City of Albany

Emu Point to Middleton Beach Coastal Adaptation & Protection Strategy

Vulnerability Assessment

EvoCoast Pty Ltd
in association with
Jeremy Benn Pacific

EVO-AL-01-R-04

Client: City of Albany

Document Title: Emu Point to Middleton Beach Coastal Adaptation & Protection Strategy – Vulnerability Assessment

Document Number: EVO-AL-01-R-04
Revision: 0

Revision Description: Final

Issued: 16 June 2017

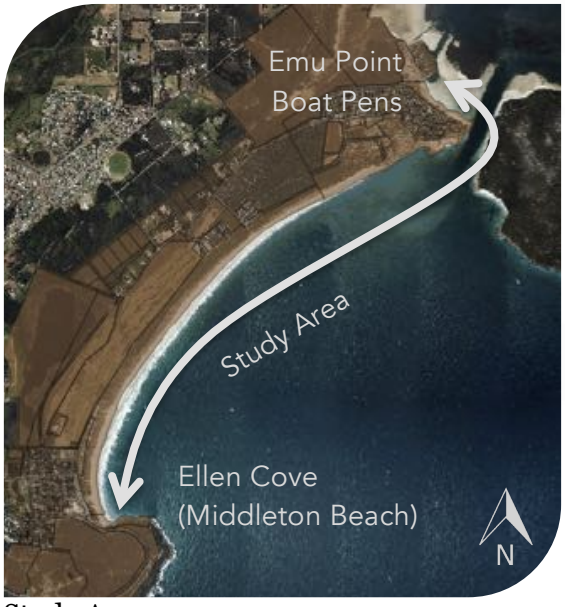
Author: Charlie Bicknell

Reviewer: Karl Ilich

Approver: Charlie Bicknell

Executive Summary

EvoCoast was commissioned by the City of Albany (City) to prepare a vulnerability assessment for the shoreline from Ellen Cove (Middleton Beach) to the Emu Point Boat Pens.



Study Area

Objectives

This assessment is intended to build on the work undertaken in tasks 1 and 2 by Royal HaskoningDHV (RHDHV). These initial tasks have focused on understanding the coastal dynamics within the study area and the likely future physical changes to the coast as a result of coastal hazards. The objective of this vulnerability study is to investigate how these physical changes will progressively impact on assets within the coastal zone.

Methodology

The study methodology has been prepared to take into account, and be consistent with, the requirements of State Planning Policy No. 2.6 State Coastal Planning Policy (SPP 2.6), the SPP 2.6 Guidelines and the Coastal Hazard Risk Management & Adaptation Planning (CHRMAP) Guidelines. The risk analysis portion of this study has also been tailored to be consistent with the City's Enterprise Risk Management Framework.

Coastal vulnerability provides a qualitative assessment of how the effects of coastal hazards will impact on assets within the coastal zone. It defines the degree to which an asset is unable to cope with the adverse effects of coastal hazards.

The assessment is very similar to a conventional risk assessment evaluating likelihood and consequence. However, it incorporates the additional component of the asset's adaptive capacity; the ability of each asset to accommodate the potential impacts of coastal hazards with minimum disruption or additional cost.

Although coastal protection structures exist within the study area, the vulnerability assessment does not take into consideration existing or future controls as its purpose is to assess the unmitigated impacts of coastal hazards. Assessment of tolerable risk levels and existing controls is incorporated into the next step of the CHRMAP process.

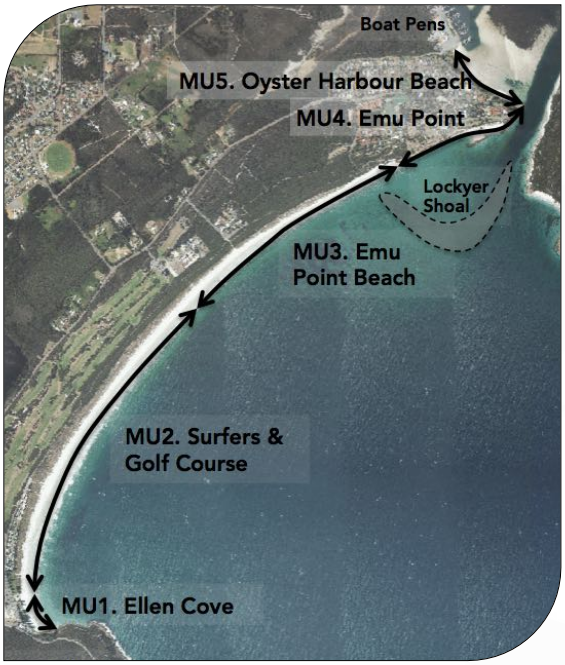
Management Units

Based on the work undertaken by RHDHV (2017) the study area has been broken into five management units.

- MU1 Ellen Cove
- MU2 Surfers & Golf Course
- MU3 Emu Point Beach
- MU4 Emu Point
- MU5 Oyster Harbour Beach

The management units define sections of the coastline which share similar

characteristics and provide a framework for monitoring and management.



Management units

Hazard Identification

The potential extent of erosion and inundation has been based on the hazard mapping undertaken by RHDHV (2017). Hazard mapping for the study area was completed by RHDHV for each of the timeframes 2017, 2030, 2050, 2070 and 2120.

The methodology adopted by RHDHV, follows the requirements of SPP2.6, whereby the extent of erosion and inundation is determined independently by considering the sum of the following factors:

erosion

- current risk of storm erosion
- historic shoreline movement trend
- future sea level rise

inundation

- current risk of storm surge
- future sea level rise

Asset Identification

Assets within the coastal zone have been identified based on review of the GIS datasets held by the City, aerial photography and a site inspection completed in March 2017. In addition, the zoning and approved land uses within the Local Planning Scheme (CoA 2017) was taken into consideration. The following types of assets have been considered:

- **Western Power assets** – streetlights, power poles, pits, overheads, transformers
- **Water Corporation assets** – water pipes, sewage pipes, hydrants, pumping stations
- **City of Albany assets** – trees, playgrounds, reticulation, storm water drains, pumps & bores, reserves, toilets
- **Transport networks** – local/major roads, parking bays, paths, trails.
- **Private land/property** – residential land and buildings
- **Commercial land/property** – tourist accommodation, cafes/restaurants
- **Developable land** – vacant or re-zoned land with the potential for development

Vulnerability to erosion

A summary of the assets most vulnerable to erosion is as follows:

MU1 Ellen Cove

- The Three Anchors Café, Toilets, and Surf Lifesaving Club were all found to be **extremely vulnerable** now.
- The beach and foreshore were found to have a medium/high vulnerability in the short-term with the foreshore reserve increasing to extreme in the longer term (2090 onwards).

As a priority, short-term (0-20 years) adaptation planning and implementation is required to address the immediate vulnerability of the Three Anchors Café, Toilets, Surf Lifesaving Club, beach and foreshore reserve. Adaptation planning should consider the vulnerability of these assets as a whole.

MU2 Surfers & Golf Course

- The beach, foreshore reserve and BIG4 Middleton Beach Holiday Park were found to have the highest short-term vulnerability within the management unit medium/high by 2030.
- Flinders Parade and the properties north of Barrett St were found to be **extremely** vulnerable only in the longer-term (2070 onwards).

Short-term (0-20 years) adaptation planning and implementation is required to address the vulnerability of the beach, foreshore reserve and BIG4 Middleton Beach Holiday Park. Medium to long-term (20-100 years) adaptation planning is required to address the vulnerability of Flinders Parade, properties north of Barrett St, and the toilet at Surfers Beach.

MU3 Emu Point Beach

- The properties on Griffith Street and Barry Court are not immediately vulnerable. However, become **extremely vulnerable** by 2030 (Griffith St) and 2050 (Barry Ct). The sudden increase in vulnerability is due to their very low adaptive capacity.
- The beach and foreshore reserve were found to have a medium/high vulnerability in the short-term increasing in the long-term (by 2090) to **extreme** for the foreshore reserve due to their high value.

As a priority, short-term (0-20 years) adaptation planning and implementation is required to address the vulnerability of the properties on Griffith Street and Barry Court. Medium to long-term (20-100 years) adaptation planning is required to address the vulnerability of the beach, foreshore reserve, and Emu Beach Holiday Park.

MU4 Emu Point

- The properties on Cunningham Street were found to have a high vulnerability now increasing to be **extremely vulnerable** by 2030 due to their very low adaptive capacity.
- The beach and foreshore reserve were found to have a medium/high vulnerability now increasing to high for the beach and **extreme** for the foreshore reserve by 2030. The extreme vulnerability of the foreshore at this location is due to it low adaptive capacity being only a relatively thin strip.
- The toilets were found to be **extremely vulnerable** now due to their close proximity to the shoreline and very low adaptive capacity.
- The Firth St pumping station is not immediately vulnerable. However, becomes highly vulnerable by 2050 and **extremely vulnerable** by 2070.
- The navigation beacon was found to have a medium vulnerability now increasing to high by 2030.

