise hazards.

The beach available for recreation and vehicle access is already impacted by high tides and wave action and the frequency of these impacts are likely to increase over time.

The beaches are backed by high parabolic dunes which may be prone to slumping in large erosion events. The beach and foredunes are likely to have some capacity to migrate landward over time which will maintain some recreational beach width.

The nature of dune response to sea level rise will depend on the underlying geology and broad scale processes. A more detailed geomorphic investigation into dune behaviour and beach response will provide further insight to inform planning guidance on 4WD use along the beach in the future.

The adaptation response for Cooloola Ocean front is 'Monitor' from present day and 'Mitigate' from 2040 through to 2100 (subject to 10-year review) (Table 13).

The Mitigate response will be accompanied by relevant region-wide initiatives, including dune protection and maintenance and planning response measures for 4WD usage along the coastline.

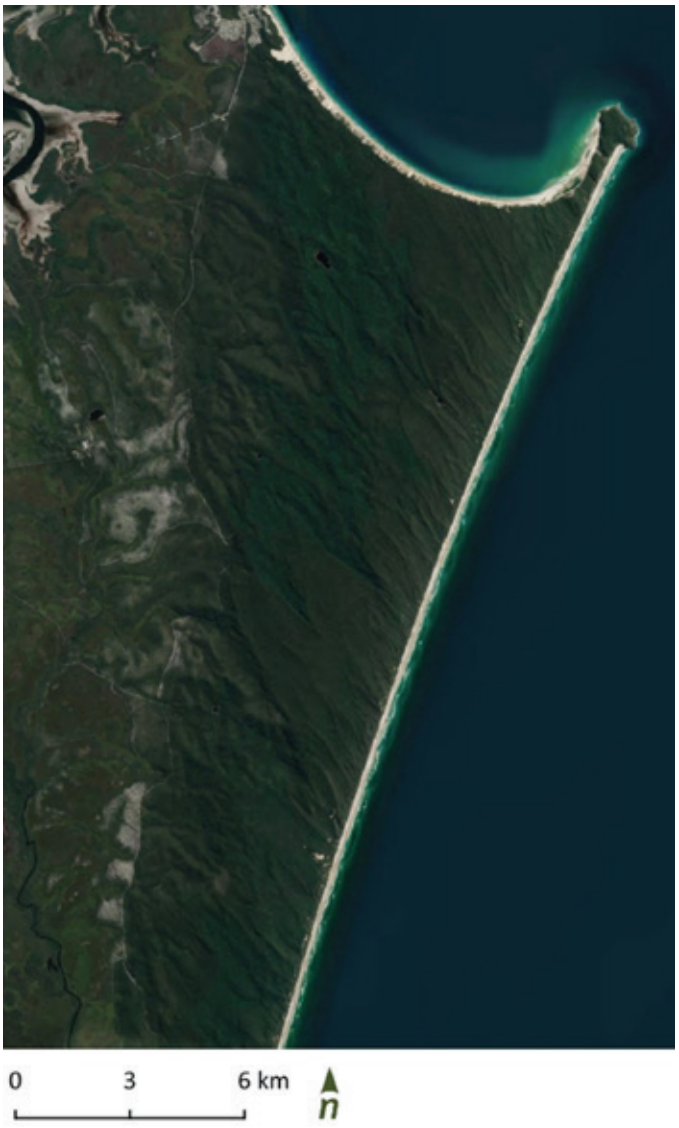


Figure 9. Cooloola (Ocean frontage)

	Present day	2040	2070	2100
Adaptation response	**Monitor**	**Mitigate**	**Mitigate**	**Mitigate**
Adaptation actions				
1. Capacity building	As per region-wide actions			
2. Planning updates	As per region-wide actions **Focus action: 2.2.1:** Update local disaster management planning for this locality based on new EPA and storm tide maps. (link to 4.3.3 4WD strategy)			
3. Modifying infrastructure	N/A			
4. Coastal management and engineering	As per region-wide actions			
4.1 Dune protection and maintenance		Implement dune protection and maintenance as part of region-wide program		
4.2 Energy dissipation approach - Mangrove protection and enhancement	N/A			
4.3 Targeted investigations	**4.3.2** Undertake a geomorphic study of beach and dune system for Cooloola (Ocean frontage) and Rainbow Beach (Ocean frontage), to assess the long-term expectation for the beach and dune response to sea level rise, and implications for use of the Beach road. **4.3.3** Develop a long-term 4WD planning strategy for the beach road. This should include likely beach access constraints into the future, guidance for 4WD users to protect dune systems, and the addition of safe 'pull out' locations along with possible alternative routes.			
4.4 Additional open coast erosion mitigation works (if required)	N/A			
4.5 Additional protection from tidal and storm tide inundation (if required)	N/A			
Potential average annual damages from coastal hazards (to be mitigated)	Minimal estimated annual average damages due to the limited assets with the coastal hazard area			

Table 13. Cooloola (Ocean frontage) adaptation pathway

6.3 Cooloola Cove

Landscape

Cooloola Cove covers the southern shoreline of Tin Can Inlet between Mullen Creek and Carland Creek (Figure 10). The landscape is relatively low-lying predominately supporting palustrine wetlands, open forest and woodlands.

