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R1962 Rev 1

August 2024

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Point Grey Peninsula Coastal Hazard Risk Management & Adaptation Plan

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1. Introduction

The Point Grey Development Company (PGDC) plan to complete a development located at Point Grey, adjacent to the Peel Harvey Estuary. The site is located on the western side of the Peel Inlet and the north eastern side of the Harvey Estuary. The site is 4 km south east of the Dawesville Cut.

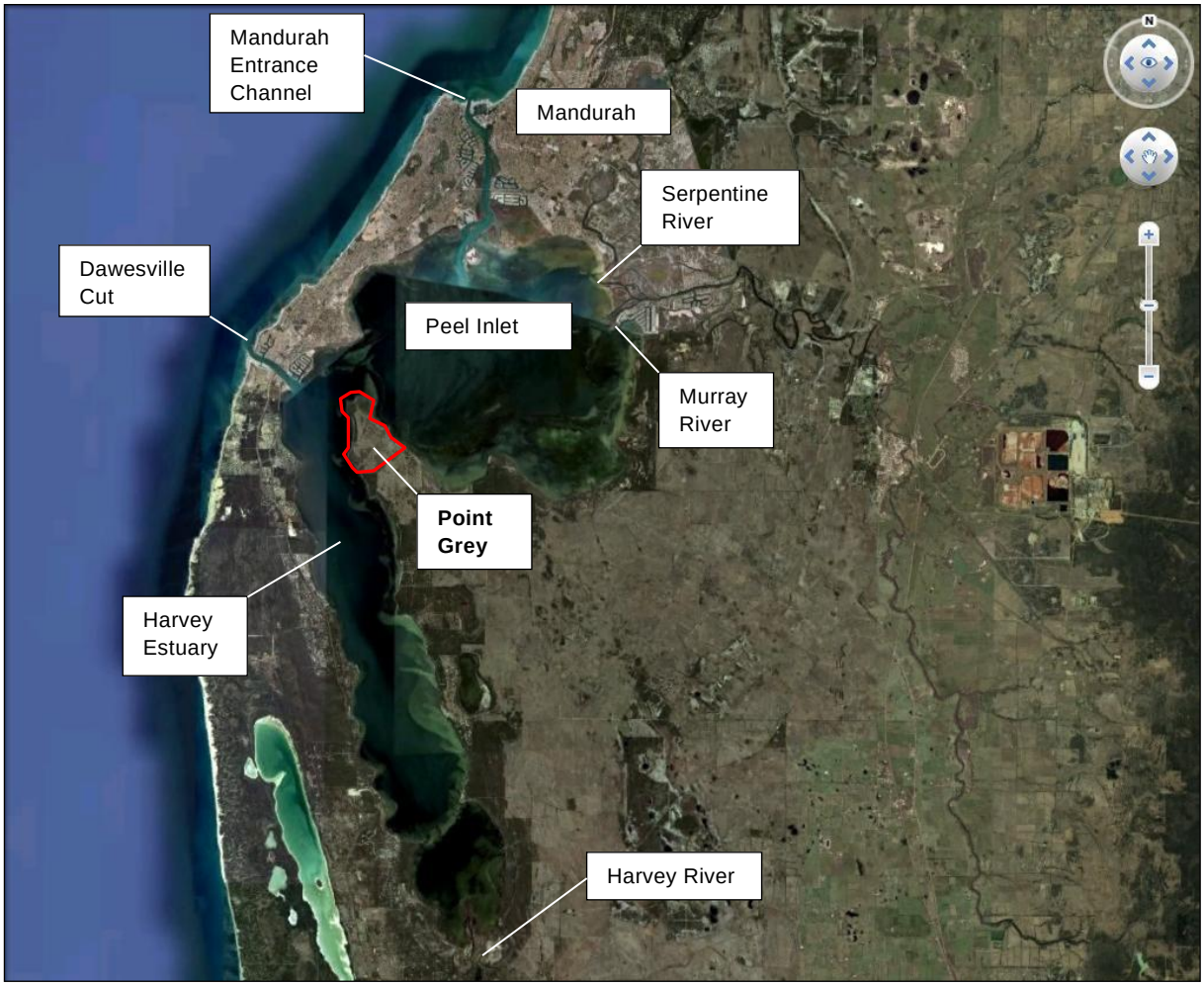

Figure 1.1 Point Grey Location

The proposed development, referred to as the Point Grey Peninsula, includes a range of residential and commercial lots as well as public facilities within foreshore areas. The public facilities include a sea scouts and canoe hire building, carpark, beach access path and playground equipment.

A landscape masterplan of the Point Grey Peninsula development has been prepared by Emerge and is shown in Figure 1.2.

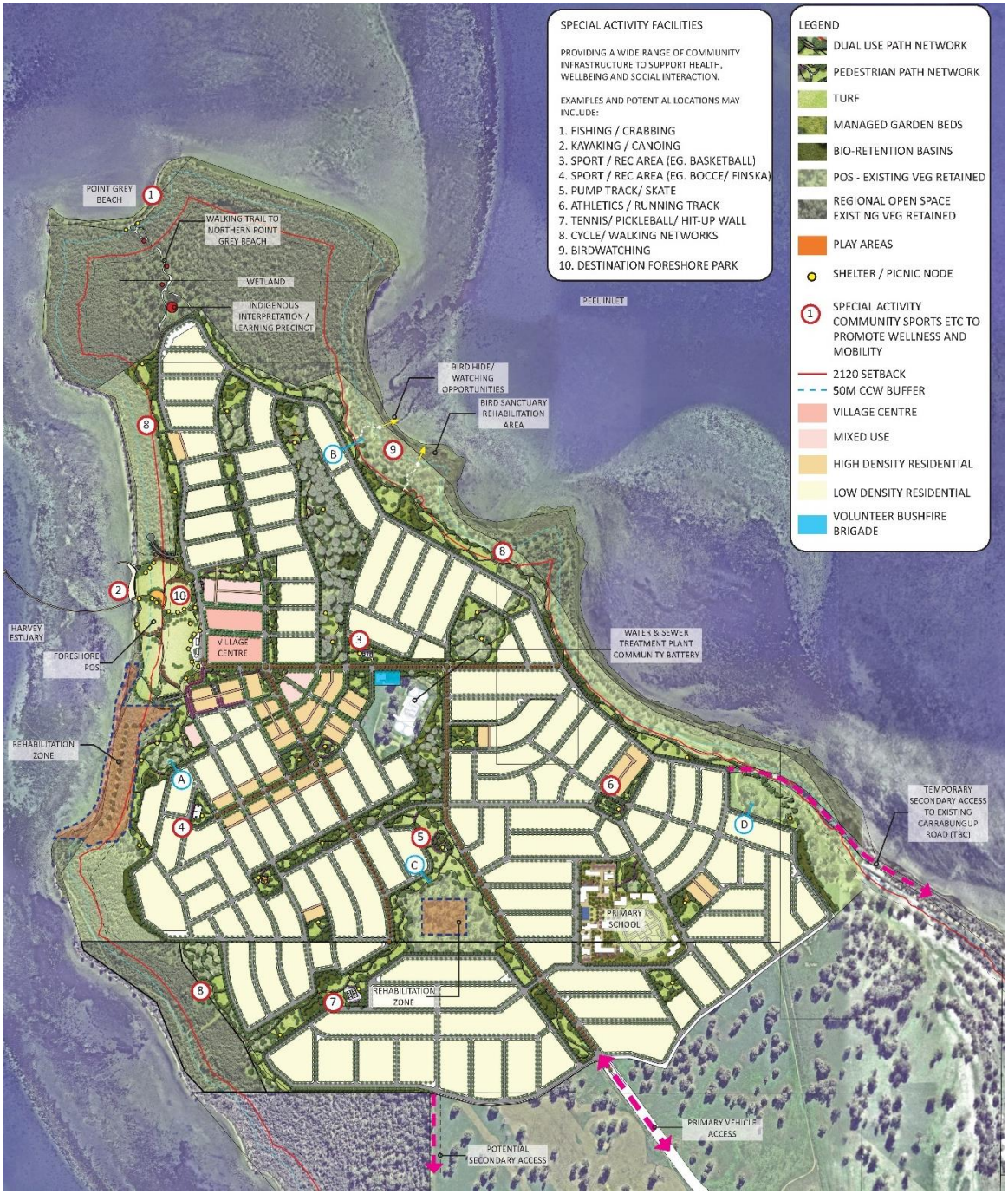

Figure 1.2 Point Grey Peninsula Landscape Plan (Emerge July 2024)

Given the coastal frontage of Point Grey Peninsula, the risks posed to the site from coastal hazards need to be considered both now and into the future. Specialist coastal engineers, M P Rogers & Associates Pty Ltd (MRA), were engaged by PGDC to form part of the project team and to assist with coastal aspects of the project.

Within Western Australia, State Planning Policy 2.6: State Coastal Planning Policy (SPP2.6; WAPC 2013) provides guidance on the assessment of coastal hazard risks for assets or infrastructure located in close proximity to the coast. The guidance on the assessment of coastal hazard risk is provided within SPP2.6 in the form of a methodology to assess the potential extent of coastal hazard impacts, as well as for the development of a Coastal Hazard Risk Management

and Adaptation Plan (CHRMAP). Further details in this regard are also provided in the CHRMAP Guidelines (WAPC 2019).

The key requirement of a CHRMAP is to develop a risk based adaptation framework for assets or infrastructure that could be at risk of impact from coastal hazards over the relevant planning timeframe. Importantly, the balance of these risks needs to be considered with reference to the expected lifetime of the assets or infrastructure.

This CHRMAP covers the following key items.

- Establishment of the context.
- Coastal hazard risk identification.
- Vulnerability analysis.
- Risk analysis and evaluation.
- Risk management and adaptation planning.
- Implementation plan.

Details regarding each of these items are provided in this CHRMAP report.

2. Establish the Context

The context for the CHRMAP is outlined in the following sections. This provides the framework for which the CHRMAP was undertaken and outlines what is included in the scope of work.

2.1 Purpose

The potential vulnerability of the coastline and the subsequent risk to the community, economy and environment needs to be considered for any coastal development.

SPP2.6 requires that the responsible management authority prepares a CHRMAP where an existing or proposed development may be at risk from coastal hazards over the planning timeframe. The main purpose of the CHRMAP is to define areas of the coastline which could be vulnerable to coastal hazards and to outline the preferred approach for the assessment and management of these hazards where required.

A CHRMAP can be a powerful planning tool to help provide clarity to existing and future developers, users, managers or custodians of the coastline. This is done by defining levels of risk exposure, management practices and adaptation techniques that the development proponent, with agreement from the appropriate management authorities, considers acceptable in response to the present and future risks posed by coastal hazards.

Specifically, the purpose of this CHRMAP is as follows.

- Identify the specific extent of coastal hazards in relation to the proposed Point Grey Peninsula development assets.
- Outline the risks associated with the Point Grey Peninsula development site and how these risks may change over time.
- Establish the basis for present and future risk management and adaptation, which will be used to inform the Point Grey Peninsula development.
- Develop appropriate risk management and adaptation strategies for Point Grey Peninsula, including monitoring, to help mitigate the coastal hazard risks where necessary.

2.2 Objectives

The key objectives of this plan are as follows.

- Inform the development by providing appropriate guidance to the development proponent and key stakeholders with respect to the management of coastal hazards.
- Ensure the proponent and key stakeholders understand the potential coastal hazards in relation to the Point Grey Peninsula development.
- Outline the required coastal adaptation approach in a project specific implementation plan for the proponent and that is acceptable to key stakeholders.

2.3 Scope

The *CHRMAP Guidelines* (WAPC, 2019) provide a specific framework for the preparation of a CHRMAP. This is outlined in the flowchart presented in Figure 2.1 which shows the risk management and adaptation process.