As a priority, short-term (0-20 years) adaptation planning and implementation

is required to address the vulnerability of the foreshore reserve, toilets, properties on Cunningham St and navigation beacon. Medium to long-term (20-100 years) adaptation planning is required to address the vulnerability of the beach, Firth St pumping station and Rose Gardens Beachside Holiday Park.

MU5 Oyster Harbour

- The Emu Point Café and properties on Roe Parade were found to be **extremely vulnerable** now due to their very low adaptive capacity.
- The foreshore reserve was found to have a high vulnerability now increasing to **extreme** in the medium-term (by 2050) due to its low adaptive capacity and being only a relatively thin strip.

As a priority, short-term (0-20 years) adaptation planning and implementation is required to address the vulnerability of the foreshore reserve, Emu Point Café and properties on Roe Parade. Medium-term (20-50 years) adaptation planning is required to address the vulnerability of the beach and toilets.

Vulnerability to inundation

Only a relatively small number of assets were identified as being impacted by inundation over the project timeframes. A summary of the vulnerability of assets to inundation across the study area is as follows:

- All beaches are immediately vulnerable to inundation and foreshore reserves progressively over the project timeframes. However, these assets have a very high adaptive capacity to temporary inundation and so have been identified as having a low vulnerability to inundation at all timeframes.
- At Ellen Cove the Three Anchors, adjacent toilets and Surf Lifesaving Club are not immediately vulnerable to inundation. However, they become highly vulnerable by 2070 to 2090 and in the case of the Three Anchors **extremely** vulnerably by 2120.
- Flinders Parade is not immediately vulnerable to inundation and only has a medium vulnerable by 2120.
- At Oyster Harbour the toilets near the boat pens start to become vulnerable to inundation by 2030 and increase in vulnerability to be **extremely vulnerably** by 2120.

Medium-term (20-50 years) adaptation planning is required to address the inundation vulnerability of the Three Anchors, toilets and Surf Life Saving Club at Ellen Cove and toilets near the boat pens at Oyster Harbour Beach.

Next steps

It is expected that the outcomes of this vulnerability assessment will assist the City in the prioritisation of future analysis in the subsequent stages of the CHRMAP process. The next steps of the CHRMAP are expected to be:

- confirmation that the consequence rating reflects the current community and stakeholder values. This may require further stakeholder and community engagement focused on the assets identified to have the highest vulnerability.
- identification and evaluation of existing controls, in particular the

existing coastal protection structures at Emu Point.

- determining tolerable risk levels for each of the assets identified as vulnerable.
- evaluation of adaptation options.
- develop short and long-term implementation plans, with a priority focus on assets identified as being immediately vulnerable.

Table of Contents

Tables

Figures

1 Introduction

EvoCoast was commissioned by the City of Albany (City) to prepare a coastal vulnerability assessment for the shoreline from Ellen Cove (Middleton Beach) to the Emu Point Boat Pens (refer to Figure 1). This assessment forms task 3 of the *Emu Point to Middleton Beach Coastal Adaptation and Protection Strategy – Coastal Vulnerability Study and Hazard Mapping*:

- Task 1 – Review of available information and knowledge summary (RHDHV)
- Task 2 – Coastal processes & hazard assessment including numerical modelling (RHDHV)
- **Task 3 – Vulnerability assessment** (EvoCoast) – *this report*
- Task 4 – Adaptation options assessment (EvoCoast)
- Task 5 – Temporary coastal monitoring and management plan (EvoCoast)

The completion of tasks 1 to 5 has been split between Royal HaskoningDHV (RHDHV) (tasks 1 & 2) and EvoCoast (tasks 3, 4 & 5). EvoCoast and RHDHV were commissioned independently by the City, but have worked in close collaboration in order to deliver this project. The hazard assessment (task 2) provides an estimation of the potential physical extent of coastal erosion and inundation. This vulnerability assessment focuses on how these hazards will impact on assets within the coastal zone.

Figure 1. Study area

1.1 Objectives

This assessment is intended to build on the work undertaken in tasks 1 and 2 by RHDHV. These initial tasks have focused on understanding the coastal dynamics within the study area and the likely future physical changes to the coast as a result of coastal hazards. The

aim of this vulnerability study is to investigate how these physical changes will progressively impact on assets within the coastal zone.

The objectives of this vulnerability assessment are for each of the time periods 2017, 2030, 2050, 2070, 2120:

- list assets at risk from coastal hazards;
- assess the potential impacts to assets;
- assess the adaptive capacity of assets.

It is intended that the outcomes of this vulnerability assessment will form part of the City's Coastal Hazard Risk Management & Adaptation Plan (CHRMAP) for the Middleton Beach to Emu Point coast. Following this vulnerability assessment the next stages of the CHRMAP process will be to undertake a risk evaluation, identify treatment (adaptation) options and develop an implementation plan. Figure 2 provides an overview of the CHRMAP process and identifies how the components of this study fit into the larger framework.

1.2 Methodology

The study methodology has been prepared to take into account, and be consistent with, the requirements of State Planning Policy No. 2.6 State Coastal Planning Policy (SPP 2.6), the SPP 2.6 Guidelines and the Coastal Hazard Risk Management & Adaptation Planning (CHRMAP) Guidelines. The risk analysis portion of this study has also been tailored to be consistent with the City's Enterprise Risk Management Framework (CoA 2014). This section provides an overview of the methodology applied to this assessment, further details are provided in each of the report sections and the full methodology provided in Appendix A.

Coastal vulnerability provides a qualitative assessment of how the effects of coastal hazards will impact on assets within the coastal zone. It defines the degree to which an asset is susceptible to, and unable to cope with, the adverse effects of coastal hazards. The assessment is comparable to a conventional risk assessment, with the added component of adaptive capacity.

The vulnerability assessment is built around the following steps, which sit within the CHRMAP processes, as illustrated in Figure 2:

1. **Risk Identification**
    a. **hazard identification** – identify the extent of coastal erosion/inundation within the coastal zone. *Hazard mapping completed by RHDHV (2017)*
    b. **asset identification** – identify the assets within the coastal zone, and where appropriate group assets sharing similar values or management requirements.
2. **Risk analysis**
    a. **determine likelihood** – identify each asset's exposure to coastal hazards and determine the likelihood of each asset being impacted by erosion/inundation for each timeframe of interest.

b. **determine consequence** – identify each asset's sensitivity to coastal hazards and determine the consequence of each asset being impacted by erosion/inundation.
c. **determine level of risk** – characterise the potential impacts of coastal hazards to each asset by taking into consideration the likelihood and consequence and allocating a risk rating.

3. **Vulnerability analysis**
   a. **determine adaptive capacity** – identify each asset's ability to accommodate (cope with) the potential impacts erosion/inundation.
   b. **determine level of vulnerability** – characterise the vulnerability of each asset by taking into consideration the potential impacts and the asset's adaptive capacity and allocating a vulnerability rating.

The vulnerability assessment does not take into consideration existing or future controls as its purpose is to assess the unmitigated impacts of coastal hazards. Assessment of tolerable risk levels and existing controls is incorporated into the next step of the CHRMAP process, risk evaluation (refer to Figure 2).

The assessment considers the vulnerability of assets at the time periods 2017, 2030, 2050, 2070, 2120, in order to assess the variation in vulnerability over the next 100 years. For simplicity and to take into account the difference in impacts, the hazards of erosion and inundation have been considered independently.

1.3 Report structure

The report follows the following structure:

- **Section 1** provides an introduction, objectives, methodology and identifies coastal management units.
- **Section 2** provides a summary of the hazard identification and work undertaken by RHDHV to map the extent of coastal hazards.
- **Section 3** provides a list of coastal assets within each management unit.
- **Section 4** identifies the risk to assets by evaluating the likelihood and consequence of being impacted by coastal hazards.
- **Section 5** identifies the vulnerability of assets by evaluating their adaptive capacity.
- **Section 6** provides a summary of the study findings.
- **Appendix A** provides a detailed methodology,
- **Appendix B** presents the hazard mapping by RHDHV,
- **Appendix C** includes the details of each asset,
- **Appendix D** provides a full set of tables. (Note although various tables are included in this report, a full set of tables is included in Appendix D and as an excel spreadsheet attachment.)