The township of Cooloola Cove, established in the 1980s, is now home to around 2,500 residents. Over the last few decades, several facilities such as shopping centres and markets have developed to service the community.

Coastal hazards exposure and implications

Given its sheltered location on the Tin Can Inlet and relatively low energy wave environment, inundation is expected to be the primary coastal hazard impacting Cooloola Cove.

Inundation risk to built assets, residential areas and associated areas within the planning scheme is likely to remain low. However, present day tidal areas do extend to the fringes of undeveloped land parcels zoned for residential living near the outlet of Mullen Creek.

There is currently a relatively large area that is zoned as 'rural' between the built areas and Tin Can Inlet. Maintaining this as an ecological buffer will provide ecosystems with the opportunity to adapt/migrate and re-establish themselves as sea levels rise.

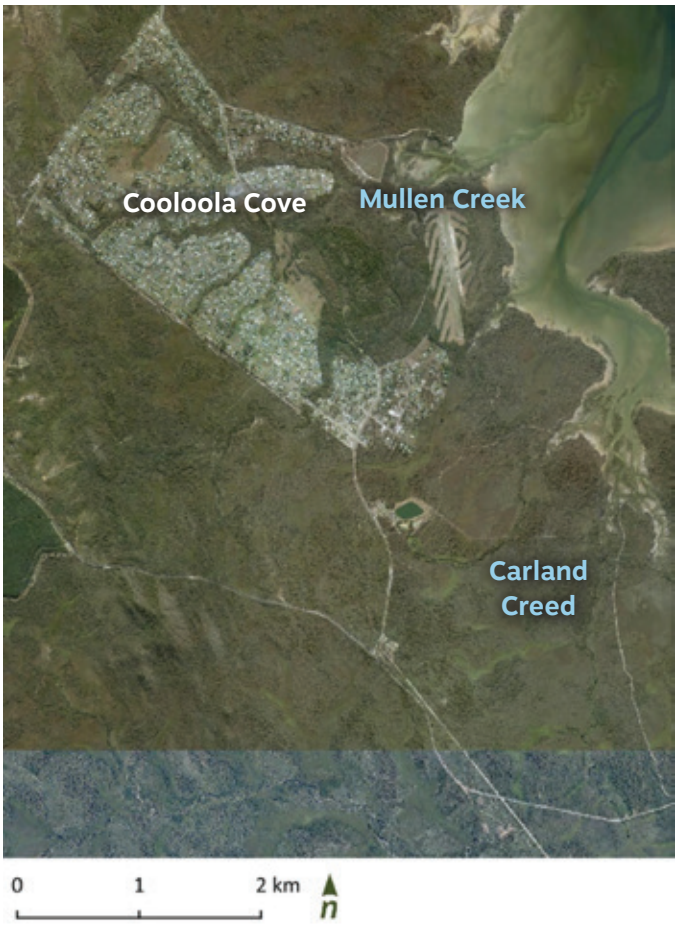


Figure 10. Cooloola Cove

The current adaptation response for Cooloola Cove is to Avoid/Monitor coastal hazards through to 2100 (Table 14).

	Present day	2040	2070	2100
Adaptation response	**Avoid/Monitor**	**Avoid/Monitor**	**Avoid/Monitor**	**Avoid/Monitor**
Adaptation actions				
1. Capacity building	As per region-wide actions			
2. Planning updates	As per region-wide actions **Focus action 2.1.2:** Review zoning and development approval conditions for lots of un-developed land with existing approvals **Focus action 2.1.2:** Clarify implications for future development approvals and conditions **Focus action 2.2.1:** Update Local disaster management planning for Cooloola Cove -Rainbow Beach and district based on new EPA and storm tide maps.			
3. Modifying infrastructure	As per region-wide actions			

Table 14. Cooloola Cove adaptation pathway

6.4 Inskip Point South

Landscape

Inskip Point South encompasses the ocean and estuarine frontages between Pelican Bay and the northern extent of Rainbow Beach (Figure 11).

