City of Joondalup

Coastal Infrastructure Adaptation Plan

2018 – 2026

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Iluka

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Burns Beach

1. Introduction

Planning for the future impacts of climate change is an important emerging issue for local government. Climate change affects a number of areas that local government is responsible for managing, including City infrastructure, environmental health services, stormwater management, local emergency management and local natural areas.

Of particular importance for the City, and other coastal local governments, are the potential impacts along the coastline from increased erosion and inundation and future sea level rise. The City of Joondalup covers an area of 97 square kilometres including 17 kilometres of coastline from Marmion to Burns Beach.

The City's coastline is highly valued by the City and its community for its natural assets including coastal dune areas, for the recreational opportunities it provides and as a tourism attraction. There are also significant infrastructure assets along the coast such as roads, carparks, dual use paths, playgrounds, park infrastructure and buildings that are either owned or managed by the City. Increasing erosion and inundation and potential sea level rise has the potential to impact on these natural and built assets and may alter the way these areas can be accessed and enjoyed.

The *Coastal Infrastructure Adaptation Plan 2018 – 2026* will address the risk to existing City infrastructure and assets, inform the planning and development of future City infrastructure and assets and identify adaptation responses to be implemented within the City's coastal zone to minimise the impact of identified risks.

1.1 Purpose

The purpose of the *Coastal Infrastructure Adaptation Plan 2018 – 2026* is to ensure the City is adequately prepared to adapt to current and future coastal hazards and risk to City infrastructure and assets is minimised.

1.1.1 Objectives

Objective 1	Improve understanding of the potential impacts of current and future coastal hazards.
Objective 2	Identify risk to the City's infrastructure and assets as a result of current and future coastal hazards.
Objective 3	Identify and implement projects to minimise risk to the City's infrastructure and assets from current and future coastal hazards.
Objective 4	Identify a long term approach that will guide the City's future adaptation responses in the coastal zone.

1.2 Study Area

The City of Joondalup has 17kms of coastline stretching from Marmion in the south to Burns Beach in the north and is generally characterised by rocky coasts and limestone cliffs with embayed beaches, interspersed with straight sandy beaches, see Figure 1 for more detail.

The City's coastline has been separated into three sections based on the City's boundaries and the location of major coastal structures which significantly influence coastal processes. A description of the three sections of coastline is provided below in Figure 1.

The City's coastal foreshore reserves contain significant infrastructure assets such as community buildings, carparks and public open space that are either owned or managed by the City and used by the public. Coastal foreshore areas provide not only an area for the community to access and enjoy the coast but also provide a buffer from coastal processes. The width of the coastal foreshore reserve varies along the coast with generally smaller widths in Section One than in Section Two and Three. Landwards of the coastal foreshore reserve there is significant road infrastructure as well as privately owned commercial and residential properties.

Figure 1 – Sections 1, 2 and 3 of the City's coastline

Section 3: Iluka to Burns Beach

Extends from the northern side of Ocean Reef Boat Harbour to the northern edge of the City's boundary (approx 2kms north of Burns Beach).

There is an isolated accretionary cusp at Burns Beach salient and north of that the shoreline is a sandy beach, backed by dune systems of varying heights.

South of Burns Beach salient, the study area is defined by rocky limestone cliffs with embayed beaches and offshore reef platforms.

Section 2: Hillarys to Ocean Reef

Extends from the northern breakwater of Hillarys Boat Harbour to the southern side of Ocean Reef Boat Harbour.

The shoreline in this stage has been modified by human activity with the construction of Hillarys Boat Harbour and Ocean Reef Boat Harbour altering the coastal processes in the area.

The majority of the shoreline is sandy beach backed by dune systems with an isolated accretionary cusp at Pinnaroo Point. Limestone cliffs and bayed beaches are present at the northern end.

Section 1: Marmion to Sorrento

Extends north from the northern side of Watermans Bay to the seawall at Hillarys Boat Harbour.

The study area includes a range of shoreline types, with limestone cliffs, headlands and nearshore reef platforms to the south and sandy beach and dune systems to the north.

Large sections of this study area have significant infrastructure located close to the coastline with only a relatively small buffer.

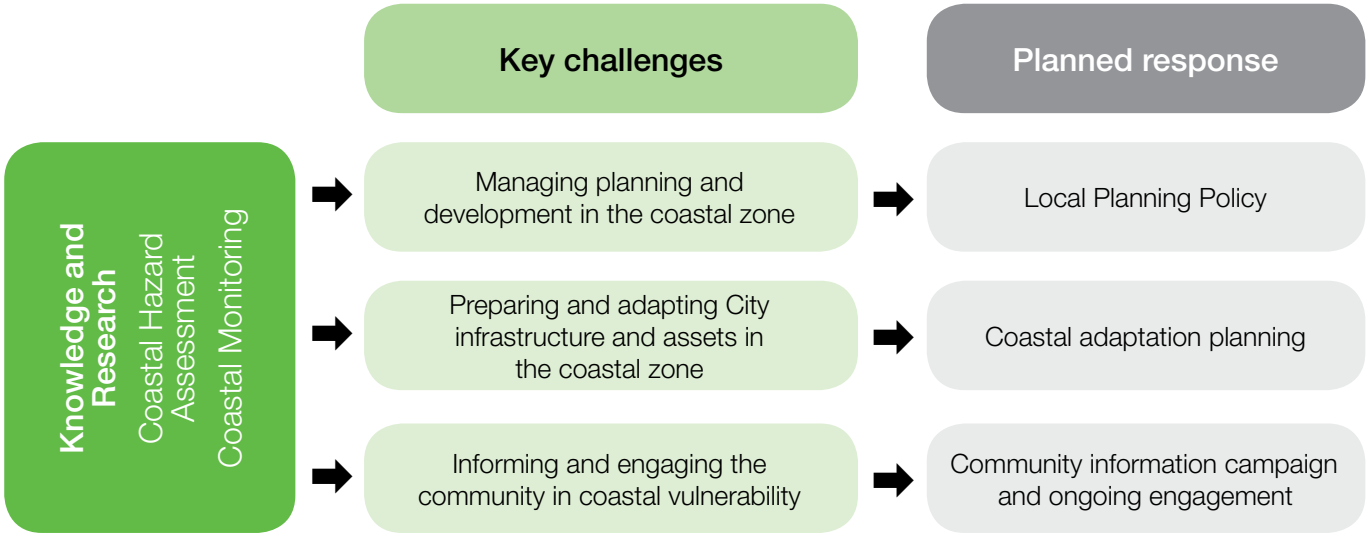


Figure 2 – City of Joondalup's Coastal Vulnerability Framework

1.2.1 Scope

The *Coastal Infrastructure Adaptation Plan* will address risk to City of Joondalup owned or managed land, infrastructure and assets. The Plan will address impacts from sea level rise, coastal erosion and inundation; however it does not consider other climate change impacts.

Whilst this Plan will not directly address risk to private property, the City's broader coastal vulnerability response will consider private development and engagement with the community. See section 1.3 for more detail. The City is facilitating and building resilience and adaptive capacity in the community by providing detailed, accurate and clear information about coastal hazard risk. It is also recognised that the majority of private property potentially at risk is landwards of the City's coastal foreshore areas and infrastructure and therefore may benefit from the City's adaptation measures.

The implementation timeframe for this Plan is eight years; however it is important to recognise that the Plan considers coastal hazard over a 100 year planning timeframe. This Plan will focus on improving the City's understanding of coastal vulnerability and assessing and prioritising risk to ensure the City is in the best position to adapt to future change when required.

1.3 Coastal Vulnerability Framework

A Coastal Vulnerability Framework has been developed to guide the City's approach and response to coastal vulnerability, see Figure 2.

The Coastal Vulnerability Framework identifies three key challenges for the City in addressing coastal vulnerability:

- Managing planning and development in the coastal zone;
- Preparing and adapting City infrastructure and assets in the coastal zone; and
- Informing and engaging the community in coastal vulnerability.

A planned response has been identified to address each key challenge. The development of a *Local Planning Policy* will guide planning and development in the coastal zone. The implementation of a community information and engagement campaign will improve the community's understanding of coastal vulnerability, potential impacts and the City's planned response. Coastal adaptation planning will help the City prepare and adapt its infrastructure and assets in the coastal zone for the impacts of coastal vulnerability.

Key Components	Description
Coastal Infrastructure Adaptation Plan	Is an overarching Plan for the City's entire coastline and includes recommended management actions to be implemented during the life of the Plan, a long term framework for coastal adaptation planning including identification of vulnerable nodes.
Coastal Hazard Risk Management Adaptation Plan	Is a Plan that will identify more detailed adaptation responses for the entire coastline and will include community engagement in the identification of adaptation responses.
Coastal Hazard Assessment	Identifies the area in which coastal processes may occur or impact over a specific timeframe including erosion during severe storms, historical shoreline movements, inundation and future potential sea level rise. The Coastal Hazard Assessment was completed in accordance with *State Planning Policy 2.6*.
Coastal Monitoring Program	Uses photo monitoring, mapping of the shoreline and beach profile surveys to monitor movement of the shoreline over time and will provide an analysis report every second year. Will be used to refine and update the Coastal Hazard Assessment in the future.

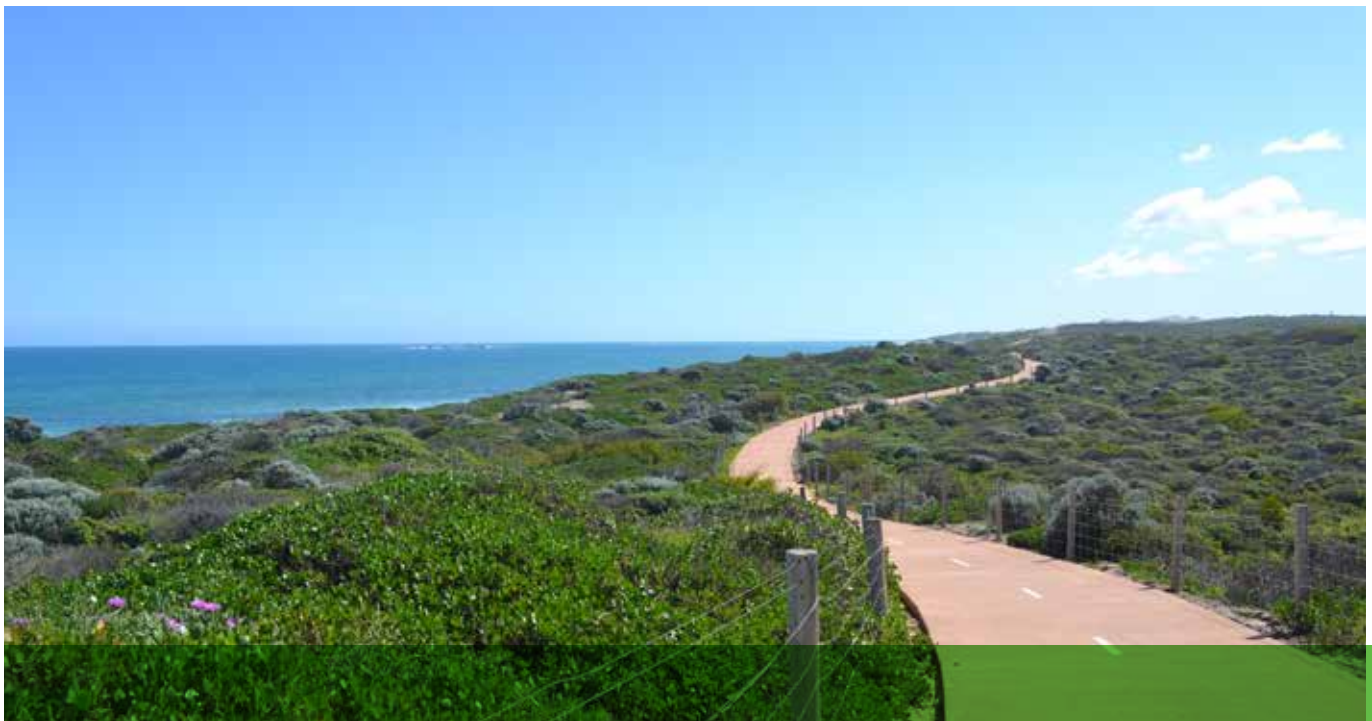
Table 1 – Key components of the City's coastal adaptation planning

The City's coastal adaptation planning includes the following key components: the *Coastal Infrastructure Adaptation Plan* and *Coastal Hazard Risk Management Adaptation Plan*. These Plans are informed by the City's Coastal Hazard Assessment and Coastal Monitoring Program. These components are briefly summarised in Table 1 and explained in more detail throughout the Plan.