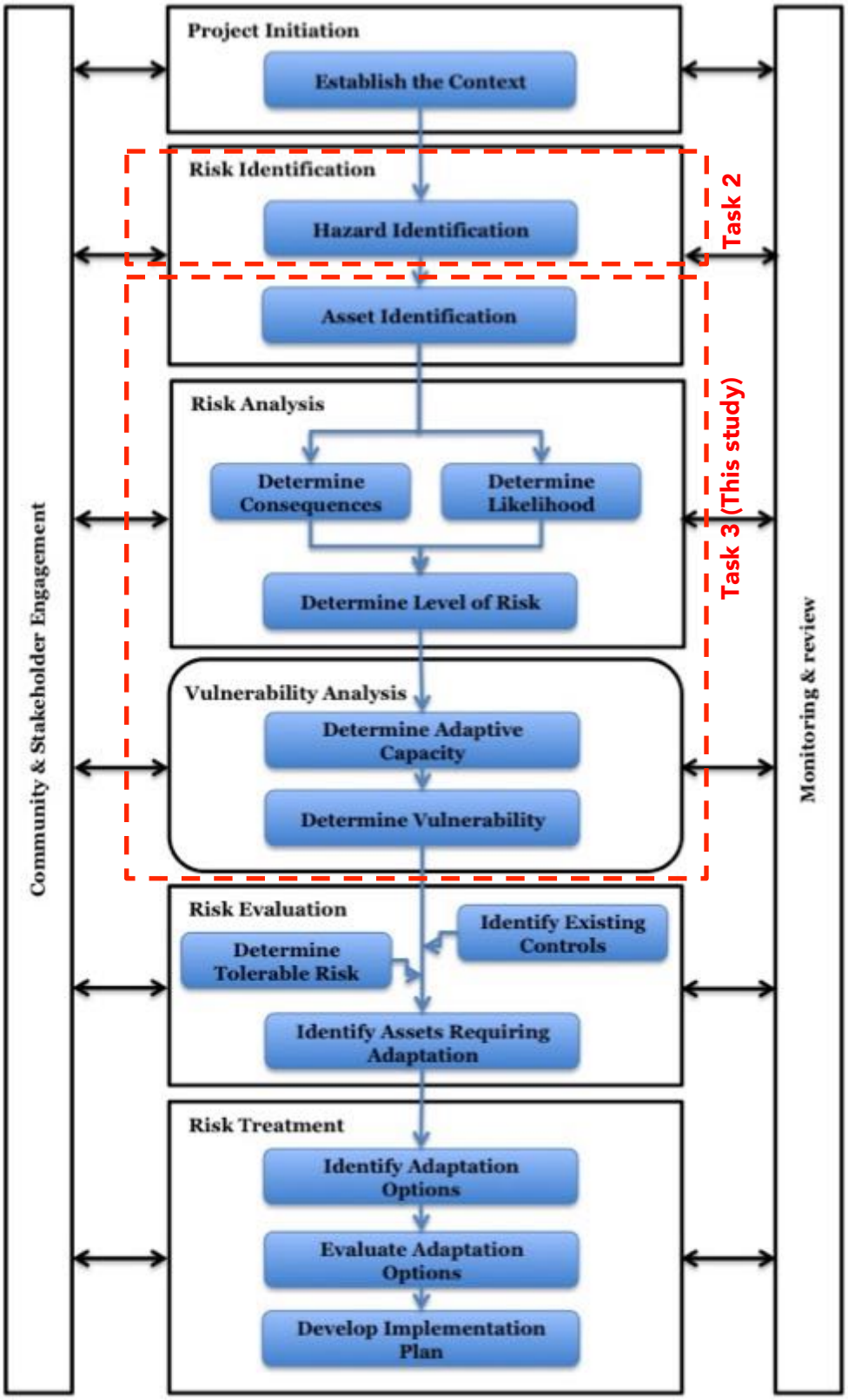


Figure 2. Overview of the CHRMAP process

(Dotted line denotes stages undertaken as part of this study)

1.4 Management units

Based on the work undertaken by RHDHV (2017) the study area has been broken into five management units. The management units define sections of the coastline which share similar characteristics and provide a framework for monitoring and management. The management units are listed with a description of their characteristics in Table 1 and illustrated on Figure 3. Typical photos of each unit are also given in Figure 4.

The management units correspond to the sectors used by RHDHV (2017) to define the study area, with the following exceptions:

- For simplicity, sectors 3 and 4 have been combined to for a single management unit MU3 Emu Point Beach.
- The boundary between management unit 2 and 3 (Golf Course and Emu Point Beach) was moved slightly southwards, based on review of the coastal assets, to locate the properties on Barry Court and Griffith Street within the same management unit.

Table 1. Management units breakdown for study area with commentary on reasons for boundary selection.

Management Unit	Sector (RHDHV 2017)	Boundaries	Characteristics
MU1. Ellen Cove	1	Wooding Point Headland to Ellen Cove SLSC	Section of shoreline in the lee of Wooding headland. Shoreline is strongly controlled by the headland, resulting in a curving alignment and relative sheltering. The beach is relatively stable and artificially maintained to provide recreational amenity. The beach is backed by a grouted rock wall.
MU2. Surfers & Golf Course (a.k.a. Dog Beach)	2	Ellen Cove SLSC to Northern boundary of the Golf Course	This section of shoreline has been accreting (growing) in recent years. This section of shoreline has the greatest exposure to storm events. It is susceptible to storm erosion, however it has the ability to rebuild and naturally repair. In the short-term it is expected to be stable with a large natural buffer to shoreward assets.
MU3. Emu Point Beach	3 & 4	Northern boundary of the Golf Course to Emu Point Revetment Seawall	This section of shoreline is strongly controlled by the feature of the Lockyer Shoal. It transitions from a stable accreting shoreline to the eroded area adjacent to the Emu Point revetment. It is possible that the erosion adjacent to the revetment is beginning to reach an equilibrium, with a reduction in recent years. This section of shoreline is relatively sheltered from normal storm events. However, it can be subject to significant erosion during less frequent storms with a more southerly aspect.
MU4. Emu Point	EP	Emu Point Revetment Seawall to Northern Groyne	This section of shoreline is defined by the existing coastal protection structures (rock revetment, breakwater/headland, training wall and groyne). It extends through the mouth into Oyster Harbour. The shoreline is controlled by the structures and the risk to assets is dependent on the structures' integrity.

MU5. Oyster Harbour Beach	OH	Northern Groyne to Boat Pens	This section of the shoreline is sheltered from the ocean storms and is a low energy environment. The shoreline is controlled by locally generated waves. The presence of the swimming facility causes wave sheltering resulting in a bulge in the shoreline and adjacent erosion requiring periodic sand management to maintain a stable beach profile. The beach is backed by a grouted rock wall.

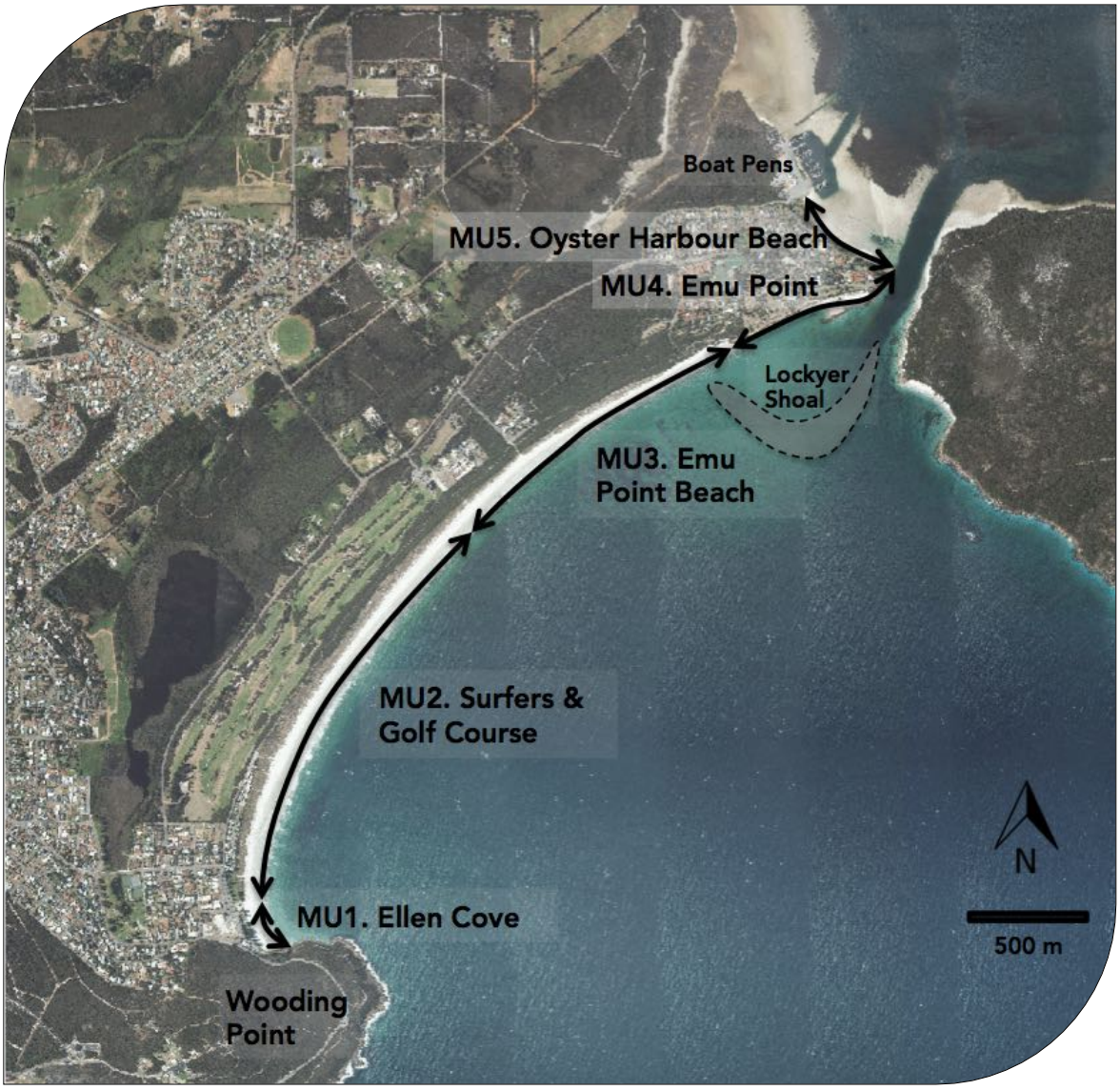


Figure 3. Management units

Figure 4. Typical photos of management units

2 Hazard Identification

The potential extent of erosion and inundation has been based on the hazard mapping undertaken by RHDHV (2017). Hazard mapping for the study area was completed by RHDHV for each of the timeframes 2017, 2030, 2050, 2070 and 2120, and is included in Appendix B. In order to assess the differing impacts of erosion and inundation, assessment of the two hazards was undertaken independently.