The landscape includes low lying mangrove swamps and estuarine wetland systems along the Inlet to the west, and open sandy beaches along the ocean to the east.

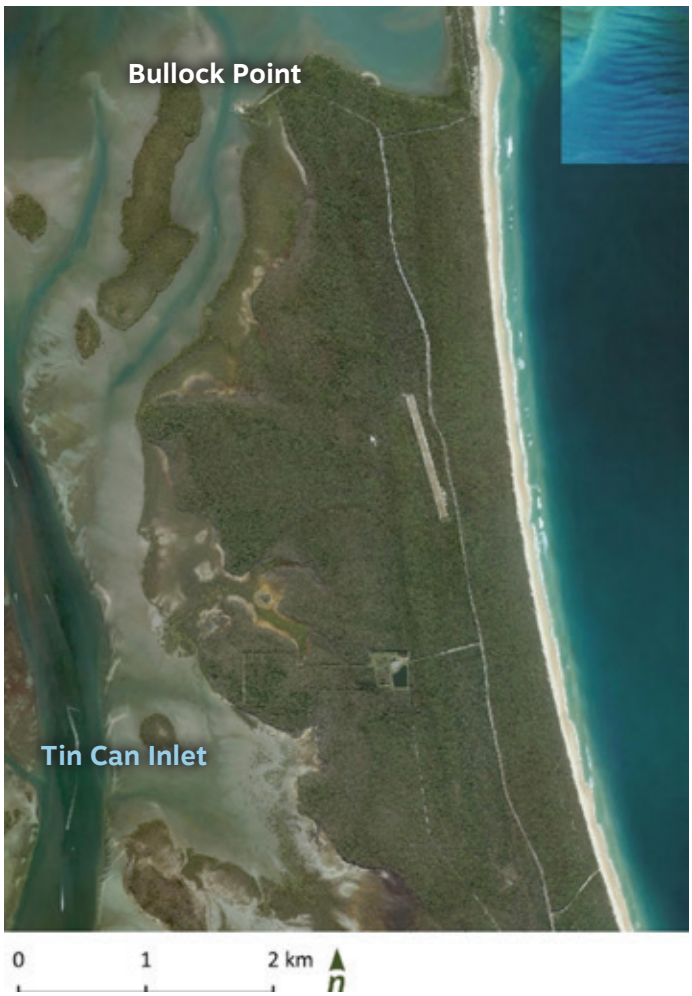


Figure 11. Inskip Point South

This area includes the Rainbow Beach Sewerage Treatment Plant and Bullock Point Boat Ramp (and Fraser Island transport link). The majority of the land is zoned as environmental management and conservation.

Coastal hazards exposure and implications

Present day inundation and erosion risk is medium to high for some assets in low-lying areas, including the camp ground at Pelican Bay, access road to Inskip Point, and infrastructure (including the carpark) at Bullock Point ferry terminal.

While most of these assets are designed to be resilient to the marine environment (e.g. floating pontoons, boat ramps), access will likely become more frequently disrupted with increasing coastal hazard exposure in the future.

A large portion of this locality is currently under environmental management and this should be maintained to facilitate ecosystem adaptation.

The adaptation response for Inskip Point South is to mitigate from present day through to 2070 (Table 15). Mitigation includes a combination of region-wide actions for capacity building, planning udpates, modifying infrastructure and dune protection and maintenance on the open coast.

A transition response for Bullock Point may be required by 2100 (subject to 10-year review). Infrastructure relocation and alternative barge landing locations may be required by 2100 due to the projected coastal hazard exposure and risk for this location. This can be considered in conjunction with transition planning for Inskip Point Spit.

Bullock Point boat ramp

	Present day	2040	2070	2100
Adaptation response	**Monitor**	**Mitigate**	**Mitigate**	**Transition***
Adaptation actions				
1. Capacity building	As per region-wide actions			
2. Planning updates	As per region-wide actions **Focus action 2.2.1:** Update Local disaster management planning for Cooloola Cove -Rainbow Beach and district based on new EPA and storm tide maps.			
3. Modifying infrastructure	As per Region-wide actions **Focus action:** **3.1.1** Review and update asset management plan, to incorporate upgrades to inundation/erosion prone sections of the road at Bullock Point and other relevant infrastructure			
4. Coastal management and engineering	As per region-wide actions			
4.1 Dune protection and maintenance		Implement as part of Region-wide program		
4.2 Energy dissipation approach - Mangrove protection and enhancement	N/A			
4.3 Targeted investigations		Review barge landing location (Fraser Island access) based on outcome from transition planning for Inskip Point Spit.		
4.4 Additional open coast erosion mitigation works (if required)	N/A			
4.5 Additional protection from tidal and storm tide inundation (if required)	N/A			
Potential average annual damages from coastal hazards (to be mitigated)	Minimal estimated annual average damages due to the limited assets with the coastal hazard area			

*A transition response may be appropriate for limited areas within zone

Table 15. Inskip Point South adaptation pathway

6.5 Inskip Point Spit

Landscape

Inskip Point Spit area is sandy barrier spit extending across the mouth of Tin Can Inlet, with the Great Sandy Straight to the north, and Pelican Bay to the south west (Figure 12).