1.4 Liability Risk Management Principles

The City will remain cognisant of the following liability risk management principles in the implementation of this Plan and the City's Coastal Vulnerability Framework to ensure it is acting responsibly and minimising risk to the organisation and the community.

- Evidence based decision making – decisions should be based upon the best available scientific data.
- Document decision making – decisions are made in good faith and are documented diligently with appropriate record keeping.
- Disclosure of risk information – regularly update and communicate risk information in a timely and accurate manner and communicate any levels of uncertainty.
- Engage with the community – effectively engage and communicate with the community on coastal adaptation.
- Collaborate with other stakeholders – ensure collaboration with other affected stakeholders i.e. State Government, other local governments, utility and service providers etc.



1.5 Strategic Context

The City's Coastal Vulnerability Framework is informed by the Federal, State, regional and local strategic context. See Figure 3.

Further details on the Federal, State and regional context for the City's coastal vulnerability framework are provided in Appendix A. These documents have informed the development of the Plan and implementation of the City's coastal vulnerability framework.

Figure 3 – Strategic Context of the City's Coastal Vulnerability Framework

1.5.1 Local – City of Joondalup

The *Coastal Infrastructure Adaptation Plan* has been developed in the context of the City's strategic framework. *Joondalup 2022: Strategic Community Plan 2012 – 2022* is the City's long-term strategic plan outlining its commitment to achieving the vision and aspirations of the community and regional stakeholders. *Joondalup 2022* includes an objective for Environmental Resilience – to continually adapt to changing local environmental conditions.

The *Coastal Infrastructure Adaptation Plan* is informed by strategic planning documents from the areas of environment, asset management, natural areas and land use planning, see Figure 4. Further detail on how the *Coastal Infrastructure Adaptation Plan* aligns with these strategic planning documents is provided in Appendix B.

Figure 4 – Strategic Framework of the Coastal Infrastructure Adaptation Plan 2018 – 2026

2.0 Coastal Vulnerability

In order to adequately plan for the impacts of climate change along the coast, the City has taken a number of steps to improve its understanding of coastal vulnerability. This has included improving knowledge of the coastal zone and coastal processes, determining coastal hazards and assessing coastal vulnerability.

An overview of the City's investigations, methodology and outcomes is provided below. Much of the City's knowledge and understanding has been informed by work undertaken by consultants MP Rogers and Associates on behalf of the City. [1, 2, 3]

2.1 The City's Coastal Zone

The coastal zone has large foreshore areas containing City-owned infrastructure used by the public including surf lifesaving clubs, community halls, public amenities, public lighting, stormwater drainage infrastructure, parks and playgrounds, dual use paths, carparks and access paths. The City's coastline is vulnerable to shoreline movement, severe storm erosion and sea level rise as a result of a changing climate. These changes to the shoreline are likely to put infrastructure and assets along the coast at risk and affect the way the community can access and enjoy these areas.

The City's coastline also includes areas of residential and commercial development, although the majority of private infrastructure is located landwards of City-owned infrastructure.

Changing coastal processes are also likely to impact on the City's environmental assets including sandy beaches, dunal areas and coastal vegetation. Much of the coastal vegetation along the City's coastline is recognised as Bush Forever and valued for its high conservation values and regional significance.

A summary of the assets and values within the City's coastal zone is summarised in Table 2.

City Assets and Infrastructure	Environmental Values	Community Values and Assets
Section 1: Marmion to Sorrento		
MAAC carpark and seawall. Sorrento Surf Life Saving Club (SLSC), seawall and carpark. Sorrento Groynes (3) Sorrento Beach Enclosure Public amenity blocks West Coast Drive Dual use path Beach access ways and landscaping Beach and dunes	There is a small amount of vegetation in this section. The vegetation complex is Cottesloe Complex-Central and South. Vegetation condition is assessed as between degraded and very good with the more degraded areas generally at the southern end of the section. The vegetation is not recognised as Bush Forever and while not considered an environmentally sensitive area does provide an ecological linkage.	Residential properties (privately owned) Marmion Angling and Aquatic Club (MAAC) (privately owned) Commercial properties (cafes, shops etc) (privately owned) Area used extensively by the community particularly the dual use path along the coast. Sorrento Beach and the newly developed foreshore area is also a popular area.
Section 2: Hillarys to Ocean Reef		
Whitfords Avenue/Oceanside Promenade/Northshore Drive Mullaloo Surf Life Saving Club building Parks and Car parks Dual use path Public amenities Beach access ways	Bush Forever Site 325. Vegetation complex is Quindalup Complex. Vegetation condition is assessed as ranging from completely degraded, degraded, and good to very good. The area is considered an environmentally sensitive area and provides an ecological linkage.	Residential properties (privately owned) The Mullaloo Surf Life Saving Club building is leased by the Surf Life Saving Club and is an important hub for the community. Tom Simpson Park at Mullaloo Beach is a popular area for community gatherings and recreation.

[1] MP Rogers and Associates (2016)a
[2] MP Rogers and Associates (2016)b
[3] MP Rogers and Associates (2016)c

Section 3: Iluka to Burns Beach		
Ocean Reef Sea Sports Club building Whitfords Volunteer Sea Rescue buildings Dual use path Beach access ways and beach shelters Public amenities Jack Kikeros Community Hall Parks and carparks Beach and dunes	The southern part of this section up to the Burns Beach caravan park is Bush Forever Site 325. Vegetation complex is Cottesloe Complex-Central and South, and Quindalup Complex. The majority of the vegetation condition is assessed as good or very good with some small pockets of degraded areas. The bushland immediately surrounding the Burns Beach townsite is not Bush Forever. The vegetation complex is considered to be Cottesloe – Central and South. North of Burns Beach to the City's boundary is Bush Forever Site 322. Vegetation complex is Cottesloe Complex-Central and South, and Quindalup Complex. Vegetation condition is assessed as very good. The entire section is considered an environmentally sensitive area and provides an ecological linkage.	Burns Beach caravan park (privately owned). Residential properties (privately owned). The Ocean Reef Sea Sports Club and Whitfords Volunteer Sea Rescue buildings are leased by community groups. Future residential development areas. Burns Beach and the Iluka foreshore areas are popular with the community and the dual use path is used extensively.

Table 2 – Summary of assets and values within the coastal zone.

2.2 Coastal Processes

The coastal zone is subject to a range of coastal processes and is an area of constant change. Sediment is continually being moved by wind, waves and currents and beaches can be either eroding or accreting. Human activities in the coastal zone can also influence these coastal processes.

The three main types of sediment transport, longshore, cross-shore and wind-blown transport are described below.

Longshore sediment transport is when sediment is moved along the coast in the surf zone by the longshore current. The longshore current is formed by the wind and the resulting waves that approach the beach at an angle. In Perth, longshore sediment transport is typically north in summer (due to sea breezes from the south-west) and south in winter (due to the direction of storm fronts). Estimates of the indicative sediment budget by MP Rogers indicate that there is generally a net northerly flux of sediment transport, although this can change from year to year depending on prevailing weather conditions.

Cross-shore sediment transport is the onshore/offshore movement of sediment and depending on the direction of movement (onshore or offshore) can result in either an accreting or eroding beach. Offshore sediment transport usually occurs during a significant storm event where increased water levels (storm surge) and steeper waves can remove sediment from a greater portion of the beach. Storm surge occurs when a storm with high winds and low pressure crosses the shoreline. Erosion of sandy beaches during storms can occur quickly and result in significant changes. Onshore sediment transport moves sediment through regular wave and swell activity but generally occurs at a much slower rate than offshore sediment transport.

Sediment moved by the wind (wind-blown sediment transport) moves sand from the beach to the dunes and is how coastal dunes are formed, develop and migrate. The coastal dunes form a natural buffer to accommodate storm erosion. Coastal vegetation helps to stabilise the dunes, while movement of people through the dunes can destabilise the dunes. Wind-blown sediment can bury fences, access ways and vegetation.

2.2.1 Coastal Structures

Coastal processes and the movement of sediment can be significantly affected by coastal structures. Hillarys Boat Harbour and Ocean Reef Boat Harbour are large coastal structures with breakwaters that extend beyond the -5m contour. These breakwaters are believed to prevent the majority of longshore sediment transport, resulting in an accreting beach on the southern side and an eroding beach (because sediment supply has been reduced) to the northern side.

Other coastal structures along the coast include groynes and seawalls which have been designed to protect the coastline by altering cross-shore or longshore sediment movement. Three groynes located in Sorrento act to trap sediment moving north (longshore sediment transport) reducing erosion of these beaches. Built in the 1980s these groynes are approximately 60m in length and are still adequate to provide their functional purpose. There is also one groyne at Burns Beach.

Seawalls are located in front of the Marmion Angling and Aquatic Club (MAAC) and the MAAC carpark, Sorrento Surf Life Saving Club and Mullaloo Surf Life Saving Club. Seawalls are generally used to protect the area behind the wall from erosion. It is thought that the sea wall in front of the Mullaloo Surf Lifesaving Club was built to prevent sand blowing into the courtyard and garage area and it is unclear whether it would be able to provide wave protection. The seawall in front of the Sorrento Surf Life Saving Club does not currently experience regular wave impact but is assessed as being sufficient to provide wave protection in the short-term. The seawall located in front of the MAAC carpark does not currently experience regular wave impact but is monitored as part of the City's coastal monitoring program.

2.3 Climate Change Impacts

When the City's coastline was planned and developed it allowed for the coastal processes of that time and while year to year variability was recognised, potential future impacts from a changing climate were not considered. It is now recognised that climate change will impact coastal processes into the future and that developed areas may become vulnerable. The most significant impact to the coastline as a result of climate change is likely to come from mean sea level rise.

The Department of Transport has reviewed mean sea level variation along the Western Australian (WA) coastline and international climate change projections and has identified that a 0.9m allowance should be used to estimate mean sea level rise over the next 100 years[4].

Higher mean sea levels may lead to inundation in low lying areas and importantly may increase extreme sea levels during storm events. Storm surges occur on top of the mean sea level and as mean sea levels rise, storm surges will be able to penetrate further inland increasing the potential for erosion and flooding[5].

Future climate change may also impact the frequency and intensity of storm events and therefore storm surges. It has been predicted by the CSIRO with high confidence that the intensity of extreme rainfall events in the south west of Western Australia will increase and extreme sea levels will also increase[6].

[4] Department of Transport (2010)
[5] CSIRO Marine and Atmospheric Research (2008)
[6] Hope (2015)
[7] MP Rogers (2016)a
[8] Department of Planning, Lands and Heritage (2013)

2.4 Assessing Coastal Hazards

In order to determine the vulnerability of the City's coastal zone and to provide information to assist the City in planning future coastal adaptation measures MP Rogers were contracted to undertake a coastal hazard assessment for the City's coastline[7]. The coastal hazard assessment has been informed by geotechnical investigations undertaken by MP Rogers. A summary of the methodology used for assessing the City's coastal vulnerability is provided below.

2.4.1 Methodology

The methodology used in the coastal hazard assessment aligns with the requirements of State Planning Policy 2.6 (SPP 2.6): *State Coastal Planning Policy*[8]. Schedule One of SPP 2.6 details the methodology for calculating the width needed to allow for coastal processes for both sandy coasts and rocky coasts. As required by SPP 2.6 the coastal hazard assessment calculated the coastal processes allowance for a 100 year planning timeframe. To assist in the City's coastal adaptation planning, allowances were also calculated for immediate and 50 year planning timeframes.

Geotechnical Investigations

The presence of continuous rock at an appropriate location and elevation can protect the shoreline against erosion. In some locations the presence of rock can be confirmed through a visual assessment. In other locations geotechnical investigations were required to confirm the presence of sufficient rock within the coastal dune. Where there is no evidence of rock along the shoreline or coastal dune the beach has been classified and treated as a sandy coast. The location and methodology of the City's geotechnical investigations are summarised in Table 3.