The methodology adopted by RHDHV, follows the requirements of SPP2.6, whereby the extent of erosion and inundation is determined by considering the sum of key factors.

Extent of erosion

The extent of erosion at each of the timeframes is estimated as the sum of the following factors:

- **current risk of storm erosion** (*referred to as S1*) – this takes into account the rapid erosion, sometimes termed the 'storm-bite' which can occur during a significant storm event. In some instances the shoreline may subsequently recover from this erosion. (Figure 5 illustrates the extent of erosion caused by the 1984 storm).
- **historic shoreline movement trend** (*referred to as S2*) – this takes into account the long-term change in the shoreline based on review of aerial photography since the early 50's.
- **future sea level rise** (*referred to as S3*) – this takes into account the natural recession of the shoreline which will occur as sea level rises.

Extent of inundation

The extent of inundation at each of the timeframes is estimated as the sum of the following factors:

- **current risk of storm surge** (*referred to as S4*) – this takes into account the temporary inundation which can occur during a significant storm event.
- **future sea level rise** – this takes into account the increased inundation which will occur as sea level rises.

Figure 5. Severe storm erosion Emu Beach

(left) August 1984 storm event causes ~40m erosion (Briss family as reported in URS 2012) (right) similar location April 2017 showing the reformation of the dunes

2.1 Existing coastal protection structures

The study area contains a mixture of existing coastal protection structures with a variety of different functions and designs, refer to Figure 6. These structures provide a varying level of protection to assets within the coastal zone. However, for the purpose of this vulnerability assessment these structures have all been classed as existing controls and assumed not to provide a reduction in the extent of coastal hazards, in particular coastal erosion.

This may appear counter intuitive as some structures, such as those at Emu Point, are substantial, and provide significant protection to the shoreward assets. The purpose of this assessment however, is to determine the inherent vulnerability of assets in the absence of any management interventions. This provides the basis for then evaluating the existing controls and identifying the optimum adaptation measures as part of the subsequent stages of the CHRMAP process (refer to Section 1 and Figure 2).

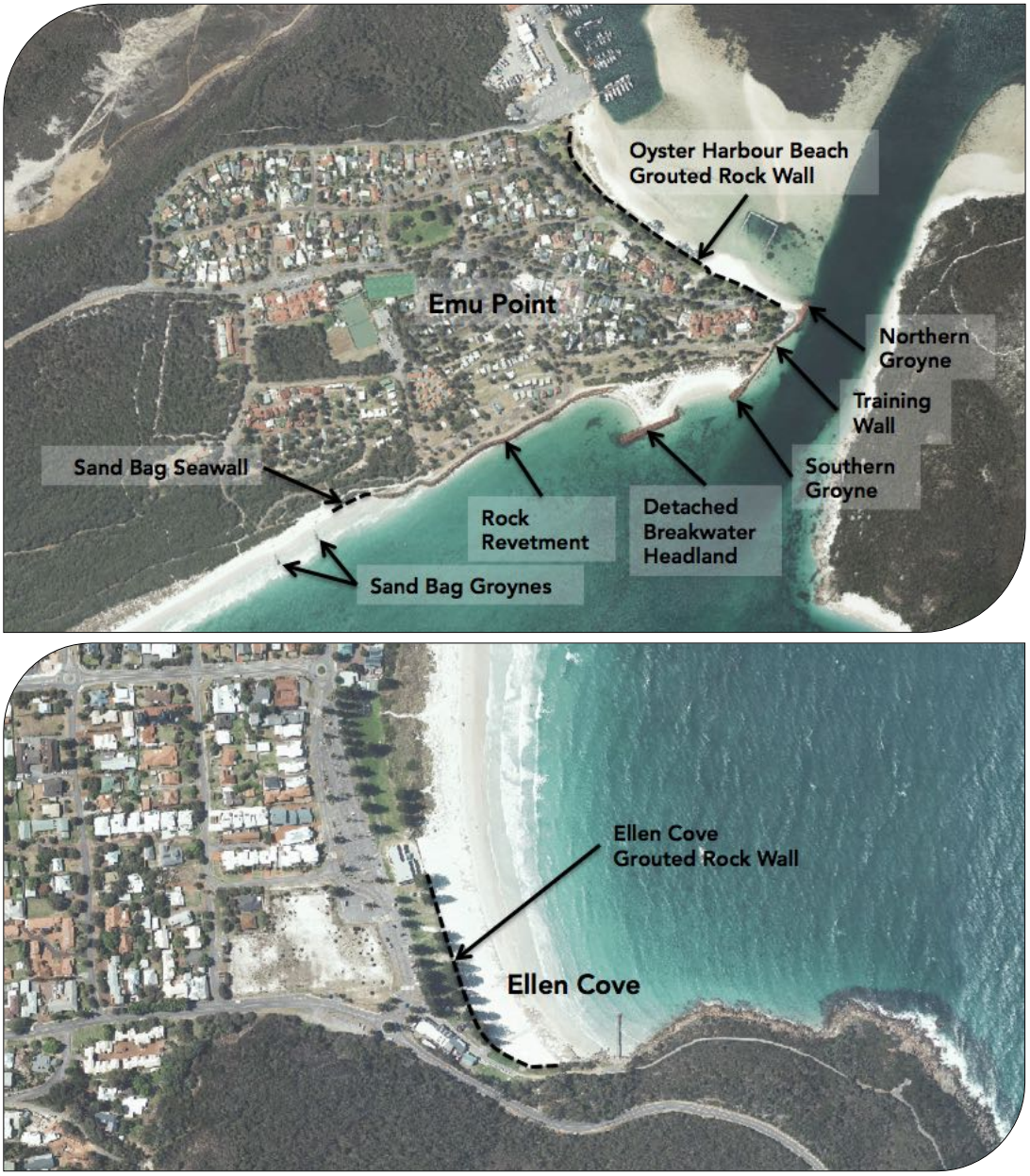


Figure 6. Coastal protection structure names MU4. Emu Point & MU1. Ellen Cove

2.2 Erosion distances & inundation levels

Table 2 and 3 provide the summary of erosion distances and inundation levels estimated by RHDHV (2017), which form the basis of the hazard mapping provided in Appendix B. The erosion distances applied from the present day active limit of the shoreline under storm activity (horizontal shoreline datum). This is typically the back of the beach, often the toe of dunes or the start of vegetation. For the purpose of this vulnerability assessment the peak steady water level (PSWL) has been used to represent the maximum extent of inundation. PSWL is the highest average elevation of the sea surface caused by the combined effect of storm surge, tide and wave setup during a storm event. In some instances wave run-up and overtopping may result in inundation extending further inland. However, this is not anticipated to be sufficient to cause a significant change to the vulnerability of assets and is not anticipated to influence the subsequent evaluation of management measures/adaptation options.

In the next 50 years the existing storm conditions and historic trends largely define the extent of erosion and inundation. However, in later timeframes the component of sea level rise becomes the dominant factor determining the extent of the hazards.

Table 2. Predicted extent of coastal erosion with no structures (RHDHV 2017)

Timeframe	Ellen Cove (Sector 1)	Surfers & Golf Course (Sector 2)	Emu Point Beach (Sector 3 & 4)	Emu Point	Oyster Harbour Beach
2017	15 m	35 m	40 m	20 m	5 m
2030	24 m	35 m	40 m	29 m	5 m
2050	41 m	51 m	66 m	46 m	37 m
2070	64 m	68 m	89 m	69 m	64 m
2090	91 m	89 m	116 m	96 m	95 m
2120	133 m	122 m	158 m	138 m	143 m

Table 3. Predicted level of coastal inundation (RHDHV 2017)

Timeframe	Peak steady water level (PSWL) at the shoreline
2017	1.65 m AHD
2030	1.71 m AHD
2050	1.84 m AHD
2070	2.03 m AHD
2090	2.26 m AHD
2120	2.62 m AHD

3 Asset Identification

This section provides an overview of the assets within each management unit, potentially impacted by coastal hazards over the next 100 years. (A detailed description of each asset/asset- group, including photos, is included within Appendix C.)