Figure 12. Inskip Point Spit

At the northern end of the spit is another transport link via a barge to Fraser Island. The land is zoned as environmental management and conservation, and also has a number of built assets including, roads, campgrounds and recreational facilities.

Coastal hazards exposure and implications

Inundation and erosion risk is moderate to high risk for roads and campgrounds and recreational uses at Inskip Point Spit. The entire spit is vulnerable to open coast erosion and dynamic estuarine processes at the present day, and coastal hazard risk is likely to increase to 2100.

The spit is a highly dynamic coastal feature that is vulnerable to major change at any point in time. The spit is not only vulnerable to open coast erosion and storm tide inundation but also estuarine process from the Inlet side and complex hydrogeomorphical changes including groundwater destabilisation (similar to past 'sink-hole events'). It is therefore anticipated that extremely rare events could cause a permanent breakthrough at any time that would result in a permanent loss of access to the northern point.

While there are limited built assets in this locality there are other implications, such as public safety and loss of access.

The adaptation response for Inskip Point Spit is to begin the transition planning process from now (Table 16). This may include maintaining the current land use until a specific trigger (erosion rate, breakthrough event or economic trigger) for changing land use and access arrangements occurs.

Emergency protection works are likely to continue as part of the transition plan to address minor / site specific erosion events for a period of time. However the transition plan will enable proactive consideration of alternative future arrangements (e.g. alterative barge location, relocation of campground / recreational facilities).

Inskip Point Spit

	Present day	2040	2070	2100
Adaptation response	**Transition***			
Adaptation actions				
1. Capacity building	As per region-wide actions			
2. Planning update	As per region-wide actions **Focus action 2.2.1:** Update Local disaster management planning for Cooloola Cove -Rainbow Beach and district based on new EPA and storm tide maps.			
2.3 Transition planning	**Focus action 2.3.1:** Develop a transition plan for Inskip Point Spit. Planning needs to consider physical mechanisms of erosion (e.g. open coast erosion and sinkholes) as well as site specific economic analysis on the value of maintaining barge access to Fraser Island, value to tourism, and alternate locations for barge access.			
3. Modifying infrastructure	As per Region-wide actions **Focus action 3.1.1:** Review and update asset management plan, to incorporate upgrades to inundation/erosion prone sections of the road at Inskip Point			
4. Coastal management and engineering	As per Region-wide actions			
4.1 Dune protection and maintenance	Implement as part of Region-wide program			
4.2 Energy dissipation approach - Mangrove protection and enhancement	N/A			
4.3 Targeted investigations	N/A			
4.4 Additional open coast erosion mitigation works (if required)	**Focus actions:** **4.4.1** Investigate appropriate rock including type and sizing for emergency works at Inskip Point, to ensure any emergency work construction is suitable to be left long term, and in the context of transition planning. **4.4.2** Maintain stockpile of rock for emergency works at Inskip Point.			
4.5 Additional protection from tidal and storm tide inundation (if required)	N/A			
Potential average annual damages from coastal hazards (to be mitigated)	***Minimal estimated annual average damages due to the limited assets with the coastal hazard area***			

Table 16. Inskip Point Spit adaptation pathway

6.6 Rainbow Beach (Estuarine frontage)

Landscape

The Rainbow Beach estuarine frontage covers the eastern shoreline of Tin Can Inlet between Carlo Point and Carlo Creek (Figure 13).

Figure 13. Rainbow Beach (Estuarine frontage)


Mangroves at Carlo Point

The landscape is predominately comprised of low open woodland on dunes and sand plains, and low-lying estuarine wetland systems, with the high parabolic dune system to the south eastern extent.

This area contains a large portion of the Rainbow Beach community on the western side of Rainbow Beach Road and south of Clarkson Drive. This comprises local centres, residential and industrial areas, situated on the elevated hind-dune areas.

A significant portion of the remaining low lying land is zoned as environmental management and conservation except for an area at Carlo Point which contains the Carlo Point Marina and an area on the eastern side zoned as residential choice (currently contains Rainbow Beach Holiday Park).