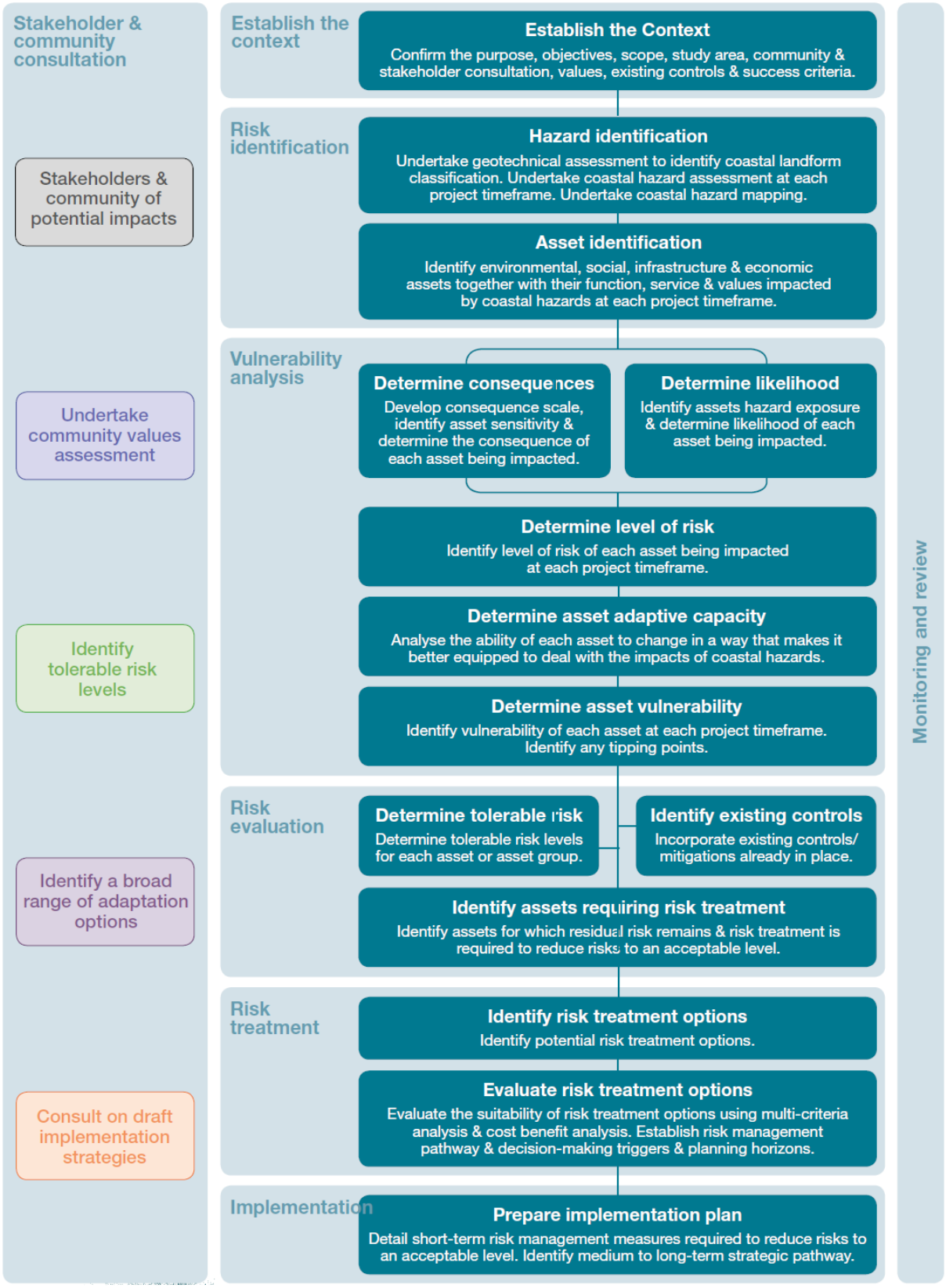

Figure 2.1 Risk Management & Adaptation Process Flowchart (WAPC 2019)

The scope of this CHRMAP provides guidance on the management of coastal risks with the potential to affect the Point Grey Peninsula development over the planning timeframe of 100

years. Intermediate planning horizons are also considered in order to assess how risk profiles may change in the future and to inform the requirement for adaptation strategies.

As presented in the flowchart, the process for the development of a meaningful CHRMAP requires a number of fundamental inputs. These inputs enable the assessment and analysis of risk, which should ultimately be informed by input received from key stakeholders, to help shape the subsequent adaptation strategies.

The management of coastal hazard risks at the Point Grey Peninsula development requires a clear adaptation plan that is acceptable to the stakeholders. As a result, the approach that has been taken for this plan is to develop a management methodology that allows for flexibility into the future.

The development of the adaptation plan is informed by the assessment of the coastal erosion and inundation hazards at the site.

Based on the results of the risk and vulnerability assessment, indicative risk mitigation strategies are developed, where required, in order to provide a framework for future management. However, it is important to realise that the risk assessment is based on the outcomes of the coastal vulnerability assessment, which, by their nature, are justifiably conservative. This is due to the uncertainty around coastal dynamics when predicting impacts over long timeframes. As a result, the framework for future risk management strategies should be considered to be a guide of future requirements.

A detailed implementation plan including coastal monitoring requirements is outlined in Section 6 of this report.

2.4 Study Area

The geomorphic setting of the Point Grey area is characterised by the Cottesloe Association within the Spearwood dune system (McArthur and Bettenay 1960). The Point Grey landform is a remnant of the late Pleistocene dunes, comprised of wind-blown and marine sediments, overlying what is now recognised as the Tamala Limestone Formation (Playford et al. 1976).

MRA completed an inspection of the Point Grey site. This involved taking photographs, boreholes and locating limestone outcropping. Figure 2.2 shows the points of interest at Point Grey identified during MRA's site visit. Observations from the site inspection are summarised below. More detail can be found in MRA (2010).

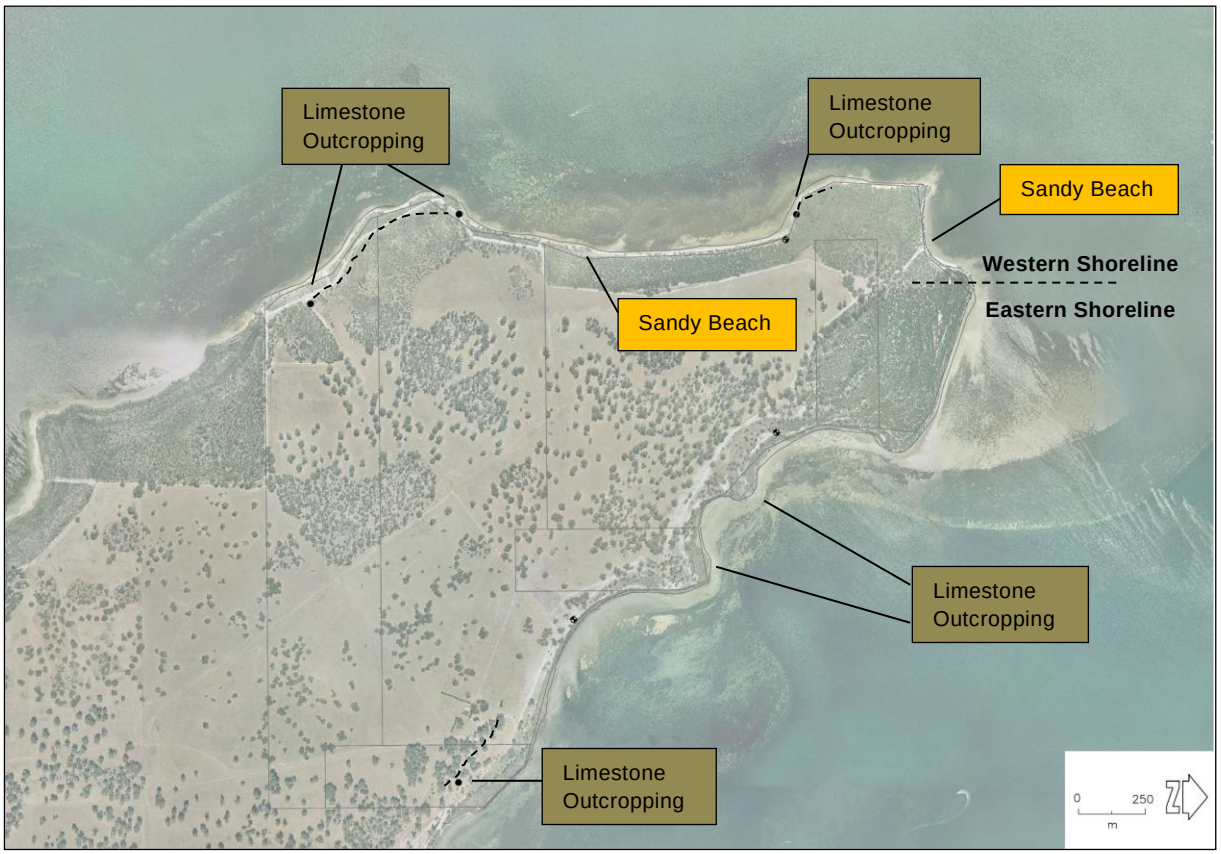

Figure 2.2 Points of Interest from the 2010 Site Inspection (MRA 2010)

The western and eastern shorelines are influenced by different meteorological and coastal processes. This is due to their different alignments and locations on the Peel Inlet and Harvey Estuary. Subsequently, the physical settings of each shoreline, the western shoreline and eastern shoreline, are outlined below separately.

2.4.1 Western Shoreline

The low energy conditions that are experienced on the western shoreline have led to the formation of an estuarine type shoreline. The low waves, narrow sandy beach and good vegetation cover prevent the formation of a conventional dune system. A photograph of the sandy beach on the western shoreline is provided in Figure 2.3.

The sandy beach on the western shoreline is generally consistent along its length. As shown in Figure 2.2, limestone outcropping was observed at a number of locations.

The presence of limestone outcropping close to the shoreline has created a number of prominent points on the western shoreline. These points appear to be acting as control points limiting the movement of the shoreline in their immediate area.

Figure 2.3 Western Shoreline Site Photograph (16 April 2010)

2.4.2 Eastern Shoreline

The low energy conditions that are experienced on the eastern shoreline has also led to the formation of an estuarine type shoreline. The low waves, narrow sandy beach and good vegetation cover prevent the formation of a conventional dune system. Figure 2.4 illustrates these conditions.

Figure 2.4 Eastern Shoreline Site Photographs (16 April 2010)

Limestone outcropping was also noted at several locations on the eastern shoreline, as presented in Figure 2.2.

2.4.3 Coastal Classification

Investigations completed by MRA (2010) determined that the limestone outcropping was not consistently present at suitable elevations to protect the shorelines from erosion.

In this regard, for the purpose of this CHRMAP, in accordance with SPP2.6, Point Grey is considered a sandy coast.

2.5 Planning Controls

2.5.1 Existing Planning Controls

Peel Region Scheme

The Point Grey site is zoned Urban under the Peel Region Planning Scheme (PRS), with an area on the western portion of the site zoned 'Rural'. To the north and south of the site are areas reserved for 'Regional Open Space'. The Point Grey peninsula is surrounded by 'Waterways' Reservation associated with the Peel Inlet and Harvey Estuary.

Shire of Murray Town Planning Scheme 4

The Point Grey site is zoned 'Special Development' and 'Rural' in the Shire of Murray Town Planning Scheme 4. This mirrors the associated zoning classifications in the PRS.

Point Grey Outline Development Plan

The Point Grey Outline Development Plan (ODP) was endorsed by the WAPC in November 2011. The ODP provides the framework for the future development of Point Grey with a village centre and various other assets supported by approximately 3,600 dwellings. An ultimate population of approximately 6,500 and a range of facilities and services to meet the needs of residents and visitors to Point Grey were envisaged.

A number of planning and environmental matters have arisen since this original ODP was endorsed by the WAPC. These changes will be addressed in future planning submissions.

2.5.2 State Planning Policy 2.6 (SPP 2.6)

SPP 2.6 and the associated guideline documents provide guidance on the assessment of coastal hazard risks for assets or infrastructure located near the coast. This guidance is provided in the form of a methodology to assess the potential extent of coastal hazard impacts, as well as for the development of appropriate coastal hazard risk mitigation and adaptation strategies.

The key requirement of SPP2.6 is to develop a coastal management and adaptation framework for assets or infrastructure that could be at risk of impact by coastal hazards over various planning horizons.

Generally, this involves preparation of a CHRMAP to provide guidance on responding to these risks, such as this report.