3.1 Asset type & grouping

Assets within the coastal zone have been identified based on review of the GIS datasets held by the City, aerial photography and a site inspection completed in March 2017. In addition the zoning and approved land uses within the Town Planning Scheme (CoA 2017) was taken into consideration. The following types of assets types have been considered:

- **Western Power assets** – streetlights, power poles, pits, overheads, transformers
- **Water Corporation assets** – water pipes, sewage pipes, hydrants, pumping stations
- **City of Albany assets** – tress, playgrounds, reticulation, storm water drains, pumps & bores, reserves, toilets
- **Transport networks** – local/major roads, parking bays, paths, trails.
- **Private land/property** – residential land and buildings
- **Commercial land/property** – tourist accommodation, cafes/restaurants
- **Developable land** – vacant or re-zoned land with the potential for development

Assets with common values, or where adaptation is likely to consider a group of assets as a whole, have been grouped for simplicity. These include:

- **Private property, local roads & utilities** - adjacent private properties and ocean side local roads have been grouped. Where utilities such as power, sewage, water also exist within the road reserve these have been included in the grouping. In these locations the viability of the private property is linked to the ability to maintain legal access and utilities.
- **Roads & car parks** – some small car parks have been grouped with roads.
- **Foreshore reserve** – community 'park' assets have been grouped as foreshore reserves: playgrounds, reticulated grassed areas, park furniture, bbqs, sun shelters, trees, shared footpaths and park lighting/water.

3.2 MU1 Ellen Cove

The management unit of Ellen Cove extends southward from the surf life saving club. It includes the recently rezoned special use area (SU25) which contains the Middleton Beach Activity Centre Precinct (Figure 7). This is the potential site of a future tourist and residential development. For the purpose of this vulnerability assessment the commercial/residential areas within this approved precinct, which are yet to developed, have been considered as developable area. Similarly the approved public open space has been grouped with the existing parks and foreshore reserve.

The assets within Ellen Cove are listed in Table 4 and identified on Figure 8.

Figure 7. Middleton Beach Activity Centre Precinct Plan (extract from LPS No. 1)

Table 4. MU1 Ellen Cove assets

Asset	Local Planning Scheme Zoning	Description
Beach	Parks & recreation	Sand area - includes volleyball courts, jetty, shark barrier, swimming pontoon.
Foreshore Reserve	Parks & Recreation SU25 Special use area (Public Open Space)	Park area south from SLSC to jetty. Incorporates area of public open space identified in LPSZ SU25. Includes – grassed areas, retic, playground, amphitheatre, lighting, utilities water, outdoor showers, bbqs, mature trees, shared pathway, stormwater drainage, portion of Flinders Pd.
Toilets	Parks & recreation	Toilet block
Three Anchors	Parks & recreation	Café/restaurant
Marine Drive/Adelaide Crescent	Priority road	Road - includes street lighting, adjacent car park
Developable land A	SU25 Special use area (Hotel / Mixed Use Precinct)	Proposed hotel site
Developable land B	SU25 Special use area (Mixed Use Precinct)	Proposed development site
Albany Surf Life Saving Club	Parks & recreation	Surf life saving club

Figure 8. MU1 Ellen Cove assets

3.3MU2 Surfers & Golf Course assets

The management unit of Surfers and Golf Course extends from the surf life saving club at Ellen Cove to the northern boundary of the golf course. The assets within Surfers and Golf Course are listed in Table 5 and identified on Figure 9.

Table 5. MU2 Surfers & Golf Course assets

Asset	Local Planning Scheme Zoning	Description
Beach	Parks & recreation	Beach
Foreshore reserve	Parks & recreation	Park area north of SLSC and established dunes. Includes: grassed area, established tress, lighting, water, bbq, park furniture, dual use path, established dunes, access paths, viewing decks.
Car park (SLSC)	Parks & recreation	Large car park adjacent to SLSC
Flinders Parade	Local road, parks & recreation	Barnett St northwards. Includes street lighting, power and water utilities.
Properties between Barrett St to Middleton Rd	R60/R80 Tourist residential	Mixture of residential and tourist properties

Asset	Local Planning Scheme Zoning	Description
Properties between north of Middleton Rd	R60/R80 Tourist residential	Mixture of residential and tourist properties
BIG4 Middleton Beach Holiday Park	Caravan and camping	Caravan park with chalets
Car park (Surfers)	Parks & recreation	Car park at Surfers
Toilets (Surfers)	Parks & recreation	Toilets at Surfers
Golf Course	Parks & recreation	Heritage listed golf course

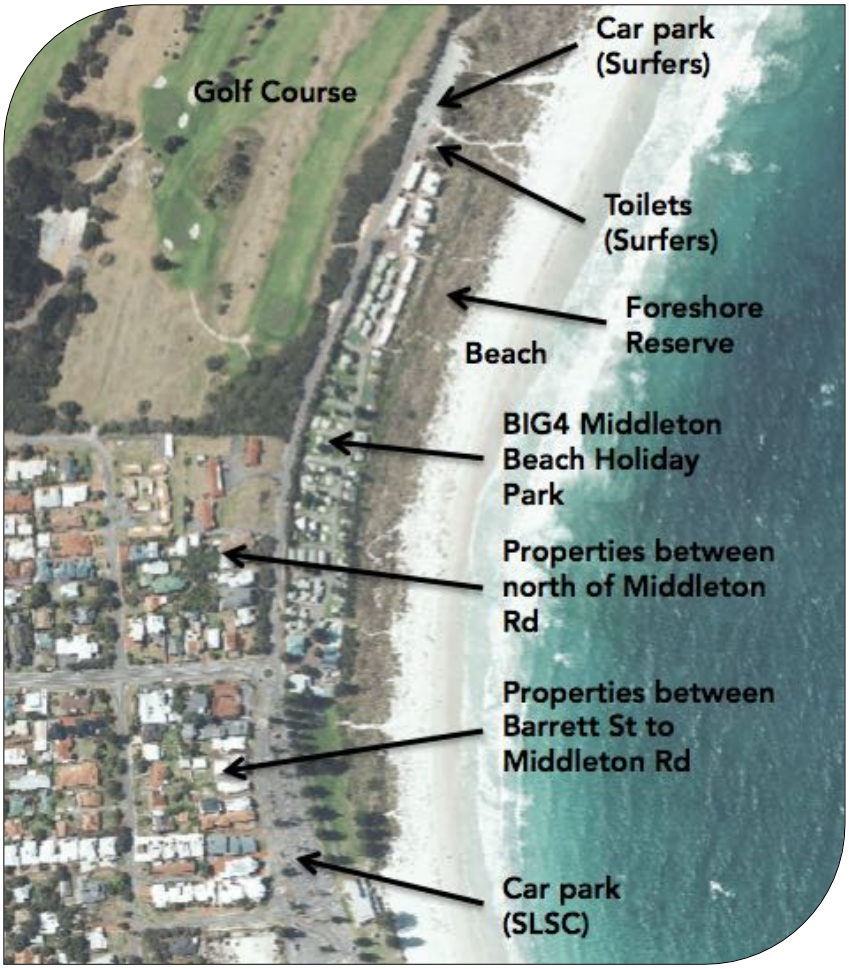


Figure 9. MU2 Surfers & Golf Course assets

3.4MU3 Emu Point Beach

The management unit of Emu Point Beach extends from the northern boundary of the golf course to the Emu Point revetment/seawall. The assets within Emu Point Beach are listed in Table 6 and identified on Figure 10.

Table 6. MU3 Emu Point Beach assets

Asset	Local Planning Scheme Zoning	Description
Beach	Parks & recreation	Beach
Foreshore reserve	Parks & recreation	Established dunes and bush. Includes dual use path.
Properties on Barry Court	R30/R50 Tourist residential, Hotel/motel	Mixture of residential and tourist developed land and undeveloped lots. Includes local roads and utilities within the road reserve.
Properties on Griffith Street	R17.5 Residential	Residential buildings. Includes local roads and utilities within the road reserve.
Developable land	Rural small lot holdings	Site of proposed Landcorp subdivision
Emu Beach Holiday Park	Tourist residential	Caravan park with chalets