Coastal hazards exposure and implications

For assets in the low-lying areas, tidal inundation and storm tide risk is expected to increase to 2100 with sea level rise.

Existing land and assets in these zones can be upgraded through staged asset management to reduce the likelihood of exposure (e.g. raised lot and floor levels, or relocation of assets), or reduce the consequence of exposure (e.g. resilient building materials).

If feasible, adaptation measures should aim to integrate with existing asset management procedures to minimise any additional costs.

For new development areas, outcomes from the Strategy will be used to review zoning and development approval conditions to ensure coastal hazard risk is minimised.

Large areas of this locality are currently under environmental management and this should be maintained to facilitate natural ecosystem adaptation processes.

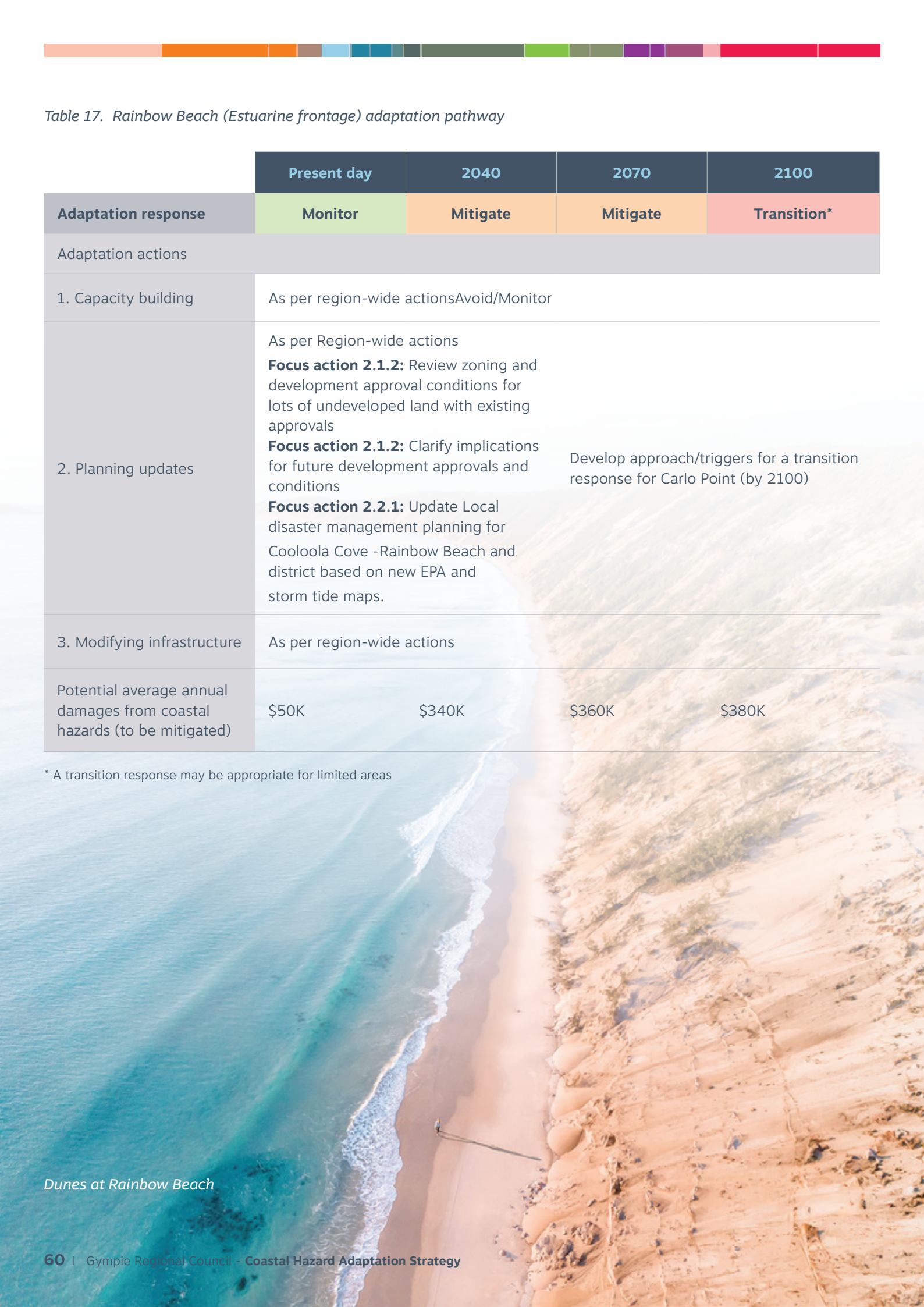
The adaptation response for Rainbow Beach (Estuarine frontage) is to monitor coastal hazards at present day, and mitigate from 2040 onwards (Table 17). Mitigation will include a combination of region-wide actions including planning updates and asset management upgrades.