2.5.3 Shire of Murray CHRMAP

The Shire of Murray (Shire) is responsible for the management over 50 km estuarine and riverine shoreline within in the Peel Harvey Estuary and the tidally influenced sections of the Murray and Serpentine Rivers.

Various works have previously been undertaken by the Shire to describe the coastal risks and associated management guidelines for its coastline. This work culminated in the preparation of the Shire of Murray CHRMAP (Baird 2022), which was ultimately endorsed by Council and adopted in June 2024.

The Shire's CHRMAP notes that sections of the land area at Point Grey are vulnerable to coastal hazards.

The Shire's CHRMAP is comprised of various assessments including the *Shire of Murray Coastal Hazard Assessment* prepared by Seashore (2021).

Shire of Murray Coastal Hazard Assessment (Seashore 2021)

Seashore (2021) completed the coastal hazard assessment to quantity coastal hazards within the Peel Harvey Estuary for the Shire's CHRMAP.

Seashore (2021) determined coastal erosion hazard allowances over the 100 year planning timeframe by summing the various erosion allowances calculated for acute storm erosion (S1), chronic erosion (S2), sea level rise (S3), and uncertainty (0.2 m/year) in accordance with SPP2.6.

Within the assessment Seashore noted that the likely response to sea level rise within the estuary will be driven by onshore sediment transport across the low lying foreshore, resulting in foreshore rollover. This notion of foreshore rollover is outlined within Davidson-Arnott (2005). This approach differs from the simple allowance typically applied under SPP2.6 for the open ocean coastline, where the Bruun Rule is used to define an offshore loss of sediment. Seashore's (2021) calculation of S3 was based on an assessment of the potential for foreshore rollover compared to a minimum fixed allowance of 50 m. In other words, the S3 erosion hazard allowance was taken as either the potential width of impact caused by onshore erosion associated with foreshore rollover, or 50 m, whichever is larger.

Using the above allowances, Seashore (2021) prepared coastal hazard lines for various planning horizons, including Present Day, 10 year, 30 year, 50 year and 100 year timeframes. These are shown in Figure 2.5 below.

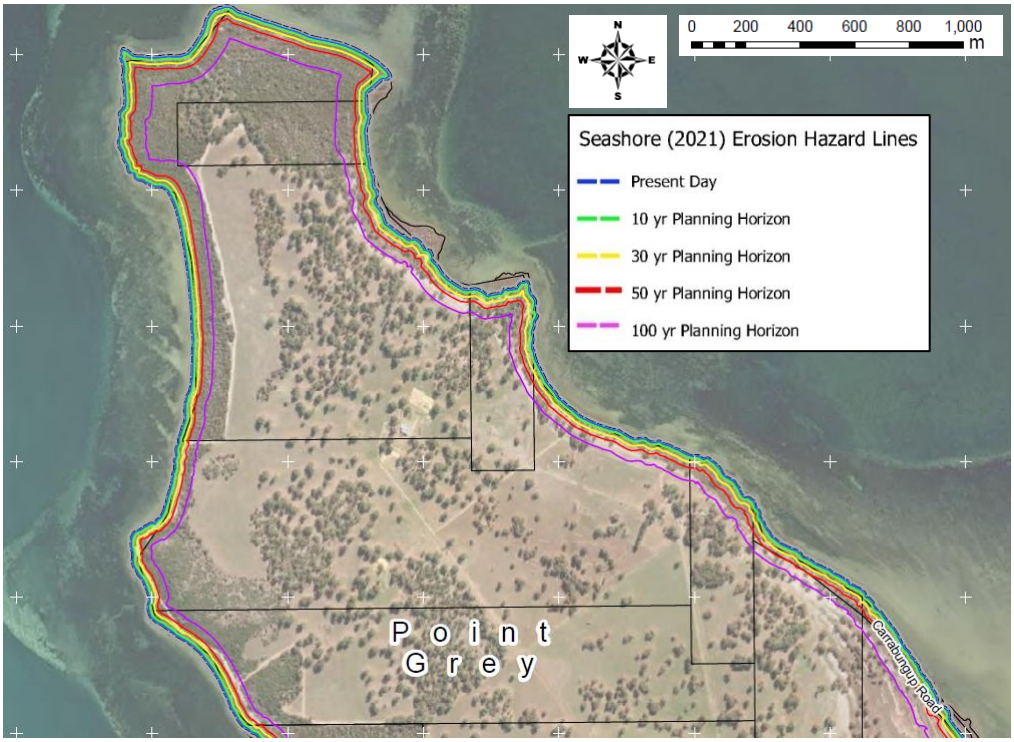

Figure 2.5 Seashore (2021) Coastal Erosion Hazard Lines

For inundation hazards, SPP2.6 requires an allowance (termed the S4 allowance) for the maximum extent of inundation experienced during a water level event with a 0.2% Annual Exceedance Probability (AEP) (500 year Average Recurrence Interval (ARI)) plus the appropriate allowance for sea level rise. Within the Mandurah/Peel region the 500 year ARI oceanic storm surge will be associated with the passage of a cyclonic event. Seashore (2021) completed a detailed review into the potential inundation levels within the Peel Inlet. The review considered both extreme analysis of water level records from within the Inlet, as well as the potential impacts of tropical cyclones. The assessment of the impact of tropical cyclones was completed through an approach of track shifting and modification of storm intensity to achieve a combination that approximates a 500 year ARI event. Using this approach, Seashore Engineering (2021) predicted that the present day 500 year ARI water level within the Peel Inlet would be 1.44 mAHD. Thus, to minimise risk to development over the full 100 year planning horizon, an allowance for sea level rise of 0.98 m should be added to this level, meaning that the S4 allowance was **2.42 mAHD**.

2.6 Success Criteria

The success criteria for this Point Grey Peninsular CHRMAP will ultimately be as follows.

- To ensure the proponent and key stakeholders understand the potential extent of impact of coastal hazards on the proposed assets within the Point Grey Peninsula development.
- To ensure the proponent and key stakeholders understand the potential likelihood of assets within the proposed Point Grey Peninsula development being impacted by coastal hazards over the 100 year planning timeframe.
- To determine and advise on the level of risk to assets within the proposed Point Grey Peninsula development being impacted by coastal hazards over the 100 year planning timeframe.

- Development of an acceptable risk management and adaptation strategy for the proposed Point Grey Peninsula development, including the foreshore reserve, over the 100 year planning timeframe.

- Development of an implementation plan to outline the requirements and responsibilities over time.

The outcomes of the success criteria listed above are presented in the following sections of this report.

3. Coastal Hazard Identification

An understanding of the coastal hazards and risks is critical for the assessment and determination of management and adaptation actions.

The coastal hazard allowances determined by Seashore (2021), as introduced in Section 2.5.3, have been used for this CHRMAP, as agreed with the Shire and Department of Planning, Lands and Heritage. This approach ensures a level of consistency with the Shire's CHRMAP.

3.1 Identified Assets

To develop appropriate adaptation strategies, the natural and built assets that may be impacted by coastal erosion and inundation hazards over the 100 year planning timeframe must first be identified.

Excerpts from the landscape plan prepared Emerge, with the identified at risk assets, are presented in the figures below. The Seashore (2021) coastal erosion hazard lines are also included in these figures.

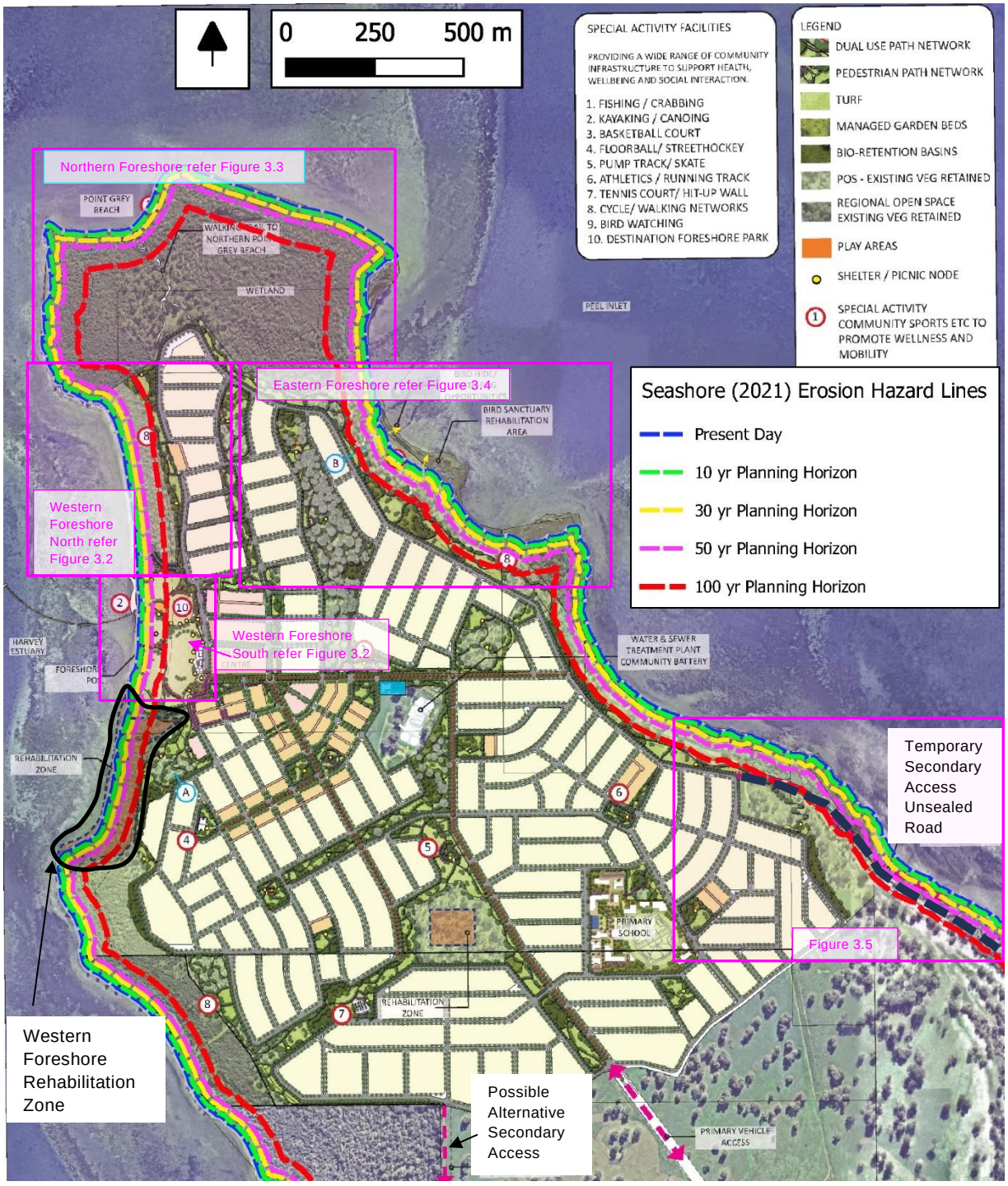

Figure 3.1 Point Grey Peninsula Landscape Plan (Emerge July 2024)