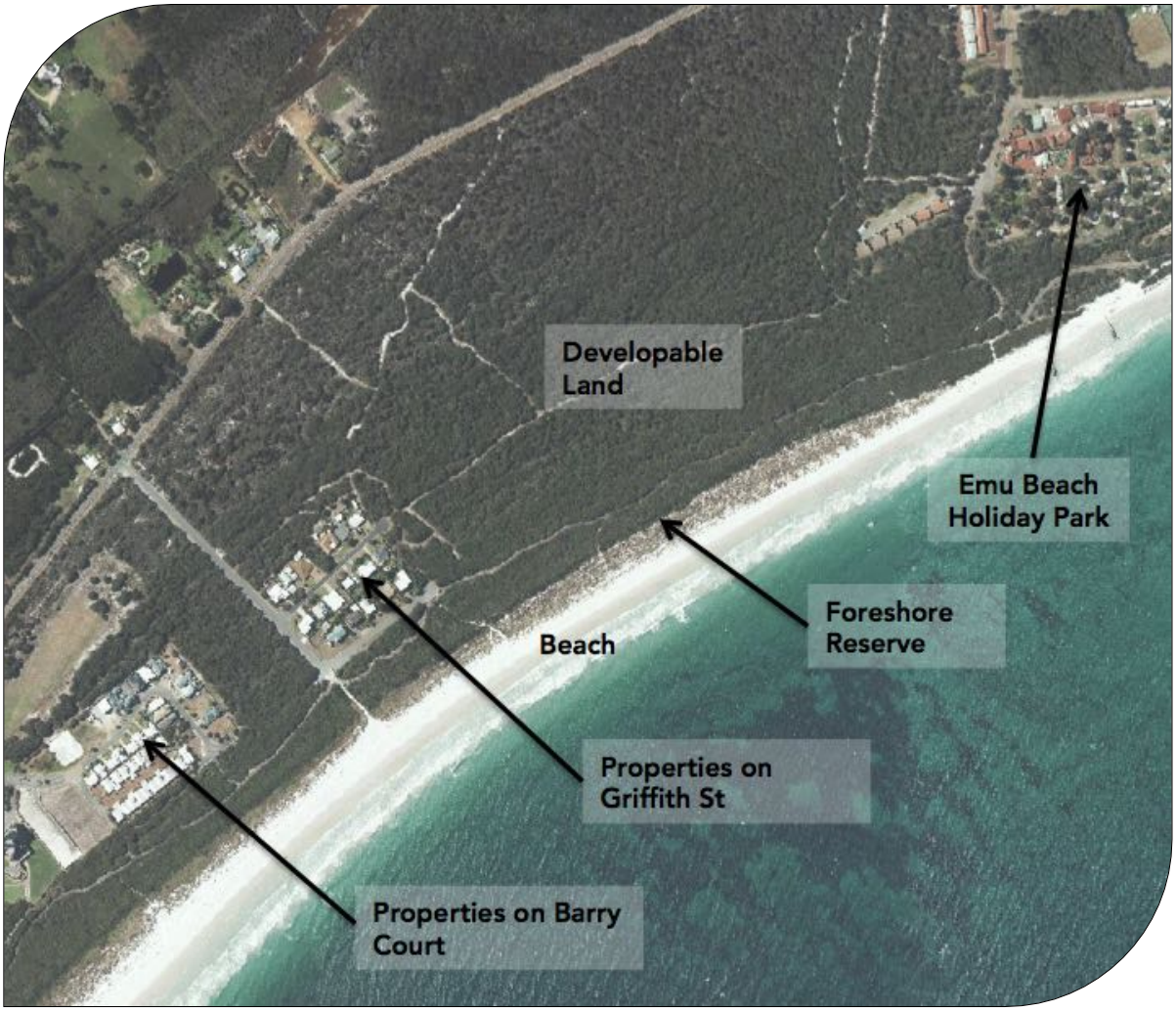


Figure 10. MU3 Emu Point Beach assets

3.5MU4 Emu Point

The management unit of Emu Point extends from the start of the revetment/seawall to the entrance to Oyster Harbour. The assets within Emu Point are listed in Table 7 and identified on Figure 11.

Table 7. MU4 Emu Point assets

Asset	Local Planning Scheme Zoning	Description
Beach	Parks & recreation	Artificial beach formed by the detached breakwater
Foreshore reserve	Parks & recreation	Includes grassed area, shared path playground, parking, portion of Boongarrie St, local utilities (power and water).
Toilets	Parks & recreation	Toilets behind revetment seawall
Firth St Pumping Station	Parks & recreation	Sewage pumping station
Rose Gardens Beachside Holiday Park	Tourist residential	Caravan park with chalets
Properties on Cunningham St	R20 Residential, Local road	Residential buildings and portion of Cunningham St, Boongarrie St Burgess Street, Includes local roads and utilities within the road reserve.
Navigation Beacon	Port industry	Navigation mark, major light

3.6MU5 Oyster Harbour

The management unit of Oyster Harbour Beach extends from the entrance to Oyster Harbour to the boat pens. The assets within Oyster Harbour Beach are listed in Table 8 and identified on Figure 11 .

Table 8. MU5 Oyster Harbour Beach assets

Asset	Local Planning Scheme Zoning	Description
Beach	Parks & recreation	Beach
Foreshore reserve	Parks & recreation	Includes grassed area, playground, lighting, water, turn around and parking at the end of the Cunningham St., swimming jetties, navigation aids.
Emu Point Café	SU14 Restaurant, convenience Store, Parks & recreation	Café including toilets
Properties on Roe Parade	R20 Residential, Local road	Residential buildings and portion of Roe Parade, Mermaid Ave, Hunter St, Bedwell St. Includes utilities within the road reserve (power, water, sewage).
Toilets	Parks & recreation	Toilets at the end of Bendwell St

Figure 11. MU5 Emu Point & Oyster Harbour Beach assets

4 Risk Analysis

This section provides details of the risk analysis of individual assets, which is the process of evaluating the likelihood and consequence of coastal hazards in order to obtain a risk rating. The methodology has been tailored to be consistent with the City's Enterprise Risk Management Framework (CoA 2014).

4.1 Likelihood of erosion & inundation

Likelihood is the term used to describe the chance of something happening (AS 5334-2013). Within the context of a vulnerability assessment it is used to consider the exposure of an asset to coastal hazards.

The hazard mapping by RHDHV (refer to Section 2, Appendix B) denotes the potential extent of erosion and inundation at different timeframes. However, the mapping does not take into consideration the likelihood of the hazard occurring. In order to factor in the uncertainty associated with hazard mapping and to consider a range of likelihood scenarios the results of the hazard mapping have been considered using the likelihood hazard matrix in Table 9 and likelihood rating in Table 10. An example of how the likelihood scale is applied is shown in Figure 12.

Table 9. Likelihood hazard matrix (adapted from the CHRMAP Guidelines)

Likelihood Rating	Present Day (2017)	2030	2050	2070	2090	2120
Almost Certain	-	-	2017	2030	2050	2070
Likely	-	2017	2030	2050	2070	2090
Possible	2017	2030	2050	2070	2090	2120
Unlikely	2030	2050	2070	2090	2120	-
Rare	2050	2070	2090	2120	-	-

Table 10. Likelihood rating (after CoA 2014 & DLG 2013)

Likelihood Rating	Descriptor
Almost Certain	Expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possible	Should occur at some time
Unlikely	Could occur but not expected
Rare	May occur, only in exceptional circumstances