A localised transition response may be required at the Carlo Point marina by 2100, which is likely to involve adaptation, including possible local relocation, of existing infrastructure. Planning for this would be reviewed in 2070.

Table 17. Rainbow Beach (Estuarine frontage) adaptation pathway

	Present day	2040	2070	2100
Adaptation response	**Monitor**	**Mitigate**	**Mitigate**	**Transition***
Adaptation actions				
1. Capacity building	As per region-wide actionsAvoid/Monitor			
2. Planning updates	As per Region-wide actions **Focus action 2.1.2:** Review zoning and development approval conditions for lots of undeveloped land with existing approvals **Focus action 2.1.2:** Clarify implications for future development approvals and conditions **Focus action 2.2.1:** Update Local disaster management planning for Cooloola Cove -Rainbow Beach and district based on new EPA and storm tide maps.		Develop approach/triggers for a transition response for Carlo Point (by 2100)	
3. Modifying infrastructure	As per region-wide actions			
Potential average annual damages from coastal hazards (to be mitigated)	$50K	$340K	$360K	$380K

* A transition response may be appropriate for limited areas



Dunes at Rainbow Beach

6.7 Rainbow Beach (Ocean frontage)

Landscape

The Rainbow Beach ocean frontage extends from the southern extent of Rainbow Beach township, to Pacific Boulevard in the north (Figure 14). The area encompasses a large section of open sandy beach with areas of exposed coffee rock (indurated sands from ancient river sediments).

This area includes the Rainbow Beach community on the eastern side of Rainbow Beach Road, and south of Clarkson Drive, as well as a small section of the Great Sandy National Park within the dune system south of Ocean View Parade.

This seaside resort town is one of the tourist gateways to Cooloola National Park, Inskip Point and Fraser Island. Popular with backpackers and sightseers, the town is dominated by tourism, particularly eco-tourism, 4WD-ing and camping. The town has a permanent population of around 900 but hosts around 70,000 visitors each year.

Figure 14. Rainbow Beach (Ocean frontage)

Coastal hazards exposure and implications

The primary hazard for this area is open coast erosion, with the shoreline and dune system exposed to periodic erosion events at the present day, and increasing exposure and risk by 2100.

Several Council assets are located within the present-day hazard area including beach access points, lifesaving tower and beach and foreshore facilities. Additional assets that may be at risk under future conditions include the surf lifesaving club, roads, pedestrian access, skate park, sewer, water and stormwater infrastructure and some park assets.

There is current uncertainty around the underlying geology of the Rainbow Beach foreshore and dune system. If underlying geology is notably stable (rock substrate), then erosion potential of the dunes will be much lower than currently anticipated. A priority action is a local geotechnical assessment of the foreshore, in and around existing assets, to assist with future adaptation planning.

Erosion is also likely to impact on the use of the beach, including 4WD access and scour of local infrastructure assets (access points, fencing). The priority action to undertake a geomorphic study of the beach and dune system for Cooloola (Ocean frontage) and Rainbow Beach (Ocean frontage) will assist to inform the planning and management for this section of the coast, including the 4WD management strategy and local access and use of the Rainbow Beach foreshore.

The adaptation response for Rainbow Beach (Ocean frontage) is to mitigate coastal hazards from present day onwards (Table 18). Mitigation includes a combination of region wide actions associated with capacity building, planning and modifying infrastructure, as well as a pilot of a dune protection and maintenance program, and the geotechnical and geomorphic assessments to inform future updates to the adaptation pathway.

A possible transition response including relocation of foreshore infrastructure may be required by 2100, depending on the outcomes of the local geotechnical assessment.