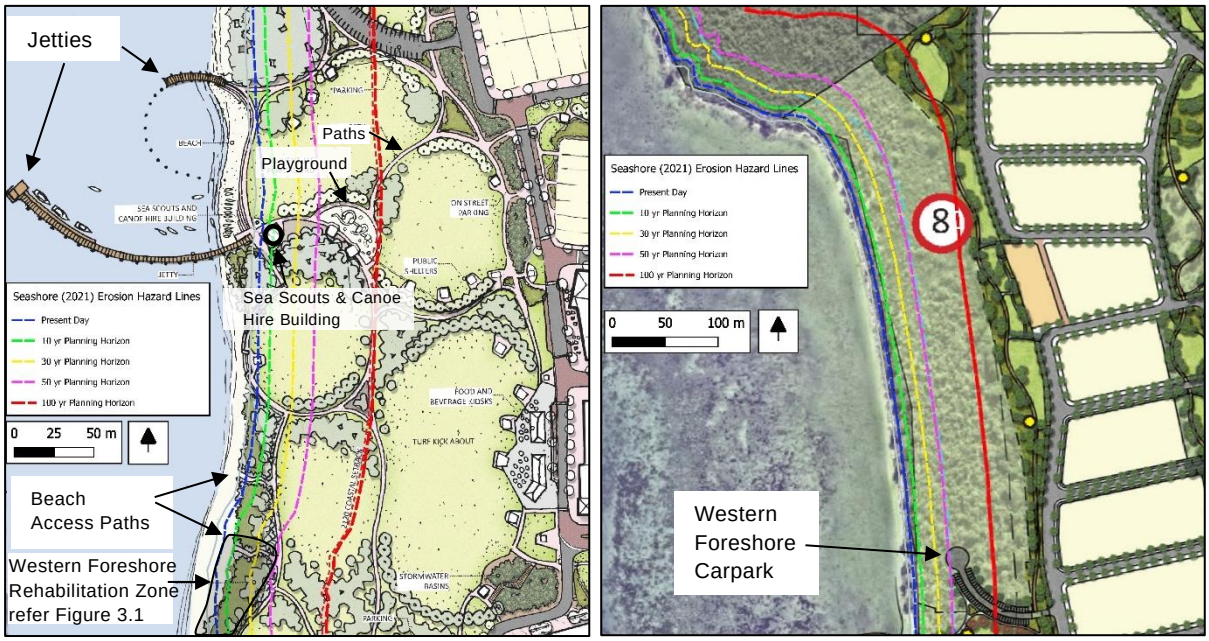

Figure 3.2 Western Foreshore South (left) & North (right) Assets (Emerge July 2024)

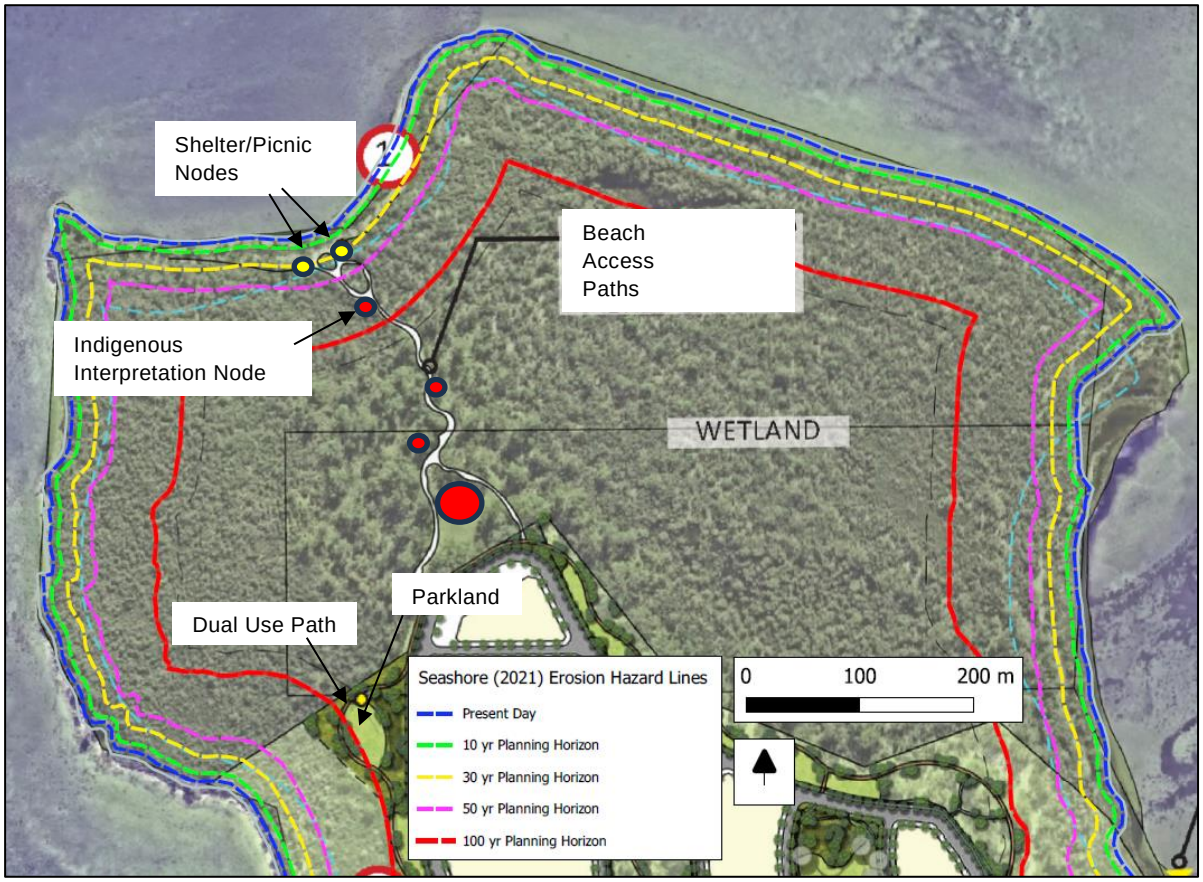

Figure 3.3 Northern Foreshore Assets (Emerge July 2024)

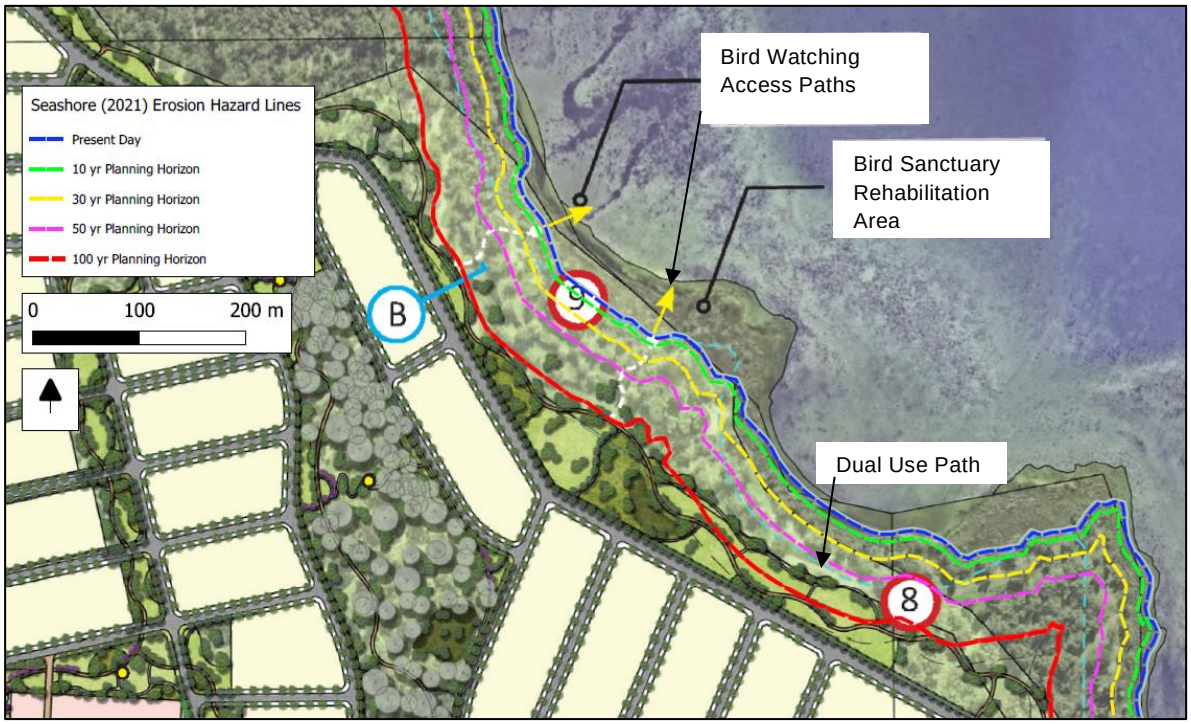

Figure 3.4 Eastern Foreshore Assets (Emerge July 2024)

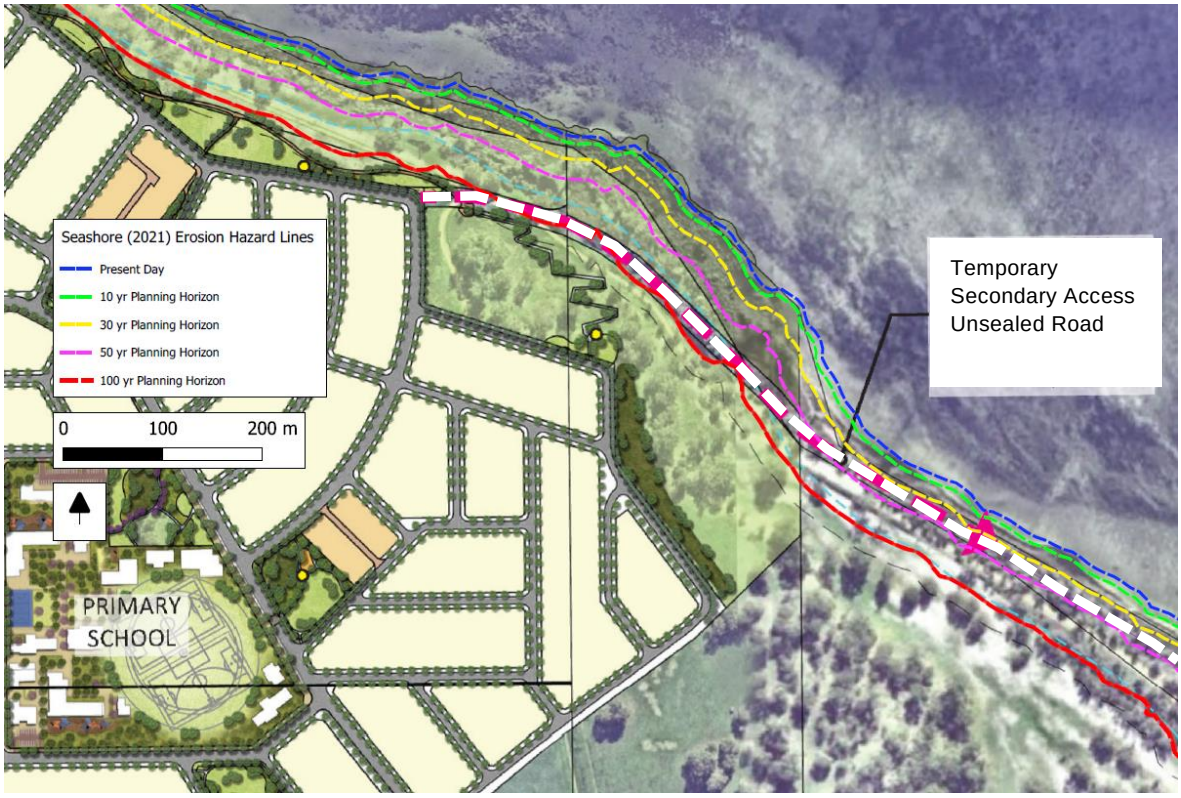

Figure 3.5 Temporary Secondary Access Unsealed Road (Emerge July 2024)

For the purpose of this assessment, assets in similar areas that share similar values or risk management requirements have been grouped together and are presented in Table 3.1 below.

Only assets located within the coastal hazard zones have been considered. For example the critical infrastructure of the development including residential areas and roads etc are all located landward of the 100 year planning horizon erosion hazard line and above the S4 inundation level (2.42 mAHD) and hence avoid these coastal hazards.

Table 3.1 Assets Within the Point Grey Peninsula Development

Asset Group	Functions, Services, & Values	Assets
Western foreshore	Coastal access, recreation and conservation. Tourism. Habitat for flora and fauna. Supports biodiversity and ecosystem integrity. Geomorphic features. Buffer to high value assets.	Paths Beach Access Paths Turfed Areas / POS Playground Sea Scouts and Canoe Hire Building
Western foreshore Jetties	Coastal access, Tourism.	Jetties
Western Foreshore Rehabilitation Zone	Recreation and conservation. Tourism. Habitat for flora and fauna. Supports biodiversity and ecosystem integrity. Buffer to high value assets	Vegetation Beach Access Paths
Western Foreshore Carpark	Coastal access, Tourism.	Carpark
Northern foreshore	Coastal access, recreation and conservation. Tourism. Habitat for flora and fauna. Supports biodiversity and ecosystem integrity. Buffer to high value assets.	Parkland Dual use Path Beach Access Paths Shelter/Picnic Nodes Indigenous Interpretation Node
Eastern foreshore	Coastal access, recreation and conservation. Tourism. Habitat for flora and fauna. Supports biodiversity and ecosystem integrity. Buffer to high value assets.	Dual use Path Bird Watching Access Paths Bird Sanctuary Rehabilitation Area
Temporary Secondary Access Unsealed Road	Secondary site access	Unsealed road

It is important to note that the service lives of the various landscaping assets (ie paths, playground, turfed areas, interpretation nodes etc.) and the western foreshore carpark would be limited to between 25 and 50 years depending on the asset. Beyond which, it is expected that the condition would be such that they would require replacement.