Location	Methodology
Near Lennard Street, Marmion	Probing with a Perth Sand Penetrometer (PSP) on a 15 x 15m grid over the coastal dunes.
North of Marmion Angling and Aquatic Club up to the first Sorrento groyne.	Probing with a Perth Sand Penetrometer (PSP) on a 15 x 15m grid over the coastal dunes.
South of Burns Beach groyne, Burns Beach	Exposed rock is visible at this site but given the small setback to infrastructure the competency of the rock was assessed by a walkover and visual assessment by specialist consultants.

Table 3 – Location and Methodology of Geotechnical Investigations

Coastal Erosion

The methodology for determining the width required for coastal erosion is dependent on whether the area is identified as a sandy or rocky coast. For sandy coasts the allowance is calculated by summing three factors (S1 + S2 + S3) and a 0.2m allowance for uncertainty see Table 4.

Factors	Description
S1 Erosion	Allowance for the current risk of storm erosion. In accordance with SPP 2.6 three repetitions of a severe storm sequence that affected south west Western Australia in July 1996 are modelled as a 100 year beach erosion event on the City's coastline.
S2 Erosion	Allowance for historic shoreline movement trends. Historical shoreline movement is examined using aerial photography and future shoreline movement is predicted. SPP 2.6 requires that the allowance for shoreline movement trends should be calculated as 100 times the historic annual rate of erosion.
S3 Erosion	Allowance for erosion caused by future sea level rise. SPP 2.6 requires that this allowance should be calculated as 100 times the adopted sea level rise value of 0.9m over a 100 year planning timeframe or 90m.

Table 4 – Calculating Allowances for Coastal Processes on Sandy Coasts

For rocky coasts the allowance for the current and future risk of erosion should be based on a geotechnical assessment of shoreline stability. If the rock present is deemed to be sufficient to provide continuous protection then an allowance of 5m is used to assess risk to existing public and recreational infrastructure. For areas where the rock is more variable a 20m coastal hazard allowance is provided.

Coastal Inundation

The allowance required for coastal inundation is calculated as the maximum extent of storm surge inundation (S4 Inundation) plus the predicted extent of sea level rise. Storm surge inundation is defined as the peak steady water level plus wave run-up[9]. SPP 2.6 requires that the allowance be based on a one in 500 year inundation event which was estimated by MP Rogers through modelling of historical data sets.

2.4.2 Findings

A summary of the findings from the geotechnical investigations and coastal hazard assessment is provided below.

Geotechnical Investigations

The site near Lennard Street, Marmion was found to have sufficient rock present within the dunes, to reduce the vulnerability of the shoreline and an approximate line of the rock was estimated based on probe locations and site investigations.

For the site between the Marmion Angling and Aquatic Club to the first Sorrento groyne, rock was present at low elevations in the southern section but only limited rock was present at the northern end. It was therefore assessed that the southern section of coast has rock present beneath the dunes but the northern section of the site was sandy. An approximate line of the rock was estimated for the south and central part of the site.

For the site south of Burns Beach groyne the rock present was confirmed to be continuous and at a reasonable elevation to provide protection to the infrastructure behind.

Other locations of rock along the coast were confirmed through a visual assessment. The coastal hazard maps in Appendix C show where rock is present along the City's coast.

Coastal Erosion

The coastal erosion allowance calculated for sandy sections of the City's coastline varies along the coast and over the planning timeframe, see summary in Table 5. The maximum extent of coastal erosion in the immediate timeframe is 46m; over a 100 year planning timeframe this maximum potential erosion may be up to 266m.

Planning Timeframe	Minimum Coastal Erosion Allowance	Maximum Coastal Erosion Allowance
2015 – immediate planning timeframe	5m	46m
2065 – 50 year planning timeframe	32m	143m
2115 – 100 year planning timeframe	85m	266m

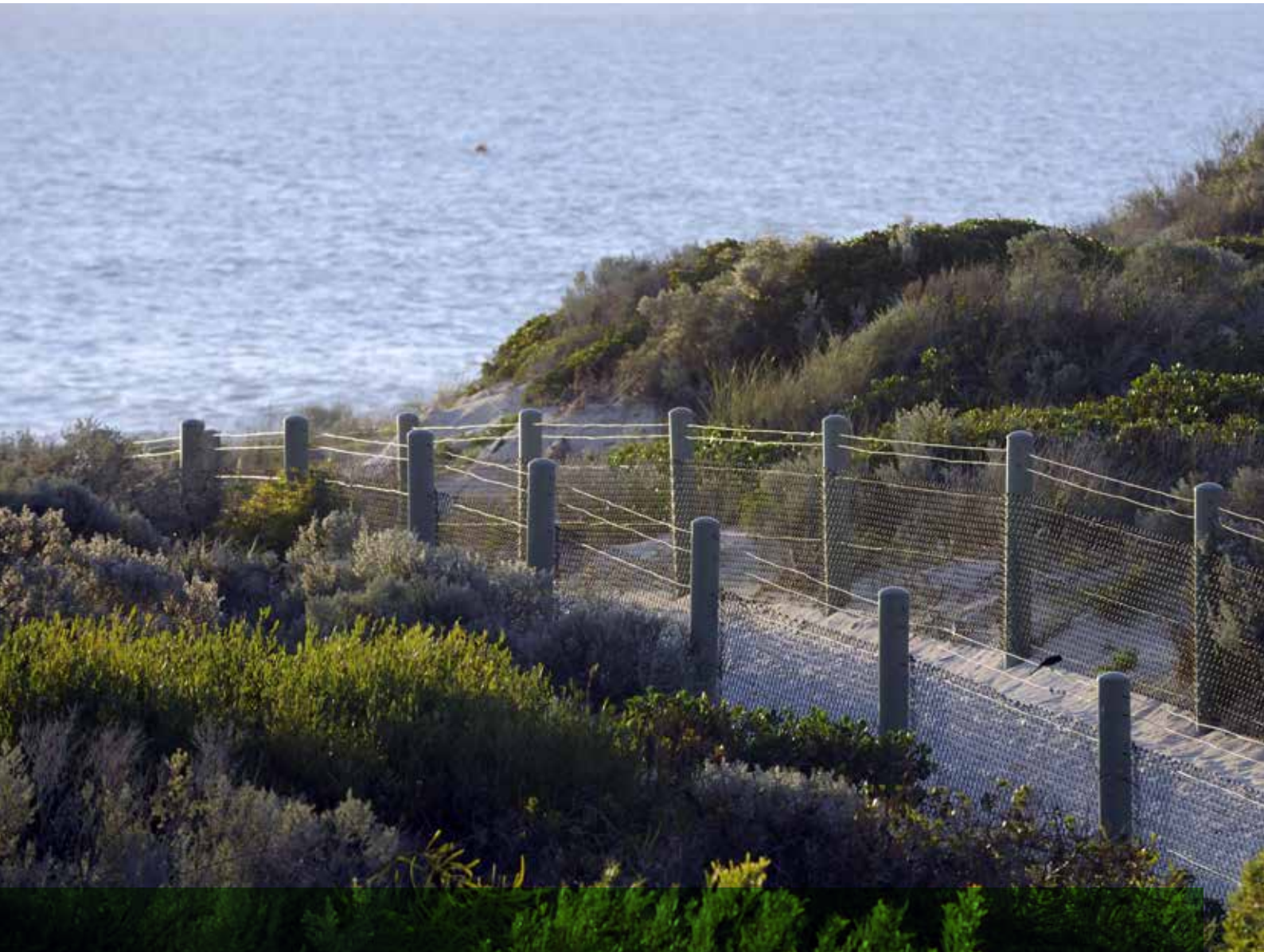
Table 5 – Summary of coastal erosion allowances

Coastal erosion allowances have been mapped and are provided in Appendix C, an example is provided in Figure 5. To assist in interpreting the mapping a legend and description is also provided.

[9] Department of Planning, Lands and Heritage (2013)

Legend	Description
2015 Coastal Erosion	Provides an indication of the possible extent of severe storm erosion in the present day.
2065 Coastal Erosion	Provides an indication of the possible extent of severe storm erosion in 50 years.
2115 Coastal Erosion	Provides an indication of the possible extent of severe storm erosion in 100 years. Note infrastructure located west of this line is considered potentially vulnerable within the 100 year planning timeframe.
Rock	Rock has been identified that will provide sufficient protection against erosion.
Seawall	A sea wall is present that will protect against erosion.

Figure 5 – Example of the City's Coastal Hazard Mapping



The City's coastal hazard mapping has found that sections of coastline within the suburbs of Sorrento, Hillarys, Kallaroo, Mullaloo, Ocean Reef and Burns Beach may be susceptible to coastal erosion over the 100 year planning timeframe.

Coastal Inundation

Analysis of coastal inundation modelling demonstrates that the City's shoreline has a low risk of inundation from sea level rise and storm surge within the 100 year planning timeframe. The low risk is due to the generally high dunes and rocky cliffs along the City's coastline which provides a high elevation barrier to potential storm surge and inundation.

Vulnerable Infrastructure

The coastal hazard mapping has been used to identify vulnerable land and infrastructure. Land and infrastructure located west of the coastal erosion lines are considered to be potentially vulnerable within that planning timeframe.

The coastal hazard mapping demonstrates that in the present day there is minimal existing infrastructure vulnerable and this is generally limited to dune fencing and beach access paths. In the longer timeframes of 50 and 100 years additional infrastructure is potentially vulnerable such as carparks, dual use paths, City buildings, playgrounds and public open space infrastructure as well as roads and associated lighting and drainage infrastructure. A summary of City infrastructure potentially vulnerable over the different planning timeframes is provided in Table 6.

Timeframe	Potentially vulnerable City Infrastructure
2015 (Immediate planning timeframe)	Numerous beach access ways. Beach dune fencing. Landscaped wall in front of Mullaloo Surf Life Saving Club.
2065 (50 year planning timeframe)	Sections of West Coast Highway and Whitfords Avenue, John Wilkie Turn. Sections of dual use path in Burns Beach, Iluka, Ocean Reef, Hillarys, Kallaroo, Sorrento. Mullaloo Surf Life Saving Club building and toilet amenities. Carparks, toilet amenities, POS infrastructure at Pinnaroo Point. Hillarys Beach Park carpark, telecommunications tower, playground. Whitfords Volunteer Sea Rescue Building.
2115 (100 year planning timeframe)	Sections of West Coast Highway, Whitfords Avenue, Northshore Drive, Oceanside Promenade, John Wilkie Turn, Beachside Drive, Padbury Circle, Raleigh Rd and Robin Ave. Sections of dual use path in Burns Beach, Iluka, Ocean Reef, Mullaloo, Hillarys, Kallaroo, and Sorrento. Sorrento foreshore public open space, carpark and toilet amenities. Hillarys Beach Park carpark, telecommunications tower, playground and toilet amenities. Toilet amenities at Hillarys North and Key West. Beachside Park and associated infrastructure. Tom Simpson Park including playgrounds, POS infrastructure and toilet amenities. Carparks at Mullaloo Surf Life Saving Club, Tom Simpson Park, Ocean Reef Boat Harbour, Key West, West View, Northshore Drive.

Table 6 – City infrastructure potentially vulnerable over different planning timeframes.

3.0 Analysing The Risk

While the coastal hazard assessment has identified land and infrastructure that may be vulnerable in the short-term and long-term the City needed to determine an approach for responding and planning for this vulnerability including how to prioritise future adaptation actions. Coastal planning practices nationally and internationally are increasingly adopting a risk management approach for dealing with the potential adverse impacts of coastal hazards.

The City has undertaken a preliminary risk assessment process to identify and prioritise the areas along the City's coastline that are at risk from coastal hazards within a 100 year planning timeframe. This has included identification of vulnerable nodes and development and implementation of a Coastal Infrastructure Risk Assessment Framework. More detailed risk assessment will be undertaken for specific areas as part of the City's proposed *Coastal Hazard Risk Management Adaptation Plan*.

3.1 Identification of Vulnerable Nodes

Based on the outcomes of the coastal hazard assessment six vulnerable nodes have been identified along the City's coastline, see Table 7. Vulnerable nodes are locations where a group of assets are identified as vulnerable and it is logical to identify adaptation measures to protect the vulnerable node in its entirety.