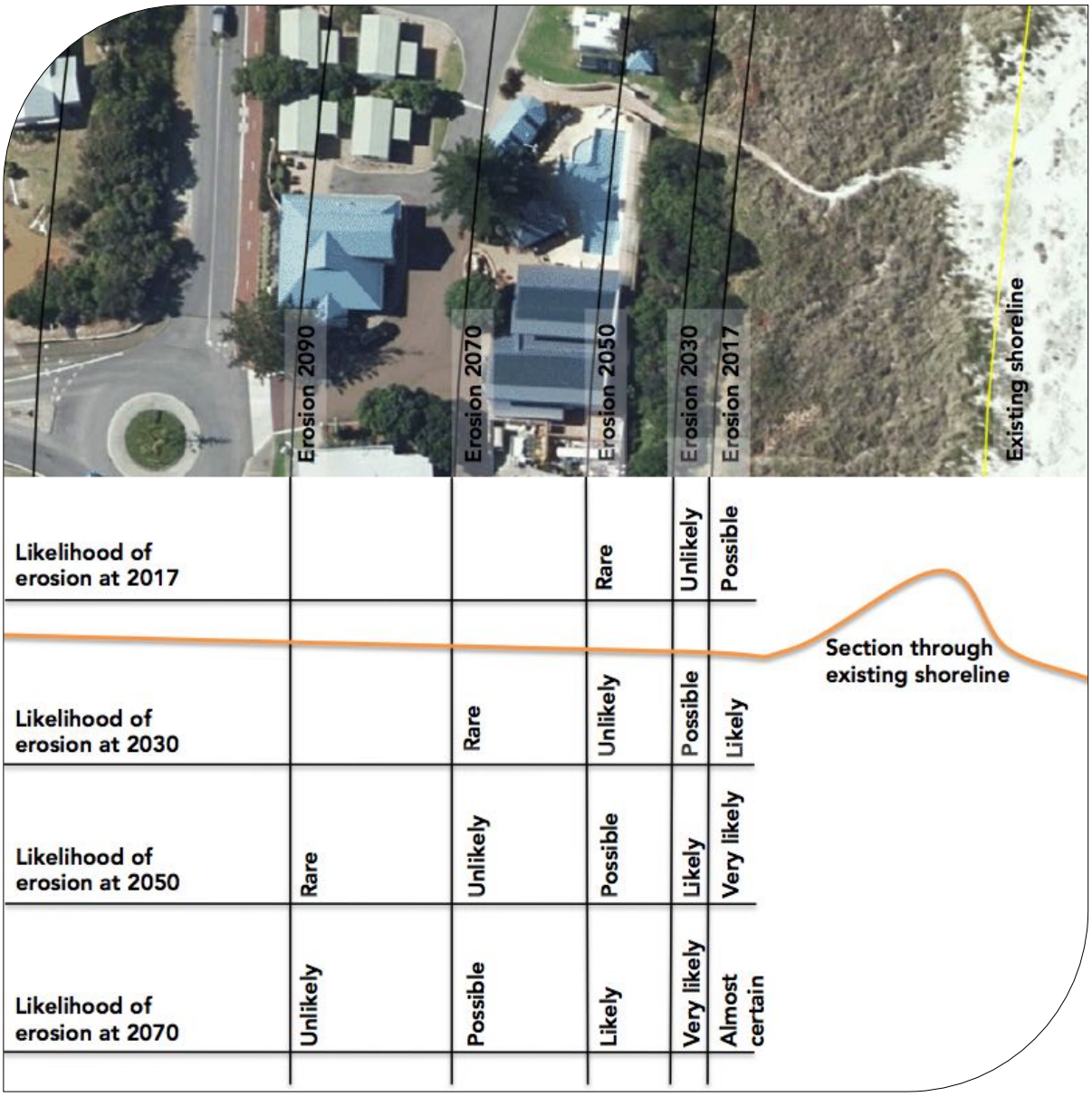


Figure 12. Likelihood of erosion at different timeframes

The following Tables 11 to 15 identify the likelihood of assets being impacted by erosion at each of the project timeframes 2017, 2030, 2050, 2070 and 2120. Table 16 identifies the likelihood of assets being impacted by inundation. (Note, Table 16 contains a reduced list of assets as only a relatively small number of assets are impacted by inundation over the project timeframes.)

Table 11. MU1 Ellen Cove likelihood of assets being impacted by erosion

Asset	Likelihood of Erosion					
	2017	2030	2050	2070	2090	2120
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore Reserve	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Toilets	Unlikely	Possible	Likely	Almost certain	Almost certain	Almost certain
Three Anchors	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain
Marine Dr/Adelaide Cr	-	Rare	Unlikely	Possible	Likely	Almost certain
Developable land A	-	-	Rare	Unlikely	Possible	Likely
Developable land B	-	-	-	Rare	Unlikely	Possible
Albany Surf Life Saving Club	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain

Table 12. MU2 Surfers & Golf Course likelihood of assets being impacted by erosion

Asset	Likelihood of Erosion					
	2017	2120	2050	2070	2090	2120
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore reserve	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Car park (SLSC)	Unlikely	Possible	Likely	Almost certain	Almost certain	Almost certain
Flinders Parade	-	-	Rare	Unlikely	Possible	Likely
Properties between Barrett St to Middleton Rd	-	-	-	Rare	Unlikely	Possible
Properties between north of Middleton Road	-	-	-	Rare	Unlikely	Possible
BIG4 Middleton Beach Holiday Park	Rare	Unlikely	Possible	Likely	Almost Certain	Almost certain
Car park (Surfers)	-	-	-	Rare	Unlikely	Possible
Toilets (Surfers)	-	-	Rare	Unlikely	Possible	Likely
Golf Course	-	-	-	Rare	Unlikely	Possible

Table 13. MU3 Emu Point Beach likelihood of assets being impacted by erosion

Asset	Likelihood of Erosion					
	2017	2120	2050	2070	2090	2120
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore reserve	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Properties on Barry Court	-	-	Rare	Unlikely	Possible	Likely
Properties on Griffith Street	-	Rare	Unlikely	Possible	Likely	Almost certain
Developable land	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain
Emu Beach Holiday Park	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain

Table 14. MU4 Emu Point likelihood of assets being impacted by erosion

Asset	Likelihood of Erosion					
	2017	2030	2050	2070	2090	2120
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore reserve	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Toilets	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Firth St Pumping Station	-	-	Rare	Unlikely	Possible	Likely
Rose Gardens Beachside Holiday Park	Unlikely	Possible	Likely	Almost certain	Almost certain	Almost certain
Properties on Cunningham St	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain
Navigation Beacon	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain

Table 15. MU5 Oyster Harbour Beach likelihood of assets being impacted by erosion

Asset	Likelihood of Erosion					
	2017	2030	2050	2070	2090	2120
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore reserve	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Emu Point Café	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain
Properties on Roe Parade	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain
Toilets	-	Rare	Unlikely	Possible	Likely	Almost certain

Table 16. Likelihood of assets being impacted by inundation

Asset	Likelihood of Inundation					
	2017	2030	2050	2070	2090	2120
MU1 Ellen Cove						
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore Reserve	-	Rare	Unlikely	Possible	Likely	Almost certain
Toilets	-	-	Rare	Unlikely	Possible	Likely
Three Anchors	-	-	Rare	Unlikely	Possible	Likely
Developable land A	-	-	Rare	Unlikely	Possible	Likely
Albany Surf Life Saving Club	-	-	-	Rare	Unlikely	Possible
MU2 Surfers & Golf Course						
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore reserve	-	-	-	Rare	Unlikely	Possible
Car park (SLSC)	-	-	-	Rare	Unlikely	Possible
Flinders Parade	-	-	-	Rare	Unlikely	Possible
MU3 Emu Point Beach						
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore reserve	-	-	-	Rare	Unlikely	Possible
MU4 Emu Point						
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore reserve	-	-	Rare	Unlikely	Possible	Likely
Navigation Beacon	-	-	-	Rare	Unlikely	Possible
MU5 Oyster Harbour Beach						
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore reserve	-	Rare	Unlikely	Possible	Likely	Almost certain
Toilets	-	Rare	Unlikely	Possible	Likely	Almost certain

4.2 Consequence of erosion & inundation

The consequence is defined as the outcome of an event or change in circumstances affecting the achievement of objectives (DLG 2013). Within the context of a vulnerability assessment it is used to consider the sensitivity of an asset to coastal hazards.

The consequences can be both immediate, with outcomes during a storm event, or knock-on with impacts only being realised into the future. In this context it is useful to understand if the consequence will be short-lived and how easily the impacts are reversible, verses persistent long-term impacts.

In order to consider a broad range of consequences, the impacts of erosion and inundation have been evaluated for each asset using the consequence scale shown in Table 17. The consequence scale has been specifically tailored for application to coastal planning. It is originally based on the scales presented in the CHRMAP guidelines, AS 5334, and DLG (2013). However, it has been adapted for the study area to be consistent with the City's Enterprise Risk Management Framework (CoA 2014); to take into consideration the objectives of the City's Local Planning Strategy (2017) and incorporate the results of the community values consultation undertaken by Green Skills in 2013.

The key community values identified through Green Skills (2013) and incorporated into the scale include:

- **social values** – the area is highly valued for a wide range of family-based recreational activities with suitability for children of all ages.
- **natural values** – scenic and naturalness of the environment and ecosystem rated strongly through the study area and highest for Dog Beach [Golf Course].
- **economic values** – personal and commercial economic values at Emu Point and Middleton Beach were relatively high in comparison to other beaches studies in Western Australia. This reflects the relatively high value placed on the close proximity to cafes and other built assets.

Where possible the consequence categories and wording has been developed to mirror the City's Enterprise Risk Management Framework (CoA 2014) to provide broader consistency across the City. However, some modifications have been required to incorporate the broader coastal values and to tailor the scale to focus on the impacts to coastal assets. The consequence scale is shown in Table 17 and includes the consideration of the impacts in the following categories:

- **people health & safety** – *note this is consistent with the category of people health & safety in CoA 2014.*
- **social and cultural** – *note this incorporates the categories of community and business interruption described in CoA 2014, but is expanded to also take into consideration recreational activities, employment, wellbeing, culture or heritage.*
- **property and finance economic and financial** – *note this combines the two categories of property and finance described in CoA 2014, but with increased financial thresholds.*

- **natural environment** – *note this has been modified from the category of environment as described in CoA 2014 to focus on the loss of flora, fauna or landform and scenic, naturalness. In order to capture this strong element of community values identified by Green Skills.*

(Note the categories of legal compliance, organisation's operation, reputation identified in CoA 2014 have not been included as they do not primarily relate to the impact of coastal assets.)

The consequences of erosion will vary over time as the extent of erosion progressively increases. For this reason the consequences of each asset have been assessed for when the asset is:

- **partially impacted** – less than 50% of the asset is impacted;
- **fully impacted** – more than 50% of the asset is impacted.

This is most relevant to assets such as foreshore reserves and caravan parks, which can still be utilised after being impacted by erosion. In the case of individual buildings, such as toilets, once impacted by erosion will require immediate removal/reconstruction and are only considered as being fully impacted.

The consequence of inundation has only been assessed for those assets impacted by inundation. Although the short-term consequences of inundation can be severe, the inundation is often temporary and overall can often result in a low consequence to many assets. Due to the level of inundation identified, in identifying the consequences it has been assumed that the inundation of each asset impacted will only be temporary.