The Temporary Secondary Access Unsealed Road is an asset the actually already exists in the area, as Carrabungup Road which is a functional unsealed road comprised of gravel and crushed limestone. PGDC propose to make use of this road as a temporary secondary access point for the Point Grey Peninsula Development in accordance with bushfire planning requirements, ie an alternative access for emergency vehicles in the case of bushfire. PGDC plan to make use Carrabungup Road for this purpose for the short to medium term before potentially implementing the alternative secondary access, the location of which is shown in Figure 3.1. Importantly this location lies well landward of the 100 year planning horizon erosion hazard line and well above the S4 inundation level (2.42 mAHD) and hence avoids the coastal hazards.

4. Coastal Hazard Risk & Vulnerability Analyses

The vulnerability of the proposed assets identified above is related to their level of exposure to coastal hazards, as well as their sensitivity to the impacts caused by these hazards and their ability to respond to them (termed adaptive capacity). With the exception of the environmental assets, which will essentially be left to naturally respond to the impacts of coastal hazards, the assets that are being considered are built form assets. Therefore, whilst for instance the foreshore assets will be constructed in a way that will allow easy migration in the future if coastal hazards are identified, the level of vulnerability of these assets will ultimately be linked to their level of exposure. This will be considered for the risk analysis and future management and adaptation strategies proposed for these assets. Details of the risk and vulnerability analyses are presented below.

4.1 Risk Analysis

In accordance with WAPC (2019), a risk based approach will be used to assess the hazards, required mitigation and adaptation strategy for the proposed Point Grey Peninsular development. As coastal hazards are the focus of this assessment, it is the likelihood and consequences of these coastal hazards that need to be considered.

4.1.1 Likelihood

Likelihood is defined as the chance of something happening (AS/NZS ISO 31000:2009). WAPC (2019) defines the likelihood as the probability of erosion and/or storm surge inundation impacting on existing and future assets and values. This requires consideration of the frequency and probability of the event occurring over a given planning timeframe.

The probability of an event occurring is often related to the AEP or the ARI. The use of the AEP to define impacts of coastal hazards over the planning timeframe assumes that events have the same probability of occurring each year. In the case of climate change and sea level rise, which has a large influence on the assessed coastal hazard risk, this is not true. In addition, there is insufficient data available to properly quantify the probability of occurrence.

A scale of likelihood has therefore been developed, which follows the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009). This is presented in Table 4.1.

Table 4.1 Scale of Likelihood

Rating	Description/Frequency
Almost certain	There is a high possibility the event will occur as there is a history of frequent occurrence. 90 – 100% probability of occurring over the timeframe.
Likely	It is likely the event will occur as there is a history of casual occurrence. 60 – 90% probability of occurring over the timeframe.
Possible	The event may occur. 40 – 60% probability of occurring over the timeframe.
Unlikely	There is a low possibility that the event will occur. 10 – 40% probability of occurring over the timeframe.
Rare	It is highly unlikely that the event will occur, except in extreme/exceptional circumstances. 0 – 10% probability of occurring over the timeframe.

The likelihood ratings are based on the Seashore (2021) coastal hazard assessment. It is important to note that hazard lines reaching a particular asset at the end of the planning horizon do not necessarily mean this will occur. This is due to the fact that coastal erosion reaching the hazard lines shown requires all of the following to occur.

- Acceleration of erosive shoreline movement trends to consume the additional 0.2 m per year allowance for uncertainty.
- The upper estimate of erosion caused by sea level rise.
- The severe storm event to be experienced at the end of the planning timeframe (ie when the other allowances have already been realised).

Only if all of these occur will the erosion hazard lines be realised. The probability of each of the coastal erosion allowances occurring within the respective planning horizons has been considered in determining the likelihood ratings.

Where an asset covers a large area or length such as a coastal path, the most critical location of that asset, in terms of potential erosion impact, defines the likelihood rating given for that asset.

4.1.2 Likelihood Assessment

The likelihood ratings given to the relevant assets are based on the coastal erosion hazard lines and the consideration of the probabilities of each of the allowances occurring within the respective planning horizons.

Coastal Erosion Impact Likelihood Assessment

The proposed Point Grey Peninsula development assets located landward of the 100 year erosion hazard line **avoid** the risks associated with erosion hazards. This is discussed by the risk adaptation and mitigation strategies in Section 7 and includes roads and buildings, etc.

The assessment of likelihood for each of the identified assets (refer to Section 3.2) located seaward of the 100 year planning hazard line and therefore potentially impacted by erosion hazards over the 100 year planning timeframe, is presented in Table 4.2.

Table 4.2 Assessment of Likelihood of Coastal Erosion Impact

Asset		Planning Timeframe				
		Present Day	10 year	30 year	50 year	100 year
Western Foreshore	Paths	Rare	Possible	Almost Certain	Almost Certain	Almost Certain
	Beach Access Paths	Possible	Almost Certain	Almost Certain	Almost Certain	Almost Certain
	Turfed Areas / POS	Rare	Rare	Possible	Almost Certain	Almost Certain
	Playground	Rare	Rare	Rare	Rare	Possible
	Sea Scouts and Canoe Hire Building	Rare	Possible	Almost Certain	Almost Certain	Almost Certain
	Jetties	Possible	Almost Certain	Almost Certain	Almost Certain	Almost Certain
	Foreshore Rehabilitation Zone	Rare	Possible	Almost Certain	Almost Certain	Almost Certain
	Carpark	Rare	Rare	Rare	Rare	Possible
Northern Foreshore	Parkland	Rare	Rare	Rare	Rare	Rare
	Dual Use Path	Rare	Rare	Rare	Rare	Rare
	Beach Access Paths	Possible	Almost Certain	Almost Certain	Almost Certain	Almost Certain
	Shelter/Picnic Nodes	Rare	Rare	Unlikely	Almost Certain	Almost Certain
	Indigenous Interpretation Node	Rare	Rare	Rare	Unlikely	Likely
Eastern Foreshore	Dual use Path	Rare	Rare	Rare	Rare	Possible
	Bird Watching Access Paths	Possible	Almost Certain	Almost Certain	Almost Certain	Almost Certain
	Bird Sanctuary Rehabilitation Area	Possible	Almost Certain	Almost Certain	Almost Certain	Almost Certain
	Temporary Secondary Access Unsealed Road	Rare	Rare	Rare	Possible	Almost Certain

Notes: 1. Based on most exposed location of each asset group.

Coastal Inundation Impact Likelihood Assessment

Assessment of the likelihood of coastal inundation is slightly different to that for coastal erosion. This is due to the fact that the potential for coastal inundation will change in the future as the sea level rises. This means that an area that would only be inundated during a very severe event in the present day could potentially be inundated by a much less severe event in the future. Assessment of the probability of an area being inundated within a given planning horizon therefore needs to consider the changing probability of event occurrence throughout that planning timeframe.

As an example, based on the estimated inundation levels determined by Seashore (2021), an area with an elevation of around 1.40 mAHD would be inundated by the 500 year ARI event in the present day. However, it may be inundated by between the 10 and 100 year ARI events in approximately 50 years. Cumulative probabilities for the occurrence of certain water levels, based on Seashore (2021), are presented in Table 4.3.

Table 4.3 Cumulative Probabilities for the Occurrence of Extreme Levels

Water Level	Present Day	10 year	30 year	50 year	100 year
0.5	100%	100%	100%	100%	100%
1	1.8%	23.8%	53.0%	100%	100%
1.5	0.2%	2.0%	4.1%	15.5%	87.2%
2	0.1%	0.8%	1.7%	4.7%	19.8%
2.5	< 0.1%	< 0.1%	< 0.1%	< 0.1%	< 0.1%
2.9	< 0.1%	< 0.1%	< 0.1%	< 0.1%	< 0.1%
3	< 0.1%	< 0.1%	< 0.1%	< 0.1%	< 0.1%

The results of the assessment of likelihood of coastal inundation for each of the assets is presented in Table 4.4. The levels noted in Table 4.4 reflect the existing ground levels at the most exposed locations of each assets. These levels have been determined based on site elevation information provided by Emerge.

Table 4.4 Assessment of Likelihood of Coastal Inundation Impact

Asset		Level (mAHD)	Present Day	10 year	30 year	50 year	100 year
Western Foreshore	Paths	1	Rare	Unlikely	Possible	Almost certain	Almost certain
	Beach Access Paths	0.5	Almost certain	Almost certain	Almost certain	Almost certain	Almost certain
	Turfed Areas / POS	0.5	Almost certain	Almost certain	Almost certain	Almost certain	Almost certain
	Playground	2.5	Rare	Rare	Rare	Rare	Rare
	Sea Scouts and Canoe Hire Building	1	Rare	Unlikely	Possible	Almost certain	Almost certain
	Jetties	TBA	Possible	Possible	Possible	Possible	Possible
	Foreshore Rehabilitation Zone	0.5	Almost certain	Almost certain	Almost certain	Almost certain	Almost certain
	Carpark	2.5	Rare	Rare	Rare	Rare	Rare
Northern Foreshore	Parkland	2.9	Rare	Rare	Rare	Rare	Rare
	Dual Use Path	2.9	Rare	Rare	Rare	Rare	Rare
	Beach Access Paths	1.5	Rare	Rare	Rare	Unlikely	Likely
	Shelter/Picnic Nodes	1.5	Rare	Rare	Rare	Unlikely	Likely
	Indigenous Interpretation Node	1.5	Rare	Rare	Rare	Unlikely	Likely
Eastern Foreshore	Dual use Path	2	Rare	Rare	Rare	Rare	Unlikely
	Bird Watching Access Paths	0.5	Almost certain	Almost certain	Almost certain	Almost certain	Almost certain
	Bird Sanctuary Rehabilitation Area	0.5	Almost certain	Almost certain	Almost certain	Almost certain	Almost certain
	Temporary Secondary Access Unsealed Road	0.5	Almost certain	Almost certain	Almost certain	Almost certain	Almost certain

Notes: 1. Based on most exposed location of each asset group.

4.1.3 Consequence

Consequence is the impact of erosion and storm surge inundation on existing and future assets and the value assigned to that asset (WAPC 2019). Within the context of the vulnerability

assessment, consequence is used to consider the sensitivity of an asset to coastal erosion and inundation hazards over the 100 year planning timeframe.

A scale of consequence has been developed which assesses a range of impacts and is generally consistent with the Australian Standard Risk Management Principles and Guidelines (ISO 31000:2009) and the Coastal Hazard Risk Management and Adaptation Planning Guidelines (WAPC 2019). The consequence scale is presented in Table 4.5.