Vulnerable nodes were identified by visually assessing aerial photographs of the City's coastline with the coastal erosion lines overlayed and taking into consideration the following factors:

- Spatial proximity of assets and infrastructure;
- Patterns of use by the community and visitors; and
- Sediment cells, coastal processes and relevant geomorphologic features.

Boundaries proposed for each of the vulnerable nodes are preliminary and will be refined as part of the adaptation planning for each node.

Node	Boundaries	City Infrastructure Affected
Burns Beach North	From where the rock ceases just north of Burns Beach Groyne to the top of the proposed Burns Beach development area.	Includes dual use path, Beachside Park and associated infrastructure, Beachside Drive and associated infrastructure.
Iluka Foreshore	Includes the two embayed beaches in Iluka (east of the Shenton Avenue and Burns Beach roundabout).	Includes two beach gazebos, beach access ways and dual use path.
Ocean Reef	Includes the two embayed beaches north of the Ocean Reef Boat Harbour.	Includes Whitfords Volunteer Sea Rescue Building, carparks, dual use path.
Mullaloo Foreshore	Starting just south of the residential infrastructure at Merrifield Place north past Mullaloo Surf Life saving Club to where the rock commences.	Includes Mullaloo Surf Lifesaving Club building, Tom Simpson Park and associated infrastructure, four carparks, Oceanside Promenade, Merrifield Place.
Pinnaroo Point – Hillarys	Extending from the northern side of Hillarys Boat Harbour to just north of the carpark at Kallaroo Foreshore Reserve (opposite St Ives Loop).	Includes public open space infrastructure at Pinnaroo Point and Hillarys Beach Park, six carparks, four toilet blocks, Northshore Drive, Whitfords Avenue, John Wilkie Turn and associated infrastructure.
Sorrento Foreshore	Extending between the southern side of Hillarys Boat Harbour south to where the rock commences.	Includes public open space infrastructure at Sorrento Beach Park, one carpark, one toilet block, West Coast Highway, Padbury Circle, Raleigh Road, Robin Avenue and associated infrastructure.

Table 7 – Vulnerable Nodes along the City's Coastline

3.2 Coastal Infrastructure Risk Assessment Framework

The City has developed a Coastal Infrastructure Risk Assessment Framework (see Figure 6) to assess risk to the City's infrastructure from coastal erosion and sea level rise and to identify adaptation options to manage those risks. The Framework is based on the Department of Planning, Lands and Heritage's Coastal Hazard Risk Management and Adaptation Planning Guidelines (2014)[10] as well as the City's Risk Management Framework[11].

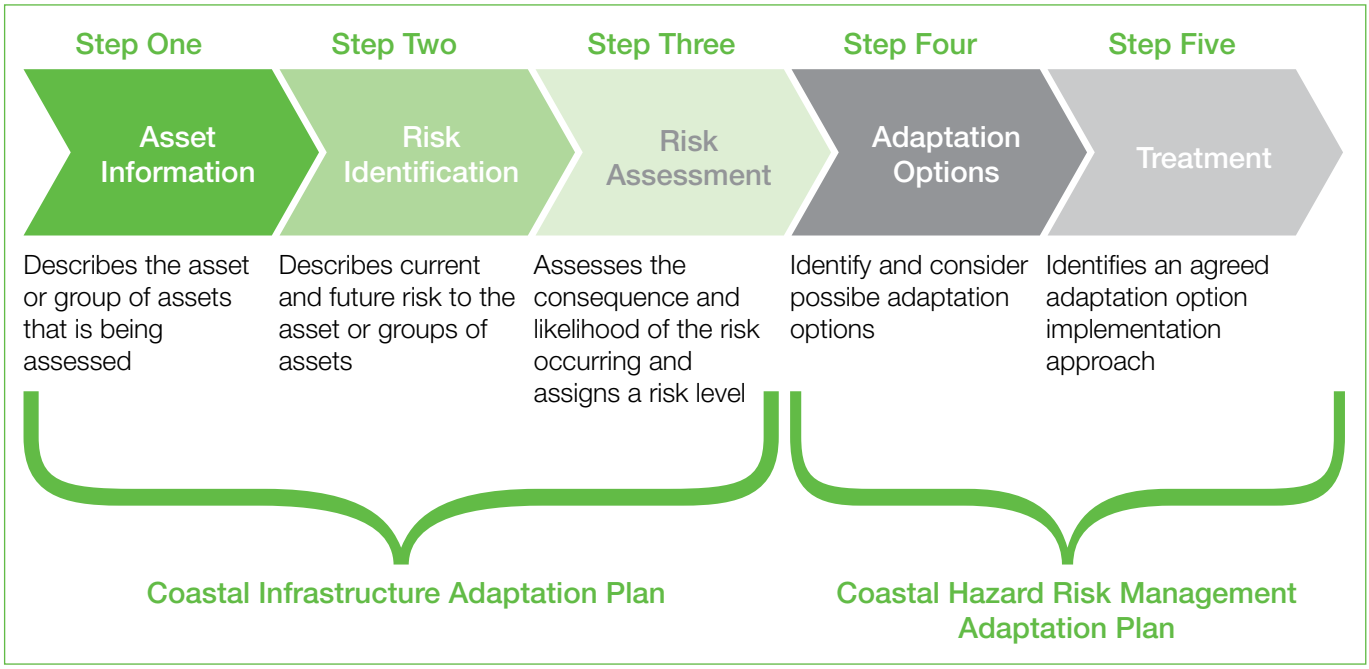


Figure 6 – Coastal Infrastructure Risk Assessment Framework

Steps one to three of the Framework have been undertaken as part of developing this *Coastal Infrastructure Adaptation Plan*. The purpose of Steps one to three is to undertake a preliminary risk assessment of the vulnerable nodes in order to prioritise the need for coastal adaptation responses. To implement Steps one to three of the Framework a Coastal Infrastructure Risk Assessment Form (Appendix D) was developed and completed for each vulnerable node through a combination of desktop and field assessments.

Steps four and five will identify and assess specific adaptation options for each vulnerable node and will be undertaken as part of developing the City's proposed *Coastal Hazard Risk Management Adaptation Plan*. Further detail on each of the steps is provided below.

3.2.1 Step one – Asset Information

Step one collated background information on the vulnerable nodes and assets within the nodes including location, description, assets present, stakeholders, services provided, community values, environmental values and existing controls.

3.2.2 Step two – Risk Identification

Step two identified and described the potential risk using both the historical evidence and the findings of the coastal hazard assessment over the different timeframes.

3.2.3 Step three – Risk Assessment

The next step determined a level of risk for each node based on the likelihood of the risk occurring and the consequences if the risk did occur. The Level of Consequence scale ranges from insignificant to catastrophic. Qualitative descriptions are provided for each risk category in Table 8. The Level of Consequence scale has been developed from the City's Corporate Risk Management Framework[12].

[10] Department of Planning, Lands and Heritage (2014)
[11] City of Joondalup (2013)
[12] City of Joondalup (2013)

Catastrophic	Major	Moderate	Minor	Insignificant
Survival of City threatened, statutory obligations not met, long term damage to reputation, risk to life.	Long term interruption to major systems, intervention or investigation by other authorities, significant financial impact, serious illness/injury.	Major systems inconvenienced, moderate financial impact, external assistance may be required.	Non major systems interrupted, low financial impact, some customer inconvenience.	Negligible impact on systems and service delivery.

Table 8 – Level of Consequence Scale

The Likelihood of Occurrence scale ranges from rare to almost certain and a description of probability for each category is provided in Table 9. The Likelihood of Occurrence scale from the Department of Planning, Lands and Heritage's Coastal Hazard Risk Management and Adaptation Planning Guidelines[13] was used rather than the City's Risk Management Framework as it was considered more relevant for assessing climate change risk given the long timeframes being considered.

	Almost Certain	Likely	Possible	Unlikely	Rare
Recurrent Risks	Could occur several times per year.	May arise about once per year.	May arise once in ten years.	May arise once in ten years to 25 years.	Unlikely during the next 25 years.
Single Events	More likely than not – Probability greater than 50%.	As likely as not – 50/50 chance.	Less likely than not but still possible – Probability less than 50% but still quite high.	Unlikely but not negligible – Probability low but greater than zero.	Negligible – Probability very small, close to zero.

Table 9 – Likelihood of Occurrence Scale

An overall risk score is calculated as a product of the Likelihood of Occurrence and the Level of Consequences, see Table 10.

Risk Score	Consequences				
	Catastrophic (5)	Major (4)	Moderate (3)	Minor (2)	Insignificant (1)
Almost Certain (5)	25	20	15	10	5
Likely (4)	20	16	12	8	4
Possible (3)	15	12	9	6	3
Unlikely (2)	10	8	6	4	2
Rare (1)	5	4	3	2	1

Table 10 – Risk Level Matrix

The risk level score is then described as Low, Moderate, High and Extreme. The identification of different risk levels may require a different level of response as described overleaf in Table 11.

[13] Department of Planning, Lands and Heritage (2014)

Score	Description	Response
1 – 5	Low	Part of routine operations and management and can be expected to be dealt with by existing controls.
6 – 12	Moderate	Part of routine operations where specific monitoring and response procedures exist. Responsibility will be assigned to the relevant Manager and progress reported to the relevant Director.
13 – 19	High	Part of routine operations but must be managed by a Manager, who reports on progress to the Executive Leadership Team.
20 – 25	Extreme	Urgent attention is required at an executive level. Action plans and management responses are required. This risk cannot be accepted as part of routine operations. A report should be provided to the Executive Leadership Team for decision by the CEO.

Table 11 – Risk Level Description and Response

To give a better indication of the vulnerability of a node the adaptive capacity of the node will also be described. Adaptive capacity refers to the ability of something to change in a way that makes it better equipped to deal with external influences[14]. Adaptive capacity will be an additional consideration to the total risk score in determining priority.

3.2.4 Step four – Adaptation Options

Step four identifies potential options that can be taken to adapt to or minimise the risk from coastal hazards. Step four will be undertaken as part of the proposed coastal hazard risk management adaptation planning.

State Planning Policy 2.6 identifies four categories of adaptation options: avoid, planned or managed retreat, accommodate, and protect (see Table 12).

These adaptation options are considered to be a hierarchy with avoid being the most preferred option and protect being the least preferred option. Adaptation options can address the entire node or specific assets within the node and may completely eliminate the risk or act to reduce the risk to acceptable levels.

3.2.5 Step five – Treatment

Step five is where the identified options are assessed or 'treated' to determine their suitability for implementation. Factors that would need to be taken into consideration include capital cost, ongoing cost, environmental impact, social impact, community acceptability, reversibility or adaptability in the future, effectiveness over time, legal risk and approvals required.

Step five will be undertaken in consultation with the community and relevant stakeholders as part of the proposed coastal hazard risk management adaptation planning.

Types of Adaptation Options	Description
Avoid	Avoid the presence of new development within an area identified to be affected by coastal hazards.
Planned or Managed Retreat	Planned or Managed Retreat or the relocation or removal of assets within an area identified as likely to be subject to intolerable risk of damage from coastal hazards over the planning timeframe.
Accommodate	If sufficient justification can be provided for not avoiding development of land that is at risk from coastal hazards then accommodation adaptation measures should be provided that suitably address the identified risks. Such measures would involve design and/or management strategies that render the risks from the identified coastal hazards acceptable.
Protect	Where sufficient justification can be provided for not avoiding the use or development of land that is at risk from coastal hazards and accommodation measures alone cannot adequately address the risks from coastal hazards, then coastal protection works may be proposed for areas where there is a need to preserve the foreshore reserve, public access and public safety, property and infrastructure that is not expendable.

Table 12 – Types of Adaptation Options

[14] Department of Planning (2014)

3.3 Risk Assessment of Vulnerable Nodes

For each of the vulnerable nodes identified, Steps one to three of the Coastal Infrastructure Risk Assessment Framework have been applied, see Table 13.

This included assessing the Likelihood of Occurrence and Level of Consequence and calculating a risk level and score for each of the planning timeframes. The risk scores for each of the planning timeframes were then added to give a total risk score.