Table 18. Rainbow Beach (Ocean frontage) adaptation pathway

	Present day	2040	2070	2100
Adaptation response	**Monitor**	**Mitigate**	**Mitigate**	**Transition***
Adaptation actions				
1. Capacity building	As per region-wide actions 1.2.3 Knowledge sharing – facilitate training, education/workshops, events **Focus action:** Targeted 4WD beach user education program. Improve education in collaboration with 4WD and tourism industries. Many 4WD users already become stranded and put themselves in danger due to not knowing tide or beach conditions. This situation may be exacerbated with increased erosion exposure in the future.			
2. Planning updates	As per region-wide actions **Focus action 2.2.1:** Update Local disaster management planning for Cooloola Cove -Rainbow Beach and district based on new EPA and storm tide maps.			
3. Modifying infrastructure	As per region-wide actions **Focus action 3.1.1:** Review upgrade schedule for critical assets around Rainbow Beach (Ocean frontage) and embed into asset management plan *Example: **Sewer & Pump Station** – identify sewer pump stations within future hazard areas and when next upgraded or replaced, improve with reduced infiltration piping/pits, raising entry points and electronics to a higher level* **Focus action 3.1.4:** Consult with utility providers on future services and upgrades and implications of coastal hazard areas at Rainbow Beach.			
4. Coastal management and engineering	As per region-wide actions			
4.1 Dune protection and maintenance	As per region-wide actions **Focus action 4.1.1:** Implement pilot program to boost community stewardship of dune protection and maintenance – trial at Rainbow Beach. May include proactive beach scraping around key access points and paths following storm events.			
4.2 Energy dissipation approach - Mangrove protection and enhancement	N/A			
4.3 Targeted investigations	**Focus actions:** **4.3.1** Undertake a geotechnical study of beach and dune system at Rainbow Beach (Ocean frontage) to confirm underlying geology and implications for erosion vulnerability. **4.3.2** Undertake a geomorphic study of beach and dune system for Cooloola (Ocean frontage) and Rainbow Beach (Ocean frontage), to assess the long-term expectation for the beach and dune response to sea level rise, and implications for use of the Beach road.			
4.4 Additional open coast erosion mitigation works (if required)	N/A	Review hazard risk and economic case for additional engineering works to mitigate erosion risk. Pending outcome of targeted investigations (4.3.)		
Potential average annual damages from coastal hazards (to be mitigated)	$5k	$185K	$245K	$440k

* A transition response may be appropriate for limited areas

6.8 Tin Can Bay

Landscape

The Tin Can Bay area encompasses the western portion of Tin Can Inlet between its confluence with Teebar Creek in the north, to the Mullen Creek in the South (Figure 15).

The township is primarily located on a peninsula bordered by Snapper Creek to the west, and the inlet to the east. Reclamation of land by filling has occurred for development, and has included the establishment of a variety of coastal protection works and seawalls around the peninsula.

Figure 15. Tin Can Bay

This area includes the community of Tin Can Bay, a popular tourist destination, with hotels, holiday units, campgrounds, and caravan parks. It has a permanent population of around 2,000 and is well known for dolphin encounters and birdwatching. The Tin Can Inlet itself is an important marine habitat area as well as servicing a fishing and prawning industry, along with recreational fishing.

The natural area north of Snapper Creek is zoned as community purpose and incorporates the Wide Bay defense training area. This area is largely inaccessible via road and includes extensive mangrove communities and estuarine wetlands.

Coastal hazards exposure and implications

The dominant coastal hazard exposure for Tin Can Bay is tidal and storm tide inundation, and localised areas of shoreline retreat. Inundation hazard risk is expected to increase for low-lying areas to 2100, with a notable increase in exposed assets by 2040.

The most at risk areas and assets are located between Crab Creek and Norman Point. Assets include residential dwellings, main access roads, sewer, water and stormwater infrastructure, pathways, carparking, amenities, waterfront open space, Tin Can Bay Marina, Tin Can Bay Swimming Pool, Coast guard, Barnacles Dolphin Centre and the Tin Can Bay Yacht Club.

There are areas of both developed and undeveloped land zoned as residential living and residential choice that may be increasingly exposed to inundation events by 2100.

Extensive areas of high ecological significance may also be increasingly exposed to tidal and storm tide inundation events into the future. Maintaining existing ecological buffers to allow natural ecosystems the opportunity to migrate landward will be important for enabling natural adaptation.

The adaptation response for Tin Can Bay is to mitigate coastal hazards from present day through to 2040, and then plan for a land use transition at site specific localities including Norman Point by 2070 (Table 19).

Mitigation includes maintenance of existing foreshore protection works, region wide actions including a trial program of mangrove protection and enhancement, planning updates to reduce risk, and modifying infrastructure including the promotion of resilient homes.

Transition planning will include asset upgrades or relocation for public and private assets, and access considerations.