Table 4.5 Scale of Consequence

Rating	Social	Economic	Environment	Infrastructure	Safety
Catastrophic	Loss of life and serious injury. Large long term or permanent (~1 yr) loss of services, public access/amenity, employment, wellbeing or culture. No suitable alternative sites exist within the LGA.	Permanent and/or entire loss or damage to property, plant and equipment, finances >$10 million. Regional economic decline, widespread business failure and impacts on state economy.	Permanent and entire loss of flora, fauna conservation or heritage area (no chance of recovery).	Damage to majority or all of infrastructure (Greater than 75%). Asset with step change sensitivity and no adaptive capacity.	Death or permanent disabilities.
Major	Serious injury. Medium term (~1 month) disruption to services, employment wellbeing, or culture. Very limited suitable alternative sites exist within the LGA.	Permanent and/or large scale loss or damage to property, plant and equipment, finances > $2 - $10 million. Lasting downturn of local economy with isolated business failures and major impacts in regional economy.	Long-term and/or large scale loss of flora, fauna or heritage area (limited chance of recovery) with local impact.	Damage to significant portion (50% - 75%) or asset with step change sensitivity. Asset with step change sensitivity and some adaptive capacity	Extensive injuries or disabilities.
Moderate	Minor injury. Major short term or minor long-term (~1 week) disruption to services, public access/amenity, employment, wellbeing, or culture. Limited suitable alternative sites exist within the LGA.	Permanent and/or medium scale loss or damage to property, plant and equipment, finances > $100,000 - $2 million. Significant impacts on local economy and minor impacts on regional economy.	Medium-term and/or medium scale loss of flora, fauna or heritage area (recovery likely) with local impact.	Damage to no more than half of the infrastructure (25% - 50%). Asset with step change sensitivity with adaptive capacity.	Medical treatment.
Minor	Small to medium short-term (~1 day) disruption to services, public access/amenity, employment, wellbeing, or culture. Many suitable alternative sites exist within the LGA.	Permanent and/or small scale loss or damage to property, plant and equipment, finances > $10,000 - $100,000. Individually significant but isolated impact on local economy.	Short-term and/or small scale loss of flora, fauna or heritage area (strong recovery) with local impact.	Minor damage to infrastructure (10% - 25%).	First aid treatment.
Insignificant	Minimal short-term (~1 hr) inconveniences to services, public access/amenity, employment, wellbeing, or culture. Many suitable alternative sites exist within the LGA.	Permanent loss or damage to property, plant and equipment, finances < $10,000. Minor short-term impacts on local economy.	Negligible to no loss of flora, fauna or heritage area (strong recovery) with local impact.	Little or no damage to infrastructure (Less than 10%).	No injuries or illness.

4.1.4 Consequence Assessment

The consequence rating has been completed separately for coastal erosion and coastal inundation. Typically for infrastructure and assets, the consequences associated with coastal erosion are more significant than those associated with coastal inundation. This arises due to the fact that coastal erosion is generally more permanent and more difficult to overcome than coastal inundation. For instance, if the foundations of a house were undermined by erosion it is likely that the house would fall. However, if a house was inundated, while there may be some damage, structural failure would be less likely. Conversely, inundation hazards can have a greater potential impact on public safety, though this is typically more important for residential development areas rather than public foreshore assets, which are unlikely to be inhabited during severe events.

The assessed consequence of coastal erosion for each of the assets and each of the planning horizons is presented in Table 4.6.

Table 4.6 Assessment of Consequence of Coastal Erosion Impact

Asset		Planning Timeframe				
		Present Day	10 year	30 year	50 year	100 year
Western Foreshore	Paths	Minor	Minor	Moderate	Moderate	Moderate
	Beach Access Paths	Minor	Minor	Minor	Minor	Minor
	Turfed Areas / POS	Minor	Minor	Minor	Moderate	Moderate
	Playground	Insignificant	Insignificant	Insignificant	Minor	Moderate
	Sea Scouts and Canoe Hire Building	Insignificant	Moderate	Moderate	Moderate	Moderate
	Jetties[2]	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Foreshore Rehabilitation Zone	Minor	Minor	Moderate	Moderate	Moderate
	Carpark	Insignificant	Insignificant	Insignificant	Minor	Moderate
Northern Foreshore	Parkland	Insignificant	Insignificant	Insignificant	Insignificant	Minor
	Dual Use Path	Insignificant	Insignificant	Insignificant	Insignificant	Minor
	Beach Access Paths	Minor	Minor	Minor	Minor	Minor
	Shelter/Picnic Nodes	Insignificant	Insignificant	Minor	Minor	Minor
	Indigenous Interpretation Node	Insignificant	Insignificant	Insignificant	Insignificant	Minor
Eastern Foreshore	Dual use Path	Insignificant	Insignificant	Insignificant	Insignificant	Moderate
	Bird Watching Access Paths	Minor	Minor	Minor	Minor	Minor
	Bird Sanctuary Rehabilitation Area	Minor	Minor	Moderate	Moderate	Moderate
	Temporary Secondary Access Unsealed Road	Insignificant	Insignificant	Insignificant	Minor	Minor

Notes: 1. Based on most exposed location of each asset group.

2. Assessment assumes the jetties will be designed to withstand the impacts of coastal processes over the structures design life.

The assessed consequence of coastal inundation for each of the assets and each of the planning horizons is presented in Table 4.7. Similar to erosion, the consequence of inundation would change over the planning horizons for various assets due to the likely increased consequence of a higher water level as sea level rise is realised over time.

Table 4.7 Assessment of Consequence of Coastal Inundation Impact

Asset		Level (mAHD)	Present Day	10 year	30 year	50 year	100 year
Western Foreshore	Paths	1	Minor	Minor	Minor	Minor	Minor
	Beach Access Paths	0.5	Minor	Minor	Minor	Minor	Minor
	Turfed Areas / POS	0.5	Minor	Minor	Minor	Minor	Minor
	Playground[1]	2.5	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Sea Scouts and Canoe Hire Building	1	Moderate	Moderate	Moderate	Moderate	Moderate
	Jetties[2]	TBC	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Foreshore Rehabilitation Zone	0.5	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Carpark	2.5	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Northern Foreshore	Parkland	2.9	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Dual Use Path	2.9	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Beach Access Paths	1.5	Minor	Minor	Minor	Minor	Minor
	Shelter/Picnic Nodes	1.5	Minor	Minor	Minor	Minor	Minor
	Indigenous Interpretation Node	1.5	Minor	Minor	Minor	Minor	Minor
Eastern Foreshore	Dual use Path	2	Minor	Minor	Minor	Minor	Minor
	Bird Watching Access Paths	0.5	Minor	Minor	Minor	Minor	Minor
	Bird Sanctuary Rehabilitation Area	0.5	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Temporary Secondary Access Unsealed Road	0.5	Insignificant	Insignificant	Insignificant	Minor	Minor

Notes: 1. Assessment assumes the playground will be designed the withstand the impacts of coastal inundation over the assets services life.
2. Assessment assumes the jetties will be designed to withstand the impacts of coastal processes over the structures design life.

4.2 Risk Evaluation

The risk rating from a risk assessment is defined as “likelihood” x “consequence”. A risk matrix defining the levels of risk from combinations of likelihood and consequence has therefore been developed for the coastal hazards and is presented below in Table 4.8.

Table 4.8 Risk Evaluation Matrix

RISK LEVELS		CONSEQUENCE				
		Insignificant	Minor	Moderate	Major	Catastrophic
LIKELIHOOD	Almost Certain	Low	Medium	High	Extreme	Extreme
	Likely	Low	Medium	Medium	High	Extreme
	Possible	Low	Low	Medium	High	Extreme
	Unlikely	Low	Low	Medium	Medium	High
	Rare	Low	Low	Low	Medium	Medium

A risk tolerance scale assists in determining which risks are acceptable, tolerable and unacceptable. The risk tolerance scale used for the assessment is presented in Table 4.9

Table 4.9 Risk Tolerance Scale

Risk Level	Action Required	Tolerance
Extreme	Active management required. Risk treatment plan must be implemented to reduce risk exposure to an acceptable level	Unacceptable
High	Management attention is required. Risk treatment plan is required to reduce risk exposure to an acceptable level.	Unacceptable
Medium	Risk acceptable with adequate controls, managed by specific procedures and subject to semi-annual monitoring	Monitor
Low	Risk acceptable with adequate controls, managed by routine procedures and subject to annual monitoring	Acceptable

The risk tolerance scale has been reviewed and accepted for use by the development proponent. It shows that the extreme and high risks need to be managed.

4.2.1 Risk Assessment

The risk assessment for the study area will be completed in accordance with the recommendations of AS5334 (2013), which requires a detailed risk analysis to include a vulnerability analysis to thoroughly examine how coastal hazards and climate change may affect the assets.

Table 4.10 presents the assessed coastal erosion risk levels for each of the identified key assets potentially at risk over the 100 year planning timeframe.

Table 4.10 Assessment of Risk of Coastal Erosion Impact

Asset		Planning Timeframe				
		Present Day	10 year	30 year	50 year	100 year
Western Foreshore	Paths	Low	Low	High	High	High
	Beach Access Paths	Low	Low	Low	Low	Low
	Turfed Areas / POS	Low	Low	Low	Medium	Medium
	Playground	Low	Low	Low	Low	Medium
	Sea Scouts and Canoe Hire Building	Low	Medium	High	High	High
	Jetties	Low	Low	Low	Low	Low
	Foreshore Rehabilitation Zone	Low	Low	High	High	High
	Carpark	Low	Low	Low	Low	Medium
Northern Foreshore	Parkland	Low	Low	Low	Low	Low
	Dual Use Path	Low	Low	Low	Low	Low
	Beach Access Paths	Low	Medium	Medium	High	High
	Shelter/Picnic Nodes	Low	Low	Low	Medium	Medium
	Indigenous Interpretation Node	Low	Low	Low	Low	Medium
Eastern Foreshore	Dual use Path	Low	Low	Low	Low	Medium
	Bird Watching Access Paths	Low	Low	Low	Low	Low
	Bird Sanctuary Rehabilitation Area	Low	Medium	High	High	High
	Temporary Secondary Access Unsealed Road	Low	Low	Low	Low	Medium

Table 4.11 Assessment of Risk of Coastal Inundation Impact

Asset		Level (mAHD)	Present Day	10 year	30 year	50 year	100 year
Western Foreshore	Paths	1	Low	Low	Low	Medium	Medium
	Beach Access Paths	0.5	Medium	Medium	Medium	Medium	Medium
	Turfed Areas / POS	0.5	Medium	Medium	Medium	Medium	Medium
	Playground[1]	2.5	Low	Low	Low	Low	Low
	Sea Scouts and Canoe Hire Building	1	Low	Medium	Medium	High	High
	Jetties	TBA	Low	Low	Low	Low	Low
	Foreshore Rehabilitation Zone	0.5	Low	Low	Low	Low	Low
	Carpark	2.5	Low	Low	Low	Low	Low
Northern Foreshore	Parkland	2.9	Low	Low	Low	Low	Low
	Dual Use Path	2.9	Low	Low	Low	Low	Low
	Beach Access Paths	1.5	Low	Low	Low	Low	Medium
	Shelter/Picnic Nodes	1.5	Low	Low	Low	Low	Medium
	Indigenous Interpretation Node	1.5	Low	Low	Low	Low	Medium
Eastern Foreshore	Dual use Path	2	Low	Low	Low	Low	Low
	Bird Watching Access Paths	0.5	Medium	Medium	Medium	Medium	Medium
	Bird Sanctuary Rehabilitation Area	0.5	Low	Low	Low	Low	Low
	Temporary Secondary Access Unsealed Road	0.5	Low	Low	Low	Medium	Medium

4.3 Coastal Vulnerability

As per the recommendations of AS 5334 *Climate change adaptation for settlements and infrastructure*, a detailed risk analysis should include a vulnerability analysis to thoroughly examine how coastal hazards and climate change may affect the assets. This includes consideration of the adaptive capacity and vulnerability of the assets previously assessed for coastal hazard risk.

The vulnerability of the proposed development assets identified previously is related to the risk from coastal hazards, as well as their sensitivity to the impacts caused by these hazards and their ability to respond to them (termed adaptive capacity). This is demonstrated by the following Figure 4.1.

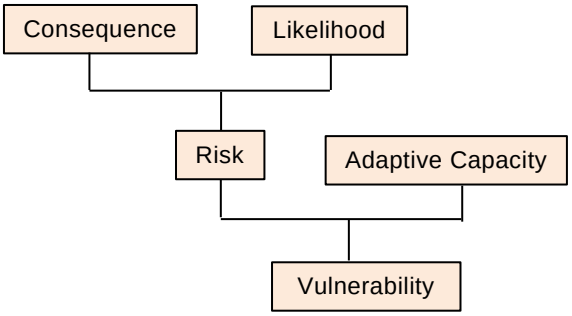

Figure 4.1 Vulnerability Assessment Flowchart

4.3.1 Asset Adaptive Capacity

Adaptive capacity is defined in AS5334 as the ability to respond to climate change to moderate potential damage, to take advantage of opportunities, or to cope with the consequences.