Node	Timeframe	Likelihood of Occurrence	Level of Consequence	Risk Level and Score	Total Risk Score
Burns Beach North	Present day	Rare	Insignificant	Low (1)	15
	2065	Possible	Minor	Moderate (6)	
	2115	Likely	Minor	Moderate (8)	
Iluka Foreshore	Present day	Unlikely	Insignificant	Low (2)	9
	2065	Possible	Insignificant	Low (3)	
	2115	Likely	Insignificant	Low (4)	
Ocean Reef	Present day	Possible	Moderate	Moderate (9)	30
	2065	Possible	Moderate	Moderate (9)	
	2115	Likely	Moderate	Moderate (12)	
Mullaloo Foreshore	Present day	Possible	Minor	Moderate (6)	34
	2065	Likely	Moderate	Moderate (12)	
	2115	Likely	Major	High (16)	
Pinnaroo Point – Hillarys	Present day	Possible	Minor	Moderate (6)	33
	2065	Likely	Moderate	Moderate (12)	
	2115	Almost certain	Moderate	High (15)	
Sorrento Foreshore	Present day	Possible	Insignificant	Low (3)	35
	2065	Likely	Major	Moderate (16)	
	2115	Likely	Major	High (16)	

Table 13 – Risk Assessment of Vulnerable Nodes

Node	Adaptive Capacity	Priority
Burns Beach North	Large foreshore area and public open space infrastructure that could be relocated relatively easily. Includes Beachside Drive and associated lighting and drainage infrastructure.	4
Iluka Foreshore	Large foreshore area. Small embayed beaches. Minor infrastructure that could be relocated relatively easily.	5
Ocean Reef	Adaptive capacity would be considered high as the node is located within the Ocean Reef Marina (ORM) concept area and covered by the ORM *Coastal Hazard Risk Management Adaptation Plan*. It is proposed that infrastructure within this node be relocated within the ORM development.	6
Mullaloo Foreshore	Is a very open and exposed beach, there is some foreshore area but not enough to retreat beyond the 100 year planning timeframe. Is highly utilised and valued area. Mullaloo Surf Life Saving Club needs to be located near the beach as part of its function and would be difficult to relocate to alternative areas. Protect options may impact on the beach front and along the coastline. Within 100 years will impact Oceanside Promenade which is a key transport link north – south.	2
Pinnaroo Point – Hillarys	Large foreshore area, POS infrastructure could be moved back but not outside the 100yr line. Will impact on Northshore Drive and Whitfords Avenue which is a north-south link. Is already experiencing erosion.	3
Sorrento Foreshore	Limited foreshore area to allow for retreat options. Existing groynes which have the potential to be extended. South of Hillarys Boat Harbour which may act to trap sediment moving from the south and therefore reduce the rate of erosion.	1

Table 14 – Adaptive Capacity of Vulnerable Nodes

The adaptive capacity for each node is described in Table 14 and a priority order for coastal adaptation has been identified that reflects both the risk level and the adaptive capacity.

Sorrento Foreshore has been identified as having the highest priority for coastal adaptation. This reflects both its high risk level with sections of West Coast Highway vulnerable within 50 years and its low adaptive capacity due to the limited coastal foreshore area. Mullaloo Foreshore also has a high risk level with Mullaloo Surf Lifesaving Club vulnerable within 50 years and public open space infrastructure and Oceanside Promenade vulnerable within 100 years. While there is a larger foreshore area at Mullaloo Foreshore it would not be possible to move the infrastructure beyond the 100 year coastal erosion line.

Hillarys Foreshore and Pinnaroo Point both contain large foreshore areas, with public open space infrastructure and road infrastructure potentially vulnerable. Hillarys Foreshore and Pinnaroo Point have been combined as a single node as the coastal processes for these two areas are significantly linked. Any adaptation actions taken at Hillarys Foreshore would affect Pinnaroo Point and vice versa.

At Burns Beach North and Iluka Foreshore there is less significant infrastructure vulnerable and these sites have a higher adaptive capacity and therefore have been ranked as a lower priority.

The Ocean Reef node while identified as having a high risk level due to the vulnerability of the Whitfords Volunteer Sea Rescue building has a very high adaptive capacity as it is located within the *Ocean Reef Marina Concept Plan*. A *Coastal Hazard Risk Management Adaptation Plan* has been undertaken as part of the approvals process for the Ocean Reef Marina development and the Ocean Reef Marina has been designed to withstand future impacts. Therefore the development of adaptation responses for this node is not currently needed. This node should be monitored however to ensure no infrastructure becomes at risk before construction of the proposed Marina commences. If development of the proposed Marina is not approved or infrastructure is identified as being at risk before the development commences then the need for coastal adaptation responses should be reassessed.

4.0 Adaptation Plan

The *Coastal Infrastructure Adaptation Plan* has been developed to ensure the City can prepare and adapt to future change along the coast. To help address the key coastal adaptation planning issues four key focus areas have been identified. Objectives for each key focus area are provided below in Table 15.

In order to achieve these objectives recommended management actions have been identified for each of the four key focus areas.

Key Focus Area	Description
Coastal Infrastructure	Maintain existing coastal infrastructure to ensure accessibility and safety of City infrastructure and City beaches for public use. The City's coastal protection infrastructure continues to provide appropriate shoreline protection.
Improving Knowledge	Knowledge and understanding of coastal processes and future coastal impacts is improved. Knowledge and understanding of best-practice coastal adaptation planning is improved through partnerships and collaboration.
Response and Preparedness	Coastal hazards are identified for any City projects or activities within the coastal zone. Significant erosion or hazard events along the City's coastline are responded to in a timely manner.
Adaptation Planning	The City's coastline is prepared and able to adapt to future long term coastal impacts. The community is engaged in the City's coastal adaptation planning.

Table 15 – Key Focus Areas and Objectives

4.1 Coastal Infrastructure

The City's coastal zone includes beach infrastructure and coastal protection infrastructure that may be impacted within the lifespan of this Plan. More frequent or more intense storm events may require greater ongoing maintenance to maintain the City's coastal infrastructure and increase their longevity.

4.1.1 Beach Infrastructure

Minor infrastructure located on the City's beaches may become vulnerable to severe storm erosion within the next eight years including beach access ways, gazebos, fencing, bins and signage. Damage to this infrastructure during a severe storm event can pose a safety risk to users of the beach and may limit the accessibility of the beach. Beach infrastructure should be inspected frequently and after a significant storm event.

Beach access ways may need to be repaired to allow safe access to the beach, this may involve re-contouring the sand where the access way meets the beach or may require more significant remedial works.

Some sections of the coastline have fencing between the sandy beach area and the vegetated dune areas to protect the vegetation. In some locations this dune fencing can become damaged, buried or washed away presenting a safety hazard to beach users. Given the potential safety risks and the significant costs to reinstall dune fencing if the fencing becomes repeatedly damaged during storm events it should be removed rather than replaced or repaired.

Beach infrastructure such as gazebos, lookouts or wooden staircases will be inspected frequently and after storm events to ensure they remain safe and functional and any required maintenance and repair works are identified. If the level of damage or risk to public safety becomes too high, the City may need to consider removing the asset. Signs and rubbish bins if damaged or dislodged in a storm event can pose a safety risk and should be removed or repaired in a timely manner.

4.1.2 Coastal Protection Infrastructure

The City's coastal protection infrastructure including sea walls and groynes play an important role in protecting and maintaining the position of the City's shoreline. Degradation of the City's coastal protection infrastructure may affect its ability to protect shoreline position resulting in increased erosion of beaches. In addition, coastal protection infrastructure i.e. groynes are often accessed and utilised by the community and provide recreational value. It could present a public safety risk if the structure is compromised.

In 2016/17 the City undertook a condition inspection to update its inventory of coastal protection assets and identify any defects or degradation of the City's coastal protection infrastructure. The condition inspection also included assessing the functionality of the coastal protection infrastructure to resist current and future levels of severe storm erosion. As a result of the condition inspection and assessment of the remaining useful life the City has developed maintenance schedules and forward works programs to ensure the long term functionality of the City's coastal protection infrastructure. An update to this condition inspection inventory will be completed in 2020/21 and maintenance schedules forward works programs will be updated accordingly.

If at any time a risk is identified then allowances should be made for temporary actions such as isolating the hazards and installing risk warning signage in the interim before more permanent works can be implemented.

4.1.3 Recommended Coastal Infrastructure Management Actions

Undertake regular and post-storm monitoring of beach infrastructure including beach access ways, gazebos, fencing, bins and signage.

Ensure there is adequate annual operating budget for the repair and maintenance of beach infrastructure.

Undertake a technical assessment of coastal protection assets to update the City's inventory and inform forward works programming and maintenance schedules.

Maintain, repair and refurbish the City's coastal protection infrastructure in accordance with existing and updated maintenance schedules and forward works program.

4.2 Improving Knowledge

4.2.1 Understanding Coastal Change

The City established a coastal monitoring program in 2015/16 to monitor shoreline movement over time. The Program:

- Monitors actual shoreline erosion and improves the City's understanding of coastal processes;
- Provides valuable information that can be used to inform planning decisions in the coastal zone;
- Informs maintenance and asset replacement schedules of coastal infrastructure;
- Provides early warning of any increased vulnerability of assets;
- Guides the timing and need for coastal adaptation works; and
- Identifies if updates to hazard and vulnerability assessments are required.

The coastal monitoring program includes: photo monitoring at identified sites (every six months), shoreline mapping from aerial photography (annually), beach profile surveys (every two years) and analysis and report (every two years).

An initial baseline data set and report was completed during 2015/16[15]. This baseline data set and report will be used as a comparative tool for ongoing monitoring activities. The next coastal monitoring analysis report will be provided in 2017/18.

The City's coastal hazard mapping was undertaken in 2015 providing a 100 year planning timeframe of 2115. The City's coastal hazard mapping will be updated approximately every 10 years, with the next update occurring in 2025 providing a new 100 year planning timeframe of 2125.

4.2.2 Partnerships and Collaboration

Coastal adaptation is not the sole responsibility of local government. State government and private landholders also have a role to play in preparing and adapting the coastline for future change. Utilities infrastructure for street lighting, water, sewage and public transport may be impacted by coastal erosion in the future and the City will need to work with the relevant State Government department or agency to ensure they are informed of the risks and are engaged in adaptation planning.

It will also be important for the City to liaise with its adjoining local governments. Coastal processes are not contained within local government boundaries and the construction of coastal protection infrastructure can impact the coast outside of a local governments boundaries. The City will need to liaise with the adjoining local governments (City of Wanneroo and City of Stirling) to inform them of any adaptation actions the City is taking and to be aware of any adaptation actions they are taking.

Coastal adaptation is a relatively new field and the City needs to remain cognisant of improvements in best-practice as well as changes to legislation and policy that may impact the City's coastal adaptation planning. Opportunities to collaborate or partner with industry bodies, research institutions, local government or State Government should be sought.

4.2.3 Educating and Informing the Community

The City's coastline is highly valued by the community as a place to live, visit, exercise, socialise, relax and engage with other members of the community. The community is likely to have a significant level of interest in how the City's coastline may change in the future and how the City plans to adapt and prepare the coastline for future change.

The City's coastal hazard mapping, Joondalup Coastal Hazard Assessment and Baseline Coastal Monitoring Report are all publically available documents and were promoted as part of the 2016 coastal vulnerability engagement campaign. Updates to the City's coastal hazard mapping, coastal hazard assessments and coastal monitoring reports should continue to be publically available and promoted to the community.

The City has established a Coastal Vulnerability Stakeholder Notification List where community members and other stakeholders can register to receive updates when coastal vulnerability information is released or engagement opportunities arise.

[15] MP Rogers (2016)c

Ensuring that the community is educated and informed about potential future changes to the City's coastline will mean that they are more likely to engage in the City's coastal hazard risk management adaptation planning and be more supportive of adaptation measure that may need to be implemented in the future.

4.2.4 Recommended Improving Knowledge Management Actions

Continue to implement the coastal monitoring program in accordance with the schedule including providing an analysis report every two years.

Investigate options for the storing and collating of coastal monitoring data to allow improved spatial and temporal interpretation and analysis.