Table 19. Tin Can Bay adaptation pathway

	Present day	2040	2070	2100
Adaptation response	**Monitor**	**Mitigate**	**Transition***	
Adaptation actions				
1. Capacity building	As per region-wide actions			
2. Planning updates	**Focus action 2.1.2:** Clarify implications for future development approvals and conditions **Focus action 2.2.1:** Update Local disaster management planning for Tin Can Bay- Toolara Forest and Cooloola Cove -Rainbow Beach and district based on new EPA and storm tide maps.			
2.3 Transition planning	2.3.2 Develop a long-term transition plan for Tin Can Bay Peninsula (by 2070). Plan needs to consider things like road raising, buildings resilient/suitable for marine environment, potential reduced level of service to the area, and potential relocation / change to infrastructure around the point (linked to action 3.2.1)			
3. Modifying infrastructure	As per region-wide actions **Focus action 3.1.1:** Review upgrade schedule for critical assets around Tin Can Bay and embed into asset management plan, and in the context of transition planning. **Focus action 3.1.2:** Review and update asset management plan, to incorporate upgrades to inundation/erosion prone sections of the road at Tin Can Bay, and in the context of transition planning. **Focus action 3.1.3:** Promote Resilient homes at Tin Can Bay **Focus action 3.1.4:** Consult with utility providers on future services and upgrades and implications of coastal hazard areas. **Focus action 3.2.1:** Consider options and timing to relocate facilities around Norman Point including Coast guard, Yacht Club, Barnacles Dolphin Centre, Swimming Pool by 2070, in context of transition planning.			
4. Coastal management and engineering	As per region-wide actions			
4.1 Dune protection and maintenance	N/A			
4.2 Additional open coast erosion mitigation works (if required)	N/A			
4.5 Additional protection from tidal and storm tide inundation (if required)	4.3.1 Investigate options to prevent tidal inundation of Tin Can Bay pool – feasibility study and concept options (also in the context of transition planning).			
Potential average annual damages from coastal hazards (to be mitigated)	$1M	$5.5M	$8.3M	$10.6M

* A transition response may be appropriate for limited areas

7. Implementation

Gympie Regional Council will implement the Coastal Hazard Adaptation Strategy through a range of mechanisms including:

- An adaptive management framework
- Embedding outcomes and actions from the Strategy into existing Council process and activities
- Implementing new initiatives from the Strategy.

To guide implementation, a plan has been developed that includes additional detail on:

- Timeframes for actions
- Costing for priority 5 – 10 year actions
- Instruments, plans and processes (existing, modified, new) required to deliver adaptation options
- Potential funding sources
- Monitoring and evaluation
- Barriers to implementation and change management actions
- Partnership opportunities with stakeholders.

The Coastal Hazard Adaptation Strategy will be reviewed every 10 years, commencing at least 2 years prior to the Planning Scheme Review which is also undertaken on a 10 year time frame. The next review of the Strategy will be in 2030. The review will include consideration of:

- ✓ Success of implementation to date:
  - Integration into Council and stakeholder plans and processes
  - Delivery of on-ground activities
  - Community perspectives
  - Reduction in coastal hazard risk.
- ✓ Triggers to update the Strategy including consideration of:
  - Any changes in the policy environment (e.g. sea level risk predictions, approach to defining coastal hazard areas)
  - Updated technical information that may be available
  - Any new development and landscape changes in the region.

REFERENCES

GRC (2017). Gympie Regional Council: Gympie Region Coastal Hazard Adaptation Strategy Phase 1 Stakeholder and community engagement strategy. Report by Ethos Urban and BMT for Gympie Regional Council.

GRC (2018). Gympie Regional Council: Gympie Region Coastal Hazard Adaptation Strategy Phase 2 Coastal Hazard Risk, Vulnerability and Hazard Adaptation Assessment Scoping Report. Report by BMT for Gympie Regional Council.

GRC (2019 a). Gympie Regional Council: Gympie Region Coastal Hazard Adaptation Strategy Phase 3 Storm tide and Erosion prone area hazard assessment. Report by BMT for Gympie Regional Council.

GRC (2019 b). Gympie Regional Council: Gympie Region Coastal Hazard Adaptation Strategy Phase 4 Asset identification. Report by BMT for Gympie Regional Council.

GRC (2020a). Gympie Regional Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 5 – 8. Phase 5 Summary report. Report by Alluvium, JBP and NCE for Gympie Regional Council.

GRC (2020b). Gympie Regional Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 5 – 8. Phase 6 Summary report. Report by Alluvium, JBP and NCE for Gympie Regional Council.

GRC (2020c). Gympie Regional Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 5 – 8. Phase 7 Summary report. Report by Alluvium, JBP and NCE for Gympie Regional Council.

GRC (2020d). Gympie Regional Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 5 – 8. Phase 8 Summary report. Report by Alluvium, JBP and NCE for Gympie Regional Council.

SUPPLEMENT A

Fact Sheets

SUPPLEMENT B

Coastal hazard mapping

SUPPLEMENT C

Adaptation actions – summary sheets

Rainbow Beach

COOLOOLA COAST

The Resilient Coast

GYMPIE REGIONAL COUNCIL