This should be considered in conjunction with any changes to the current risk factors over time which may influence an assets future adaptive capacity. A scale of adaptive capacity has been developed for this assessment and is presented in Table 4.12 below.

Table 4.12 Adaptive Capacity Scale

Rating	Adaptive Capacity
Insignificant – No Adaptation Required (NA)	Potential impact has insignificant effect on asset. Controls are re-established naturally or with ease before more damage would likely occur.
Very High	Good adaptive capacity. Functionality restored easily. Adaptive systems restored at a relatively low cost or naturally over time.
High	Decent adaptive capacity. Functionality can be restored, although additional adaptive measures should still be considered. Natural adaptive capacity restored slowly over time under average conditions.
Moderate	Small amount of adaptive capacity. Difficult but possible to restore functionality through repair and redesign.
Low	Little or no adaptive capacity. Potential impact would destroy all functionality. Redesign required.

Asset Adaptive Capacity Assessment

The assessment of the adaptive capacity of each of the identified assets to erosion and inundation hazards is provided in Table 4.13.

Table 4.13 Asset Adaptive Capacity Assessment

Asset		Adaptive Capacity	
		Erosion	Inundation
Western Foreshore	Paths	Low	High
	Beach Access Paths	Moderate	High
	Turfed Areas / POS	Low	Very High
	Playground	Low	High
	Sea Scouts and Canoe Hire Building	Low	Low
	Jetties	Insignificant	Insignificant
	Foreshore Rehabilitation Zone	Moderate	Very High
	Carpark	Low	High
Northern Foreshore	Parkland	Low	Very High
	Dual Use Path	Low	High
	Beach Access Paths	Moderate	High
	Shelter/Picnic Nodes	Low	High
	Indigenous Interpretation Node	Low	High
Eastern Foreshore	Dual use Path	Low	Very High
	Bird Watching Access Paths	Moderate	High
	Bird Sanctuary Rehabilitation Area	Moderate	Very High
	Temporary Secondary Access Unsealed Road	Low	High

4.3.2 Asset Vulnerability

To determine the vulnerability of the assets, the following matrix was developed for this assessment in line with the CHRMAP Guidelines (WAPC 2019). The matrix is shown in Table 4.14 below.

Table 4.14 Vulnerability Matrix

VULNERABILITY LEVELS		Risk			
		Low	Medium	High	Extreme
Adaptive Capacity	Low	Low	High	Very High	Very High
	Moderate	Low	Medium	High	Very High
	High	Low	Medium	High	High
	Very High	Low	Medium	Medium	High

A vulnerability tolerance scale assists in determining which vulnerability levels are acceptable, tolerable and unacceptable. The following tolerance scale has been developed and adopted for this assessment.

Table 4.15 Vulnerability Tolerance Scale

Vulnerability Level	Further Action Required	Vulnerability Tolerance
Very High	Asset has minimal capacity to cope with the impacts of coastal hazards without additional action. Adaption needs to be considered as a priority.	Unacceptable / Intolerable
High	Asset has limited ability to cope with the impacts of coastal hazards. Adaptation should be considered to reduce vulnerability to acceptable levels.	Tolerable, if as low as possible
Medium	Asset has some ability to cope with the impacts of coastal hazards. Actions should be considered to reduce vulnerability as low as reasonably practical (ALARP).	Tolerable / Acceptable
Low	Assets has high resilience and is able to cope with the impacts of coastal hazards without additional action.	Acceptable

The vulnerability tolerance scale shows that assets with ***High*** and ***Very High*** vulnerability need to be managed to reduce vulnerability levels to ***Medium*** or ***Low***. Despite being considered acceptable, assets with ***Medium*** or ***Low*** vulnerabilities should also be considered and adaptation measures should be implemented to reduce vulnerability levels *as low as reasonably practical* (ALARP). This is discussed in the following sections of this CHRMAP.

The assets identified as having ***High*** and ***Very High*** vulnerability from coastal erosion and inundation impact, therefore requiring management over the 100 year planning timeframe, are summarised in the following tables.

4.3.3 Asset Vulnerability Assessment

Based on the results of the risk analysis completed previously, Tables 4.16 and 4.17 .present the coastal erosion vulnerability levels for each of the identified assets potentially at risk from erosion and inundation impacts.

Table 4.16 Assessment of Vulnerability of Coastal Erosion Impact

Asset		Planning Timeframe				
		Present Day	10 year	30 year	50 year	100 year
Western Foreshore	Paths	Low	Low	Very High	Very High	Very High
	Beach Access Paths	Low	Low	Low	Low	Low
	Turfed Areas / POS	Low	Low	Low	High	High
	Playground	Low	Low	Low	Low	High
	Sea Scouts and Canoe Hire Building	Low	High	Very High	Very High	Very High
	Jetties	Low	Low	Low	Low	Low
	Foreshore Rehabilitation Zone	Low	Low	Very High	Very High	Very High
	Carpark	Low	Low	Low	Low	High
Northern Foreshore	Parkland	Low	Low	Low	Low	Low
	Dual Use Path	Low	Low	Low	Low	Low
	Beach Access Paths	Low	Low	Low	Low	Low
	Shelter/Picnic Nodes	Low	Low	Low	High	High
	Indigenous Interpretation Node	Low	Low	Low	Low	High
Eastern Foreshore	Dual Use Path	Low	Low	Low	Low	High
	Bird Watching Access Paths	Low	Low	Low	Low	Low
	Bird Sanctuary Rehabilitation Area	Low	Medium	High	High	High
	Temporary Secondary Access Unsealed Road	Low	Low	Low	Low	High

The results of the risk assessment show that all of the Point Grey Peninsula assets have a ***Low*** vulnerability of being impacted by coastal erosion in the present day.

The vulnerability of various assets on the Western Foreshore including Paths, Turfed Areas/POS, the Sea Scouts and Canoe Hire Building, carpark and the Foreshore Rehabilitation Zone increase to ***High*** and ***Very High*** for the longer planning timeframes. This is similar to the Northern Foreshore as the vulnerability of the Shelter/Picnic Nodes and Indigenous Interpretation Node are

High for the 50 and 100 year planning timeframes respectively. These risks are intolerable and will need to be managed to reduce the risks to acceptable levels.

The vulnerability of the Dual Use Path on the Eastern Foreshore is ***High*** for the 100 year planning timeframe, the vulnerability of the Bird Sanctuary Rehabilitation Area is ***High*** for the 30 year planning timeframe and beyond and the vulnerability of the Temporary Secondary Access Unsealed Road Temporary Secondary Access Unsealed Road is ***High*** for the 100 year planning horizon . These risks are intolerable and will need to be managed to reduce the risks to acceptable levels.

Table 4.17 Assessment of Vulnerability of Coastal Inundation Impact

Asset		Level (mAHD)	Present Day	10 year	30 year	50 year	100 year
Western Foreshore	Paths	1	Low	Low	Low	Medium	Medium
	Beach Access Paths	0.5	Medium	Medium	Medium	Medium	Medium
	Turfed Areas / POS	0.5	Medium	Medium	Medium	Medium	Medium
	Playground[1]	2.5	Low	Low	Low	Low	Low
	Sea Scouts and Canoe Hire Building	1	Low	High	High	Very High	Very High
	Jetties	TBA	Low	Low	Low	Low	Low
	Foreshore Rehabilitation Zone	0.5	Low	Low	Low	Low	Low
	Carpark	2.5	Low	Low	Low	Low	Low
Northern Foreshore	Parkland	2.9	Low	Low	Low	Low	Low
	Dual Use Path	2.9	Low	Low	Low	Low	Low
	Beach Access Paths	1.5	Low	Low	Low	Low	Medium
	Shelter/Picnic Nodes	1.5	Low	Low	Low	Low	Medium
	Indigenous Interpretation Node	1.5	Low	Low	Low	Low	Medium
Eastern Foreshore	Dual use Path	2	Low	Low	Low	Low	Low
	Bird Watching Access Paths	0.5	Medium	Medium	Medium	Medium	Medium
	Bird Sanctuary Rehabilitation Area	0.5	Low	Low	Low	Low	Low
	Temporary Secondary Access Unsealed Road	0.5	Low	Low	Low	Medium	Medium

The results of the risk assessment show the vulnerability for the Sea Scouts and Canoe Hire Building is ***High*** for the 10 to 30 year planning timeframes and ***Very High*** for the 50 to 100 year planning timeframes . This risk is intolerable and will need to be managed to reduce the risks to acceptable levels.

5. Risk Mitigation Strategies

5.1 Available Risk Mitigation Strategies

Risk adaptation and mitigation strategies are required to address the coastal hazard risks and asset vulnerabilities identified in Section 4. SPP2.6 outlines a hierarchy of risk adaptation and mitigation options, where options that allow for a wide range of future strategies are considered more favourably. This hierarchy of options is reproduced in Figure 5.1, taken from WAPC (2019).

Figure 5.1 Risk Management & Adaptation Hierarchy

These four broad option categories are generally outlined below.

- Avoid – avoid new development within the area impacted by coastal hazards.
- Managed Retreat – the relocation or removal of assets within an area identified as likely to be subject to intolerable risk of damage from coastal hazards.
- Accommodation – measures which suitably address the identified risks.
- Protect – used to preserve the foreshore reserve, public access and public safety, property and infrastructure.

The assessment of these options is generally done in a progressive manner, moving through the various options until an appropriate mitigation option is found. Adaptation options can vary between asset groups, and often a range of complementary strategies may be required to mitigate coastal hazard risks. For example, beach nourishment can be completed in conjunction with construction of a seawall.

The coastal adaptation options are illustrated in Figure 5.2.

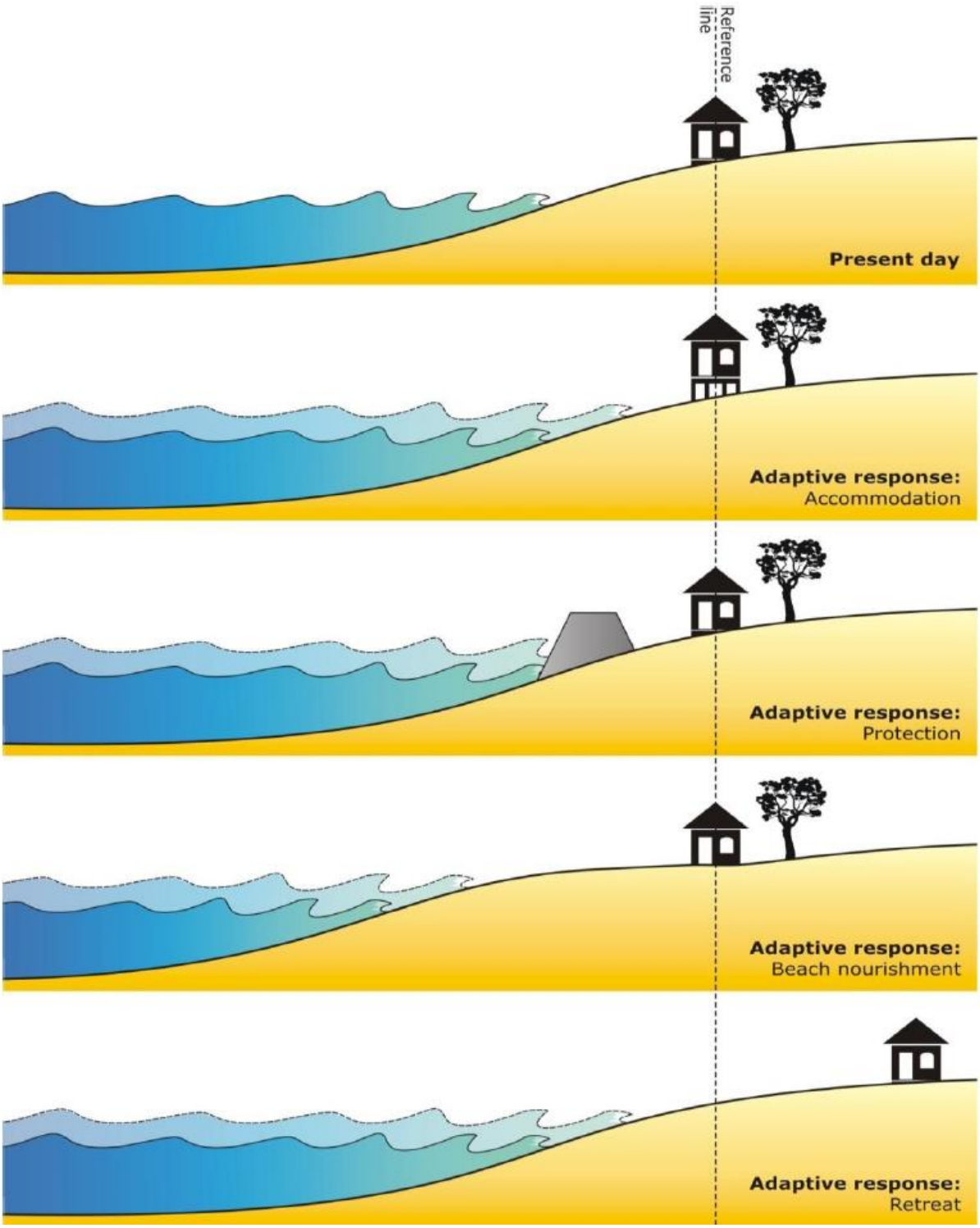

Figure 5.2 Coastal Adaptation Strategies (WRL 2017)

5.2 Proposed Mitigation Strategy

PGDC has acknowledged and accepted the coastal hazard risks for each of the proposed assets as outlined in this report. This acceptance is on the basis that the risk management and adaptation principles, as previously introduced and detailed herein, are put in place.