Investigate opportunities to partner with state and local government, industry groups and research institutions to enable the City to build capacity and gain information relating to best practice approaches to coastal adaptation.

Continue to keep the community informed about the vulnerability of the City's coastline, and improve their understanding of coastal processes and the City's coastal adaptation planning activities.

Update the City's coastal hazard mapping in 2025 to obtain a new 100 year planning timeframe of 2125.

4.3 Response and Preparedness

4.3.1 Severe Storms and Coastal Hazards

Impacts on the City's coastline within the next eight years are most likely to be a result of a severe storm event. Severe storm events can result in a large amount of sand eroding in a short period of time. It is possible that the City could experience a significant storm event that could impact on public open space and existing infrastructure above and beyond what is normally experienced during the winter season. The City may need to act if an area becomes unsafe or if remedial action is required to prevent further erosion. Activities that the City may need to take could include sand bagging, fencing off areas or undertaking sand renourishment. The City will develop an erosion response process to be implemented if a significant erosion event occurs as a result of a severe storm.

Limestone rock along the City's coastline is slowly degrading due to natural processes that occur over hundreds to thousands of years. Human activity can influence and increase degradation.

Failure events e.g. collapsing of overhangs are rare but can occur and may be associated with extreme weather events. This poses a public safety risk if the public can access areas above and below the cliffs. The City has previously undertaken an audit to identify any coastal cliff hazards and has installed signage to warn visitors to the area. The City will review the outcomes of the previous audit; determine if there have been any changes to the cliff hazard areas and make recommendations to improve existing warning signage or access restrictions.

4.3.2 Corporate Protocols and Processes

The City undertakes a number of projects along the coast such as upgrading public open space areas, installing infrastructure, undertaking major developments, developing coastal foreshore management plans, master planning and structure planning. Reviewing and updating the City's corporate protocols, processes and templates will ensure that if a project is located in a coastal hazard area it will be identified early in project planning stages.

Identifying in the early stages whether a project is in a coastal hazard area will ensure the project is informed by the City's coastal hazard assessment, coastal monitoring program and coastal adaptation planning, ensure coastal hazard risks are considered when decisions are being made and appropriate action taken. The identification that a project is within a coastal hazard area does not mean that the project cannot proceed but will ensure that coastal hazard risks are taken into account when developing and implementing the project.

4.3.3 Recommended Response and Preparedness Management Actions

Develop an erosion response process to ensure the City is able to respond to a significant erosion event.

Review previous audits of the City's coastline to identify any potential coastal cliff hazards and make recommendations to improve public safety.

Review corporate protocols, processes and templates to ensure that coastal hazards for projects being undertaken in a coastal zone are identified in the early planning stages.

4.4 Coastal Adaptation Planning

4.4.1 Coastal Hazard Risk Management Adaptation Planning

The City will develop a *Coastal Hazard Risk Management Adaptation Plan* to identify adaptation actions to ensure that vulnerable areas can adapt to future climate change impacts as they arise. A *Coastal Hazard Risk Management Adaptation Plan* is being developed for the entire coastline to ensure that adaptation responses

implemented in one area does not adversely impact on another area. As part of the development of these Plans, Steps one to three of the Coastal Risk Assessment Framework will be undertaken again in more detail and Steps four and five will be completed, see Figure 6. The development of the *Coastal Hazard Risk Management Adaptation Plan* will incorporate the use of adaptation pathways and community engagement.

Adaptation Pathways

Given the long timeframes for expected coastal impacts it is important that the City's adaptation planning is flexible and timed appropriately. Over the planning timeframe risks and impacts are likely to increase; community attitudes and needs may change and the policy and legislative framework may also change. A single adaptation option may not be sufficient to completely minimise the risk and may not be appropriate for the entire planning timeframe. Multiple adaptation options are likely to be needed and implemented either concurrently or sequentially.

The use of adaptation pathways in the City's *Coastal Hazard Risk Management Adaptation Plan* is one way to ensure the City's adaptation planning remains flexible over the planning timeframe. Adaptation pathways are 'sequences of alternative prioritised courses of action, and whose implementation is informed by increasing understanding of the interactions between environmental changes and human wellbeing under climate change, in response to interventions'[16].

The use of adaptation pathways requires the identification of trigger points. Trigger points are points in time when a decision will need to be made about the next course of action. This trigger point could be linked to a physical impact e.g. when erosion gets within a certain distance from a specific asset or another factor i.e. when an asset reaches the end of its life-span. The identification of trigger points should allow appropriate time for planning and establishment of the next adaptation option.

The benefit of this type of approach is that adaptation options do not need to be implemented until they are needed or can be avoided if the modelled erosion is not realised. It is preferable to start with low cost, low impact options and as the risk and impacts increase further adaptation options can be implemented. Increasingly the adaptation options may become more costly, more resource intensive and may have greater impact on the coastline.

For example the construction of a seawall may be appropriate to protect significant infrastructure that is modelled to be at risk in 80 years time. Rather than build a sea wall now that is costly and will impact on the amenity of the area, lower cost and lower impact options can be undertaken in the meantime. When these options are no longer able to sufficiently reduce the risk the reaching of a trigger point will ensure appropriate time for the sea wall to be constructed to meet that increased risk. If the trigger point is not reached or reached much later than expected the construction of the sea wall can be avoided or delayed. An example of how an adaptation

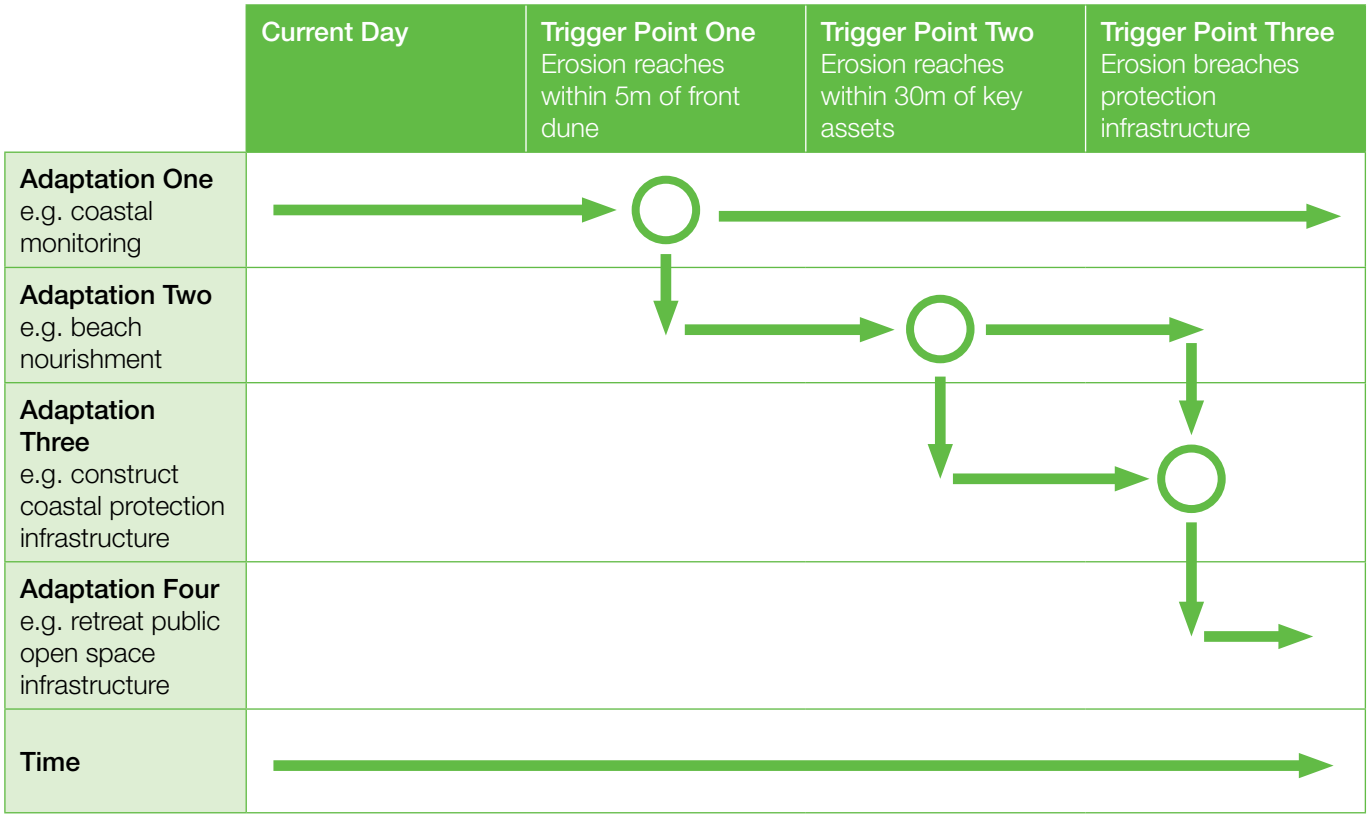


Figure 7 – Example of an Adaptation Pathway O = Trigger Point

[16] Wise and Capon (2016)

Community Engagement

The City's coastline is highly valued by the community as a place to live, visit, exercise, socialise, relax and engage with other members of the community. Coastal vulnerability may impact how the community can access and enjoy the coast into the future. Given the importance of the coast to the community, effective and meaningful community engagement will be integral to the successful development and implementation of the *Coastal Hazard Risk Management Adaptation Plan*.

Engagement will occur throughout the development of the *Coastal Hazard Risk Management Adaptation Plan*. Engaging early will ensure the community's values and concerns for the local area are understood and can inform the development of the plan. Engaging during the selection of adaptation options and pathways can help to build community acceptance of options that may need to be implemented in the future. The City will need to engage with local residents, users and visitors to the area and relevant stakeholders such as community groups, local businesses and State Government departments.

The City's commitment to engage with the community when developing the *Coastal Hazard Risk Management Adaptation Plan* aligns with *State Planning Policy 2.6* which states 'community consultation and engagement strategies should be developed to encourage informed community input into decision making processes'[17] and will be informed by the City's *Community Consultation and Engagement Policy*[18].

4.4.2 New City Developments

Any new major City developments proposed within an identified coastal hazard area will need to have a *Coastal Hazard Risk Management Adaptation Plan* (CHRMAP) developed. The purpose of developing a CHRMAP is to ensure that any coastal hazard risks are identified and appropriate adaptation options are considered before the development occurs. The CHRMAP may identify that the risks are too great and the development should not proceed or it may consider the risk acceptable but make a number of adaptation recommendations to minimise the risk. The CHRMAP's will be developed in accordance with the Department of Planning, Land and Heritage's Coastal Hazard Risk Management Adaptation Planning Guidelines[19].

The City has already developed CHRMAP's for a number of completed and proposed major City developments within the City's coastal hazard areas including the *Ocean Reef Marina Concept Plan*.

4.4.3 Recommended Coastal Adaptation Planning Management Actions

Develop a *Coastal Hazard Risk Management Adaptation Plan* for the City's entire coastline including community engagement.

Implement the City's overall *Coastal Hazard Risk Management Adaptation Plan*.

Develop *Coastal Hazard Risk Management Adaptation Plans* for new major City developments on City owned or managed land as required.

[17] Department of Planning, Lands and Heritage (2013)
[18] City of Joondalup (2010)
[19] Department of Planning, Lands and Heritage (2014)

5.0 Implementation Plan

Future planning for coastal adaptation will be an ongoing process for the City, influenced by outcomes of the coastal monitoring program, community input and engagement, changing policy and legislative frameworks and improvements in best practice for adaptation planning.

To ensure the effective implementation of the *Coastal Infrastructure Adaptation Plan 2018 – 2026* an implementation plan has been identified and appropriate monitoring and review processes will be established. As the coastal hazards are assessed over a 100 year planning timeframe and extend beyond the life of this Plan long term planning, implementation and renewal timeframes are also considered.

5.1 Management Action Summary

Focus Area	Management Action	Adaptation Type	Project Commence	Project Status
Coastal Infrastructure	Undertake regular and post-storm monitoring of beach infrastructure including beach access ways, gazebos, fencing, bins and signage.	Accommodate	2018/19	Existing
	Ensure there is adequate annual operating budget for the repair and maintenance of beach infrastructure.	Accommodate	2018/19	Existing
	Undertake a technical assessment of coastal protection assets to update the City's inventory and inform forward works programming and maintenance schedules.	Protect / Accommodate	2020/21	New
	Maintain, repair and refurbish the City's coastal protection infrastructure in accordance with existing and updated maintenance schedules and forward works program.	Protect	2018/19	Existing
Improving Knowledge	Continue to implement the coastal monitoring program in accordance with the schedule including providing an analysis report every two years.	Accommodate	2018/19	Existing
	Investigate options for the storing and collating of coastal monitoring data to allow improved spatial and temporal interpretation and analysis.	Accommodate	2018/19	New
	Investigate opportunities to partner with state and local government, industry groups and research institutions to enable the City to build capacity and gain information relating to best practice approaches to coastal adaptation.	Accommodate	2018/19	New
	Continue to keep the community informed about the vulnerability of the City's coastline, and improve their understanding of coastal processes and the City's coastal adaptation planning.	Accommodate	2018/19	Existing

Focus Area	Management Action	Adaptation Type	Project Commence	Project Status
	Update the City's coastal hazard mapping in 2025 to obtain a new 100 year planning timeframe of 2125.	Accommodate	2025/26	New
Response and Preparedness	Develop an erosion response process to ensure the City is able to respond to a significant erosion event.	Accommodate	2018/19	New
	Review previous audits of the City's coastline to identify any potential coastal cliff hazards and make recommendations to improve public safety.	Accommodate	2019/20	New
	Review corporate protocols, processes and templates to ensure coastal hazards for projects being undertaken in a coastal zone are identified in the early planning stages.	Accommodate	2018/19	New
Adaptation Planning	Develop a *Coastal Hazard Risk Management Adaptation Plan* for the City's entire coastline including community engagement.	All	2018/19	New
	Implement the *Coastal Hazard Risk Management Adaptation Plan*.	All	2019/20	New
	Develop *Coastal Hazard Risk Management Adaptation Plan*s for new major City developments on City owned or managed land.	All	2018/19	Existing

5.2 Monitoring and Review

In line with the City's Project Management Framework the City will undertake an annual review of the Plan including assessment of the progress and status of each project and identification of any implementation issues or significant lack of progress.

5.3 Timeframes

The City's coastal adaptation planning includes the *Coastal Infrastructure Adaptation Plan* and the *Coastal Hazard Risk Management Adaptation Plan* which are informed by the City's coastal hazard mapping and coastal monitoring program.

Given the timeframes for long term climate change this Plan will also put in place a framework for long term coastal adaptation planning beyond the life of this Plan. A summary of the planning timeframes, implementation timeframes and renewal timeframes for the City's coastal adaptation planning is provided in Table 16. The planning timeframe is the time over which the coastal hazard is considered, the implementation timeframe is the period over which management actions under that plan will be implemented and the renewal timeframe refers to how often it will be updated.

The *Coastal Infrastructure Adaptation Plan 2018 – 2026* will guide the City's coastal adaptation activities over the next eight years and will be renewed and updated in eight years time to coincide with the update of the coastal hazard mapping.

	Planning Timeframe	Implementation Timeframe	Renewal Timeframes
Coastal Infrastructure Adaptation Plan	100 years	8 years	8 years
Coastal Hazard Risk Management Adaptation Plan	100 years	10 years	10 years
Coastal Hazard Mapping	100 years	N/A	10 years
Coastal Monitoring Program	N/A	N/A	2 years

Table 16 – Planning, Implementation and Renewal Timeframes

The City's coastal hazard mapping considers a hazard timeframe of 100 years and currently provides a 100 year coastal erosion line for 2115. The coastal hazard mapping will be updated approximately every 10 years. The next coastal hazard assessment will be undertaken in 2025 and will provide a 100 year coastal erosion line for 2125.

The *Coastal Hazard Risk Management Adaptation Plan* will consider and plan for hazards over a 100 year timeframe, identify management actions for the next ten years and will be updated every 10 years to reflect the updated coastal hazard mapping.

The proposed renewal timeframes will be influenced by the outcomes of the Coastal Monitoring Program. Significant differences in the monitored shoreline movements compared to the coastal hazard mapping may require renewal timeframes for the *Coastal Infrastructure Adaptation Plan*, *Coastal Hazard Risk Management Adaptation Plan* and coastal hazard mapping to be brought forward. Major changes in policy or legislative requirements may also require changes to the renewal timeframes.

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Appendix A – Strategic Context

Federal Government

National Climate Resilience and Adaptation Strategy

The *National Climate Resilience and Adaptation Strategy*[20] sets out how Australia is managing the risks of a variable and changing climate. The Strategy identifies eight key sectors and provides an overview of the risks, current activities and future needs for each key sector. The *National Climate Resilience and Adaptation Strategy* identifies Coasts as one of the key sectors for adaptation and resilience.

Climate Change Risks to Australia's Coasts Report

The *Climate Change Risks to Australia's Coasts Report*[21] provides an assessment of climate change risks for the whole of Australia's coastal zone including an assessment of high risk areas, barriers to effective responses and identified national priorities for adaptation.

The Report found the local governments within Western Australia with the highest risk of inundation of residential properties due to sea level rise were Busselton, Mandurah, Rockingham and Bunbury. While erosion was found to be not as significant a factor for the Perth Metropolitan area, Pinnaroo Point within the City of Joondalup was one of three locations identified as susceptible to erosion.

National Climate Change Research and Adaptation Facility

The National Climate Change Adaptation Research Facility (NCCARF) is funded by the Australian Government, to undertake research and develop tools to support decision makers throughout Australia to prepare for and manage the risks of climate change and sea level rise.

NCCARF has developed *CoastAdapt* a coastal climate risk management tool, which provides practical guidance on how to manage the risks from climate change and sea level rise. This tool is targeted at local government and will provides guidance on all aspects of adaptation planning in the coastal zone including community engagement, risk assessment and adaptation options[22].

State Government

WA Coastal Zone Strategy

The WA Coastal Zone Strategy[23] establishes the State Government's vision, goals and objectives for coastal zone management and provides a high level framework for collective action including:

- Identifying five high level goals and detailed objectives related to the environment, community, economy, infrastructure and governance;
- Discusses the key issues for coastal zone management;
- Outlines the State Government's position on the use of protection to mitigate the impacts of coastal erosion and inundation; and
- Identifies broad roles and responsibilities of government, private organisations, natural resource management groups and the community.

State Coastal Planning Policy 2.6

An updated *State Planning Policy 2.6: State Coastal Planning Policy* (SPP2.6)[24] was released in July 2013. SPP 2.6 provides guidance for land use and development decision-making within the coastal zone including the establishment of coastal foreshore reserves; to protect, conserve and enhance coastal values. Schedule One of SPP 2.6 outlines how to calculate the necessary width to allow for coastal processes (including erosion, accretion and inundation) by allowing for landform stability, natural variability and climate change over the proposed planning period.

In addition SPP 2.6 now requires that lots identified as subject to coastal hazard risk within the planning timeframe (100 years), should have:

- Coastal hazard risk management and adaptation planning as part of the planning process for new developments; and
- Notifications placed on the Certificate of Title as part of the development/ subdivision approval process.

SPP 2.6 has guided how the City has assessed coastal hazard risk and also informed the City's broader coastal vulnerability response.

[20] Australian Government (2015)
[21] Department of Climate Change (2009)
[22] National Climate Change Adaptation Research Facility (2016)
[23] Department Planning, Lands and Heritage (2017)b
[24] Department of Planning, Lands and Heritage (2013)

Coastal Hazard Risk Management and Adaptation Planning Guidelines

The Department of Planning, Lands and Heritage's *Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) Guidelines*[25] are designed to assist decision-makers to:

- Consider coastal hazards and evaluate the risk for specific assets;
- identify effective management and adaptation responses to those risks; and
- Prioritise management and adaptation responses.

The CHRMAP Guidelines have informed the development of this Plan, particularly in relation to the risk assessments undertaken and the identification of adaptation responses.

Draft Planned or Managed Retreat Guidelines

The *Draft Planned or Managed Retreat Guidelines*[26] outline the planning process for a local government to undertake planned or managed retreat – if planned or managed retreat is identified as the adopted approach through a coastal hazard risk management adaptation planning process. The principles of the Draft Guidelines are to:

- Ensure land in the coastal zone is continuously provided for coastal zone management, public access, recreation and conservation;
- Ensure public safety and reduce risk associated with coastal erosion and inundation;
- Avoid inappropriate land use and development of land at risk from coastal erosion and inundation; and
- Ensure land use and development do not accelerate coastal erosion or inundation risks; or have a detrimental impact on the functions of public reserves.

The draft Guidelines outline three mechanisms for planned or managed retreat involving the cessation of private land uses.

Sea Level Change in Western Australia Report

The *Sea Level Change in Western Australia Report*[27] reviewed information on mean sea level variation along the Western Australian coastline and provided recommendations on an appropriate allowance for mean sea level change to be used in coastal planning. The Report recommends that "a vertical sea level rise of 0.9m be adopted when considering the setback distance and elevation to allow for the impact of coastal processes over a 100 year planning timeframe". This recommendation has been formally adopted and used in Schedule One of SPP 2.6 as part of the methodology for calculating setback for coastal processes.

Coastal Hazard Management Role Statement

The Department of Transport's *Coastal Hazard Management Role Statement*[28] articulates the role of the Department of Transport in regard to data, advice and funding for coastal hazard management in Western Australia. Specifically the Department's role is identified as:

- Provide specialist scientific and engineering advice for coastal hazard risk assessment and management when and where resources permit;
- Where appropriate provide funding assistance to local coastal managers through a competitive coastal grants scheme to undertake projects which manage coastal hazards for the public benefit; and
- Provide technical advice and assistance for temporary coastal erosion management measures when and where resources permit.

Regional

The Western Australian Local Government Association has released a number of resources to support and assist local government in their understanding of climate change particularly relating to land use planning and legal liability, including:

- Local Government and Coastal Land Use Planning – Discussion Paper[29]
- Coastal Risk Management and Adaptation Planning – Notification on Title – Discussion Paper[30]
- Climate Change Policy Legal Risks[31]
- Climate Change Litigation to Flood Planning and Development in Coastal Areas[32]

[25] Department of Planning, Lands and Heritage (2014)
[26] Department of Planning, Lands and Heritage (2017)a
[27] Department of Transport (2010)
[28] Department of Transport (2016)
[29] Western Australian Local Government Association (2014)
[30] Western Australian Local Government Association (2015)
[31] Freehills (2010)b
[32] Freehills (2010)a

Appendix B – Strategic Alignment

For the City's coastal adaptation activities to be effective it is important that the *Coastal Infrastructure Adaptation Plan 2018 – 2026* is aligned to the City's broad range of strategic planning documents.

Strategic alignment of the *Coastal Infrastructure Adaptation Plan 2018 – 2026* with the City's other strategic planning documents is outlined in the table below.

	Overall purpose/ aim	Relevant Key Focus Area (KFA)/Theme	Relevant objectives
Coastal Infrastructure Adaptation Plan 2018 – 2026	To ensure the City is adequately prepared to adapt to current and future coastal hazards and risk to City infrastructure and assets is minimised.		• Improve understanding of the potential impacts of current and future coastal hazards; • Identify risk to the City's infrastructure and assets as a result of current and future coastal hazards; • Identify and implement adaptation options to minimise risk to the City's infrastructure and assets from current and future coastal hazards; and • Identify a longer term approach that will guide the City's future adaptation responses in the coastal zone.
Climate Change Strategy 2014 – 2019	Provide guidance to the City's climate change activities over the next five years. The Strategy has a dual purpose of both mitigation and adaptation.	KFA 1: Infrastructure and Assets	• To improve the City's understanding of future climate scenarios and associated impacts for the City of Joondalup; • To identify the likely risks to the City's environment, operations, infrastructure, activities and services as a result of climate change; • To put in place strategies that will minimise the risk to the City's environment, operations, infrastructure, activities and services as a result of climate change; and • To support and encourage the community to prepare and adapt for climate change.
Environment Plan 2014 – 2019	To ensure that the City's operations are delivered in an environmentally sustainable manner and that the City takes measures to effectively influence positive environmental behaviours within the community.	Theme 4: Biodiversity Management	• To provide long-term protection and enhancement of the City's biodiversity through adaptive management and the delivery of targeted projects and programs.
Joondalup 2022: Strategic Plan 2012 – 2022	City of Joondalup's long-term strategic planning document that outlines its commitment to achieving the vision and aspirations of its community and regional stakeholders.	Theme 5: Natural Environment	• Environmental Resilience – To continually adapt to changing local environmental conditions.