Importantly, the critical infrastructure of the Point Grey Peninsula development including residential areas and roads etc. are located outside of the coastal hazard zones, these assets ***Avoid*** the coastal hazards.

The assets which have an intolerable level of vulnerability are located within the Western and Eastern Foreshores. The proposed mitigation strategies for assets in these areas are discussed below.

5.2.1 Western Foreshore

The Western Foreshore paths, turfed areas/POS and carpark each have intolerable levels of vulnerability to erosion.

As discussed previously, it is likely that the service lives of these assets within the foreshore areas would be limited to between 25 and 50 years depending on the asset. Beyond which, it is expected that their condition would be such that they would require replacement. This would include an updated review of coastal hazards and climate change impacts on the shoreline movements, so that appropriate setback distances could be implemented. At this time, it is envisaged that these assets would be removed and/or relocated further landward. In other words the strategy of ***Managed Retreat*** is proposed for these assets.

As shown in Figure 3.1, approximately 80 m of foreshore width lies between the 100 year planning horizon erosion hazard line and the critical infrastructure of the development. This provides ample space for a foreshore reserve and relocation of the Western Foreshore paths, turfed areas/POS and carpark as required.

Sea Scouts and Canoe Hire Building

The Sea Scouts and Canoe Hire Building has a ***High*** level of vulnerability to erosion hazards in the 10 year planning horizon and a ***Very High*** level of vulnerability to erosion hazards for the 30 to 100 year planning horizons. Considering inundation hazards, the building has a ***High*** level of vulnerability in the 10 and 30 planning horizons and ***Very High*** vulnerability for the 50 to 100 year planning horizons.

It is important to highlight that this asset relies on being located in close proximity to the shoreline for functionality, ie for the sea scouts to access the estuary waters and for the public to readily be able to hire and use canoes. SPP2.6 recognises this asset as *development that may need to occur within an area identified to be potentially impacted by physical coastal processes within the planning timeframe*.

Considering these hazards, it is envisaged that this building will be a relatively simple and low cost structure. This will enable a ***Managed Retreat*** strategy to be implemented for this building. This strategy would involve monitoring of the coastal hazards (discussed in Section 6) and relocation of the building when the level of risk becomes intolerable. Similar to the other Western Foreshore assets noted above, relocation of the building would need to be informed by an updated review of coastal hazards and climate change impacts. This may include raising of the ground levels at the new location of the building.

5.2.2 Northern Foreshore

The Northern Foreshore shelter/picnic nodes and indigenous interpretation node both have intolerable levels of vulnerability to erosion. Similar to the various Western Foreshore assets noted above, the service life of this asset would likely be limited to between 25 and 50 years. Beyond which, it is expected that the asset would require replacement. At this time, the coastal

hazards would be reviewed and if need be, the shelter/picnic nodes and indigenous interpretation node could be relocated. In other words the strategy of ***Managed Retreat*** is proposed.

5.2.3 Eastern Foreshore

The Eastern Foreshore dual use path has a ***High*** level of vulnerability to erosion hazards in the 100 year planning horizon.

Similar to the various Western Foreshore assets noted above, the service life of this asset would likely be limited to between 25 and 50 years. Beyond which, it is expected that the asset would require replacement. At this time, the coastal hazards would be reviewed and if need be, the dual use path could be relocated. In other words the strategy of ***Managed Retreat*** is proposed.

Temporary Secondary Access Unsealed Road

The Temporary Secondary Access Unsealed Road on the Eastern Foreshore path has a ***High*** level of vulnerability to erosion hazards in the 100 year planning horizon.

As noted above, it is proposed to use this road as a temporary secondary access for the development in the short to medium term before potentially implementing the alternative secondary access which is located well landward of the 100 year planning horizon erosion hazard line and well above the S4 inundation level (2.42 mAHD). The potential change of this secondary access road would be carried out as required and the timing would depend on either the condition of the road, or the coastal hazards, whichever is sooner. In other words, a ***Managed Retreat*** strategy is proposed for this asset. This strategy would also involve monitoring of the coastal hazards (discussed in Section 6) and proactively relocating the secondary access as required when the level of risk becomes intolerable.

5.2.4 Environmental Assets

The Western Foreshore Rehabilitation Zone and the Eastern Foreshore Bird Sanctuary Rehabilitation Area have been considered as natural environmental assets. Importantly, these areas would be subject to the erosion and inundation hazards regardless of the Point Grey Peninsula development.

It is proposed that these assets will be left to respond naturally to the impacts of coastal hazards.

6. Implementation Plan

The risk mitigation and adaptation strategies outlined in Section 5 set out the general proposed coastal management approach of ***Managed Retreat*** for the vulnerable assets of the Point Grey Peninsula development. Direct guidance on when, what, how and by who these processes will be completed is provided within this implementation plan. For ease of reference, these details have been broken down to outline the requirements for each stage of the project and/or asset life.

6.1 Planning & Initial Construction

Coastal planning for this development, largely informed by the findings of this CHRMAP, have identified that coastal hazard risks exist for a number of proposed assets within the foreshore area over the 100 year planning timeframe.

The other element that is key during the planning and construction phase is to ensure that the designs of each of the individual foreshore assets that may experience erosion or inundation over their respective service lives are appropriately designed to withstand these potential impacts.

A summary of the requirements of the planning and construction stage is presented in Table 6.1.

Table 6.1 Implementation Plan – Planning & Initial Construction Stage

Requirement	Timing	Responsibility
Acceptance of disclosed hazards/vulnerability	Planning Stage	Proponent & Shire It is noted that the proponent has completed this through the acknowledgement and acceptance of the risks outlined
Appropriate design of foreshore assets to ensure that erosion and inundation risks are managed as best as possible over the assets service lives.	Planning & Construction Stage	Proponent (supported by engaged design team)

6.2 Operation Over the Infrastructure Service Life

Over the service lives of the proposed assets, there will be a requirement to complete coastal monitoring to ascertain whether coastal risks to the assets are increasing.

If, at some stage during the service life of an asset, the risks from coastal hazards become intolerable, the assets will be relocated in accordance with the proposed ***Managed Retreat*** adaptation strategy. If this is not financially viable or aligned with the development requirements at this time, the relevant assets can be abandoned and removed from the site.

A summary of the requirements during the operation of the assets over their service life is presented in Table 6.2.

Table 6.2 Implementation Plan – Operation Over the Infrastructure Service Life

Requirement	Timing	Responsibility
Monitoring coastal hazard risk to assess if risks become intolerable and assets need to be retreated (Refer Section 6.4)	Operation over service life	Proponent initially then the Shire
IF REQUIRED Asset relocation/retreat in accordance with the requirements outlined in Section 6.3 OR Abandon and remove infrastructure for that particular asset	If risks to assets are intolerable	Proponent initially then the Shire

6.3 Asset Replacement

Replacement of assets after their service life requires that they be located in an area where the risk to that asset over its remaining service life is considered to be acceptable. To do this will require a revised coastal hazard risk assessment to be completed in accordance with the requirements at that time. The appropriate location for replacement assets can then be chosen based on tolerable risk levels. Alternatively, that particular asset could be removed and not replaced, which is essentially an abandon management approach. The responsibility for these actions would rest with the proponent initially then the Shire.

A summary of the requirements during the replacement of assets is presented in Table 6.3.

Table 6.3 Implementation Plan – Asset Replacement

Requirement	Timing	Responsibility
Complete a revised coastal hazard risk assessment to quantify the risk level at that time.	Planning for asset replacement	Proponent initially then the Shire
Determine appropriate retreat location for replacement assets based on acceptable risk level. OR Remove infrastructure and abandon for that particular asset.	Planning for asset replacement	Proponent initially then the Shire

6.4 Monitoring & Review

Coastal monitoring and review is essential in order to track changes to the shoreline over time. Whilst the results of the *Shire of Murray Coastal Hazard Assessment* (Seashore 2021) provide an indication of the potential changes to the shoreline (and incorporate a justifiable level of conservatism), the system is inherently complex and the actual shoreline response could be different to that presented. Monitoring should therefore be completed to track changes over time and indicate whether the timing for risk mitigation should be adjusted. Triggers for further assessment of the shoreline movement have previously been discussed. As a result, the following trigger will be used for the proposed assets within the foreshore area.

- Retreat of the shoreline within 10 m (the S1 allowance across the site (4 m) plus 6 m) of the proposed foreshore assets will prompt review by a specialist coastal engineer to review if the assets of concern are designed to withstand the coastal erosion hazards and/or commence planning for managed retreat.

If the rate of change in shoreline position observed during the monitoring is materially different from that allowed for with the *Shire of Murray Coastal Hazard Assessment (Seashore 2021)*, it would be recommended that the hazard assessment and this CHRMAP be updated to quantify any changes to the risks posed by coastal hazards.

Likewise, should the State Government guidance for the determination of the required allowances change as a result of new information becoming available, the coastal hazard assessment and this CHRMAP should also be updated. This is especially the case for information regarding climate change and projected sea level rise, however may also apply for the calculation of severe storm erosion, shoreline movement erosion and inundation allowances. The responsibility for both of these actions would rest with the proponent.

A summary of the requirements for the monitoring and review is presented in Table 6.4.

Table 6.4 Implementation Plan – Monitoring & Review

Requirement	Timing	Responsibility
Shoreline monitoring	Ongoing	Proponent initially then the Shire
Review of Coastal Hazard Assessment and CHRMAP	If shoreline behaviour changes substantially from that identified within the *Shire of Murray Coastal Hazard Assessment* (Seashore 2021) OR If guidance changes on the determination of the required allowances as a result of new information becoming available	Proponent initially then the Shire

7. Conclusion

This CHRMAP has been completed to provide guidance on required adaptation and management actions associated with proposed assets within the Point Grey Peninsula development. This CHRMAP has been completed based on the coastal hazards assessment completed by Seashore (2021) as part of the Shire of Murray CHRMAP (Baird 2022), which was endorsed by the Shire of Murray Council and adopted in June 2024. This CHRMAP report has been completed in line with the recommendations of SPP2.6 and the CHRMAP Guidelines (WAPC 2019).

The Seashore (2021) coastal hazard assessment showed that there is a risk of coastal erosion and inundation hazards impacting the Point Grey Peninsula development site. However, these risks are limited to assets within the foreshore areas.

An adaptation strategy of ***Managed Retreat*** is proposed to mitigate these risks. This strategy will involve monitoring of the coastal hazards and subsequent removal and/or relocation of the relevant assets further landward when appropriate. This may occur at the end of the service life, or when the coastal hazards become intolerable.

This CHRMAP outlines the general framework of a coastal monitoring program which is required to monitor the coastal hazards and inform coastal management.

8. References

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