	Overall purpose/ aim	Relevant Key Focus Area (KFA)/Theme	Relevant objectives
Joondalup Coastal Foreshore Management Plan	To provide mechanisms to protect and enhance biodiversity values of the natural area whilst maintaining appropriate community access and awareness of the natural area.		• Establish a baseline description of the environment to guide future environmental planning and recommended management actions; • Outline key environmental threats and management strategies to minimise impact and protect conservation and recreation values; and • Outline management actions to address key threats including monitoring and reporting.
Asset Management Strategy 2014 – 2024	Provides the context from which to guide a whole-of-organisation approach to asset management and assists in the achievement of the City's strategic objectives contained within *Joondalup 2022*.	Implementing effective asset management processes.	• Review/develop asset management class plans to identify and improve demand forecasting, prioritisation of capital expenditure and long-term investment forecasts.

Appendix C – Coastal Hazard Maps


2015 Coastal Erosion
2065 Coastal Erosion
2115 Coastal Erosion
Rock
Seawall
IONROSS
BURNS BEACH
CURRAMBINE
JOONDALUP
CONNOLLY
OCEAN REEF
HEATHRIDGE
EDGEWATER
MULLALOO
WOODVALE
KALLAROO
PADBURY
KINGSLEY
HILLARYS
SORRENTO
DUNCRAIG
GREENWOOD
MARMION
WARWICK
Aerial Photo Date: 29th April 2016
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Fax: 08 9300 1383
info@joondalup.wa.gov.au
www.joondalup.wa.gov.au
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Scale (A3): 1 : 6000
Date: 29/7/2016
Compiled A Gilbert
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Coastal Hazard Assessment
Map 2


2015 Coastal Erosion
2065 Coastal Erosion
2115 Coastal Erosion
Rock
Seawall
Whitfords Volunteer Sea Rescue
Ocean Reef Sea Sports Club
IONROSS
BURNS BEACH
CURRAMBINE
ILUKA
JOONDALUP
CONNOLLY
OCEAN REEF
HEATHRIDGE
EDGEWATER
MULLALOO
CRAIGIE
WOODVALE
KALLAROO
PADBURY
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HILLARYS
SORRENTO
DUNCRAIG
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MARMION
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Coastal Hazard Assessment
Map 3


2015 Coastal Erosion
2065 Coastal Erosion
2115 Coastal Erosion
Rock
Seawall
Oceanside Promenade
Vulnerable residential properties
Mullaloo Surf Lifesaving Club
Vulnerable residential properties
Northshore Drive
Aerial Photo Date : 29th April 2018
IONROSS
BURNS BEACH
CURRAMBINE
ILUKA
JOONDALUP
CONNOLLY
OCEAN REEF
HEATHRIDGE
EDGEWATER
MULLALOO
BELDON
CRAIGIE
WOODVALE
KALLAROO
PADBURY
KINGSLEY
HILLARYS
SORRENTO
DUNCRAIG
GREENWOOD
MARMION
WARWICK
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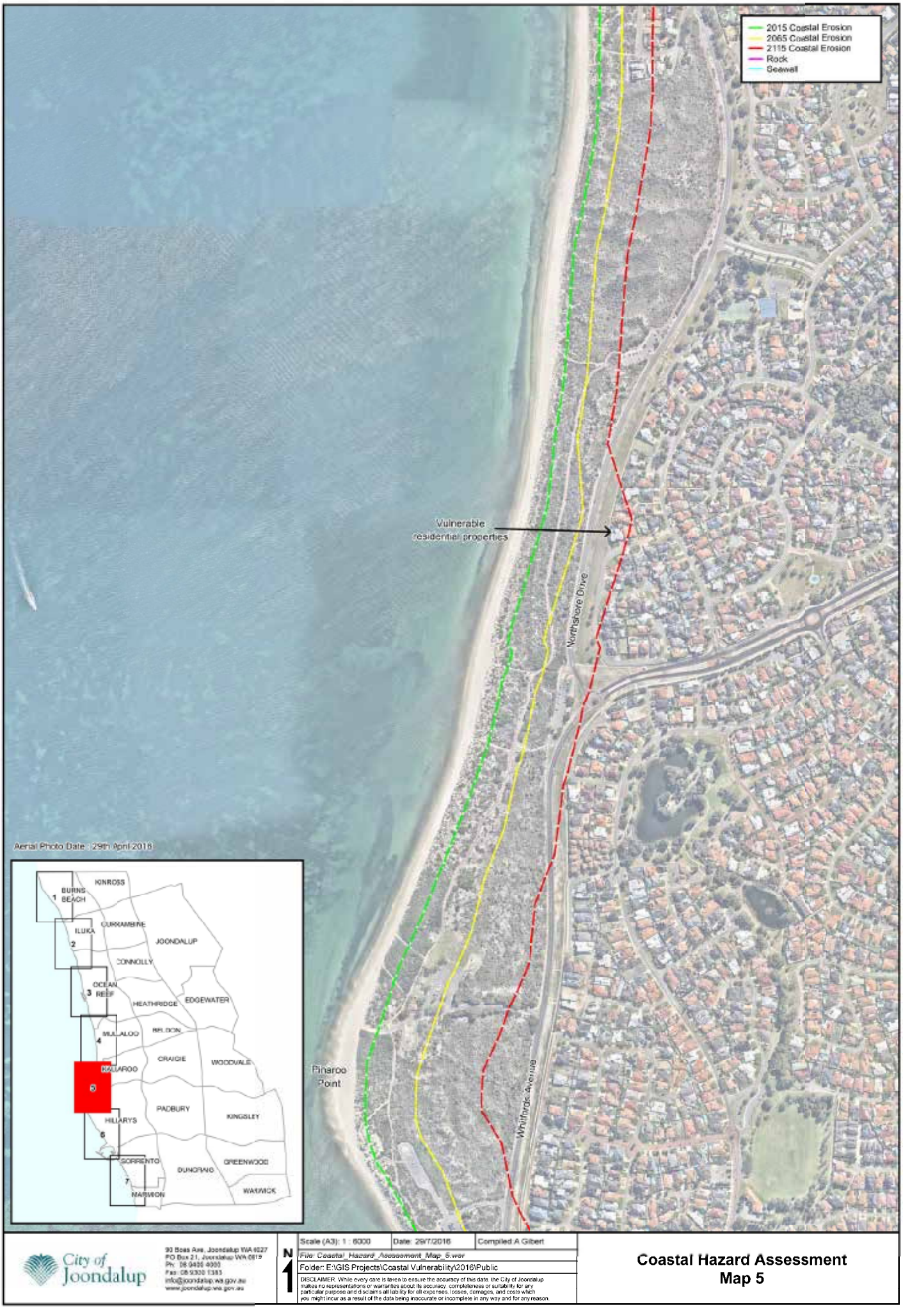
Coastal Hazard Assessment
Map 4


2015 Coastal Erosion
2065 Coastal Erosion
2115 Coastal Erosion
Rock
Seawall
Vulnerable residential properties
Northshore Drive
Whitfords Avenue
Pinaroo Point
Aerial Photo Date: 29th April 2016
IONROSS
BURNS BEACH
CURRAMBINE
ILUKA
JOONDALUP
CONNOLLY
OCEAN REEF
HEATHRIDGE
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Coastal Hazard Assessment
Map 5


2015 Coastal Erosion
2065 Coastal Erosion
2115 Coastal Erosion
Rock
Seawall
Eric Halliday Centre
IONROSS
BURNS BEACH
CURRAMBINE
ILUKA
JOONDALUP
CONNOLLY
OCEAN REEF
HEATHRIDGE
EDGEWATER
MULLALOO
BELDON
CRAIGIE
WOODVALE
KALLAROO
PADBURY
KINGSLEY
HILLARYS
SORRENTO
DUNCRAIG
GREENWOOD
MARMION
WARWICK
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Coastal Hazard Assessment
Map 6


2015 Coastal Erosion
2065 Coastal Erosion
2115 Coastal Erosion
Rock
Seawall
Groyne
Sorrento Surf Life Saving Club
Groyne
Sorrento Local Centre
Groyne
Vulnerable residential properties
West Coast Drive
IGNROSS
BURNS BEACH
CURRAMBINE
ILUKA
JOONDALUP
CONNOLLY
OCEAN REEF
HEATHRIDGE
EDGEWATER
MULLALOO
BELDON
CRAIGIE
WOODVALE
KALLAROO
PADBURY
KINGSLEY
HILLARYS
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Coastal Hazard Assessment
Map 7

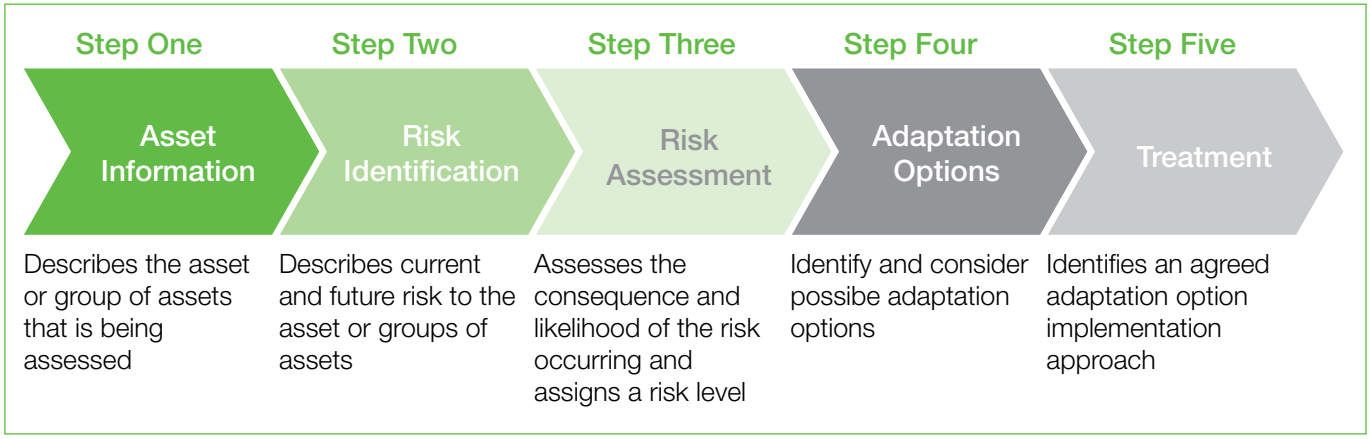
Appendix D – Coastal Risk Assessment Framework

Coastal Infrastructure Risk Assessment

Vulnerable node: _____

Date completed: _____

This template is used to assess risk to assets within a vulnerable node. The template follows the below process and is to be used to complete the first three steps: Asset Information, Risk Identification and Risk Assessment.



Step One: Asset Information

Complete Table 1 and attach any relevant information.

Table 1: Asset Information			
Location OT			
Description OT			
List of assets present	**At risk by**	**Value ($)**	**Expected life-span**
Stakeholders OT			
Services provided OT			
Values **Community**		**Environmental**	
Existing Controls			
Other information OT			

Step Two: Risk Identification

Complete Table 2 and attach any relevant information.

Table 2: Risk Identification
Current/Historical Risk (anecdotal/observed) Describe coastal flooding and/or erosion which has or is affecting the asset (or the area) OT
Future Vulnerability Summarise possible future vulnerability of the asset includng the probable impact that increased flooding and erosion will have on the asset. **Short-term (SSE)** OT **Long-term (2065 and 2115)** OT

Step Three: Risk Assessment

Use the below drop down menus to indicate the Level of Consequence and Likelihood of Occurrence and determine the Risk Priority Level.

Table 3: Risk Assessment			
	Severe Storm Erosion	**2065**	**2115**
Level of Consequence			
Likelihood of Occurrence			
Priority Rating Level			

List of attachments: (e.g. maps, design plans etc.)

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