The following Tables 18 to 22 identify the consequence of assets being partially and fully exposed to erosion and fully exposed to inundation.

Table 17. Consequence Scale (adapted from CHRMAP guidelines, AS 5334, DLG 2013, CoA 2014)

Rating	People Health & Safety	Social & Cultural	Property & Financial	Natural Environment
Insignificant	No injuries	Minimal or no loss/damage/interruption to services, recreational activities, employment, wellbeing, culture or heritage. Little or no disruption to the community. Less than 5% of community affected. Many alternative sites or facilities exist.	Inconsequential or no damage to infrastructure, property, or equipment. Less than $10,000 or 2% of annual operating budget.	Negligible to no loss of flora, fauna or landform. Scenic, naturalness of the environment unchanged.
Minor	One or more minor injuries such as first aid treatments.	Short-term, temporary loss/damage/interruption to services, recreational activities, employment, wellbeing, culture or heritage. Minor disruption to the nearby community. 5 - 10% of community affected. Alternative sites or facilities exist.	Localised damage rectified by internal arrangements. Loss or damage to infrastructure, property, or equipment of $10,000 - $100,000 or 2 - 5% of annual operating budget.	Short-term loss of flora, fauna or landform (strong recovery) with local impact. Localised or minor impact on the scenic, naturalness of the environment.
Moderate	One or more injuries, not severe, such as medical treatments.	Medium-term, temporary loss/damage/interruption to services, recreational activities, employment, wellbeing, culture or heritage. Significant disruption to the nearby community. 10 - 25% of community affected. Regional impact, limited alternative sites or facilities exist.	Localised damage rectified by internal and external arrangements. Permanent loss or damage to infrastructure, property, or equipment of $100,000 - $2 million or 5 - 10% of annual operating budget.	Medium-term loss of flora, fauna or landform (recovery likely) with regional impact. Moderate loss of scenic, naturalness of the environment.
Major	One or more severe injuries such as temporary or permanent disabilities	Long-term, prolonged loss/damage/interruption to services, recreational activities, employment, wellbeing, culture or heritage. Substantial disruption to widespread community. 25 - 50% of community affected. Regional impact, very limited alternative sites or facilities exist.	Significant damage requiring external resources. Permanent loss or damage to infrastructure, property, or equipment of $2 - $5 million or 10 - 20% of annual operating budget.	Long-term loss of flora, fauna or landform (limited chance of recovery) with regional impact. Widespread or major loss of scenic, naturalness of the environment.
Severe	One or more fatalities or multiple severe injuries.	Permanent, prolonged loss/damage/interruption, recreational activities, employment, wellbeing, culture or heritage. Major/multiple disruption to widespread community. More than 50% of community affected. National impact, no suitable alternative sites or facilities exist.	Extensive damage resulting in a prolonged period of recovery. Permanent loss or damage to infrastructure, property, or equipment of more than $5 million or 20% of annual operating budget.	Permanent loss of flora, fauna or landform (no chance of recovery) with national impact. Total loss of scenic, naturalness of the environment.

Table 18. MU1 Ellen Cove consequence of assets being impacted by erosion and inundation

Asset	Consequence of Erosion Partial Impact (<50% of asset impacted)				Consequence of Erosion Full Impact (>50% of asset impacted)				Consequence of Inundation			
	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.
Beach	Insig.	Major	Insig.	Insig.	N/A	N/A	N/A	N/A	Insig.	Insig.	Insig.	Insig.
Foreshore Reserve	Insig.	Major	Major	Moderate	Insig.	Severe	Major	Moderat	Moderate	Minor	Insig.	Insig.
Toilets	Any impact considered full				Insig.	Moderate	Moderate	Insig.	Insig.	Insig.	Minor	Minor
Three Anchors	Any impact considered full				Insig.	Severe	Major	Insig.	Minor	Minor	Moderate	Insig.
Marine Dr/Adelaide Cr	Insig.	Major	Major	Insig.	Insig.	Severe	Severe	Insig.	Moderate	Major	Minor	Insig.
Developable land A	Insig.	Major	Major	Insig.	Insig.	Major	Major	Insig.	Insig.	Insig.	Insig.	Insig.
Developable land B	Insig.	Major	Major	Insig.	Insig.	Major	Major	Insig.	N/A	N/A	N/A	N/A
Albany Surf Life Saving Club	Any impact considered full				Insig.	Severe	Major	Insig.	Minor	Minor	Moderate	Insig.

Table 19. MU2 Surfers & Golf Course consequence of assets being impacted by erosion and inundation

Asset	Consequence of Erosion Partial Impact (<50% of asset impacted)				Consequence of Erosion Full Impact (>50% of asset impacted)				Consequence of Inundation			
	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.
Beach	Insig.	Moderate	Insig.	Insig.	N/A	N/A	N/A	N/A	Insig.	Insig.	Insig.	Insig.
Foreshore reserve	Insig.	Moderate	Insig.	Moderate	Insig.	Major	Insig.	Major	Moderate	Minor	Insig.	Insig.
Car park (SLSC)	Insig.	Moderate	Moderate	Insig.	Insig.	Major	Major	Insig.	Insig.	Minor	Moderate	Insig.
Flinders Parade	Any impact considered full				Insig.	Severe	Major	Insig.	Major	Moderate	Minor	Insig.
Properties between Barrett St to Middleton Rd	Insig.	Severe	Severe	Insig.	Insig.	Severe	Severe	Insig.	N/A	N/A	N/A	N/A
Properties between north of Middleton Rd	Insig.	Severe	Severe	Insig.	Insig.	Severe	Severe	Insig.	N/A	N/A	N/A	N/A

Asset	Consequence of Erosion Partial Impact (<50% of asset impacted)				Consequence of Erosion Full Impact (>50% of asset impacted)				Consequence of Inundation			
	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.
BIG4 Middleton Beach Holiday Park	Insig.	Minor	Moderate	Insig.	Insig.	Moderate	Major	Insig.	Major	Minor	Moderate	Insig.
Car park (Surfers)	Any impact considered full				Insig.	Moderate	Minor	Insig.	N/A	N/A	N/A	N/A
Toilets (Surfers)	Any impact considered full				Insig.	Minor	Moderate	Insig.	N/A	N/A	N/A	N/A
Golf Course	N/A	Minor	Minor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 20. MU3 Emu Point Beach consequence of assets being impacted by erosion and inundation

Asset	Consequence of Erosion Partial Impact (<50% of asset impacted)				Consequence of Erosion Full Impact (>50% of asset impacted)				Consequence of Inundation			
	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.
Beach	Insig.	Moderate	Insig.	Insig.	N/A	N/A	N/A	N/A	Insig.	Insig.	Insig.	Insig.
Foreshore reserve	Insig.	Moderate	Insig.	Moderate	Insig.	Major	Insig.	Major	Insig.	Minor	Insig.	Insig.
Properties on Barry Ct	Insig.	Severe	Major	Insig.	Insig.	Severe	Severe	Insig.	N/A	N/A	N/A	N/A
Properties on Griffith St	Insig.	Severe	Major	Insig.	Insig.	Severe	Severe	Insig.	N/A	N/A	N/A	N/A
Developable land	Insig.	Minor	Minor	Insig.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Emu Beach Holiday Park	Insig.	Minor	Moderate	Insig.	Insig.	Moderate	Major	Insig.	N/A	N/A	N/A	N/A

Table 21. MU4 Emu Point consequence of assets being impacted by erosion and inundation

Asset	Consequence of Erosion Partial Impact (<50% of asset impacted)				Consequence of Erosion Full Impact (>50% of asset impacted)				Consequence of Inundation			
	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.
Beach	Insig.	Moderate	Insig.	Insig.	Insig.	Moderate	Insig.	Insig.	Insig.	Insig.	Insig.	Insig.
Foreshore reserve	Insig.	Moderate	Insig.	Insig.	Insig.	Moderate	Insig.	Insig.	Insig.	Minor	Insig.	Insig.
Toilets	Any impact considered full				Insig.	Minor	Moderate	Insig.	N/A	N/A	N/A	N/A
Firth St Pumping Station	Any impact considered full				Insig.	Insig.	Major	Insig.	N/A	N/A	N/A	N/A
Rose Gardens Beachside Holiday Park	Insig.	Minor	Moderate	Insig.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Properties on Cunningham St	Insig.	Major	Moderate	Insig.	Insig.	Severe	Severe	Insig.	N/A	N/A	N/A	N/A
Navigation Beacon	N/A	N/A	Minor	N/A	N/A	N/A	Moderate	N/A	N/A	N/A	Minor	N/A

Table 22. MU5 Oyster Harbour Beach consequence of assets being impacted by erosion and inundation

Asset	Consequence of Erosion Partial Impact (<50% of asset impacted)				Consequence of Erosion Full Impact (>50% of asset impacted)				Consequence of Inundation			
	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.	People Health & Safety	Social & Cultural	Property & Financial	Natural Enviro.
Beach	Insig.	Moderate	Insig.	Insig.	N/A	N/A	N/A	N/A	Insig.	Insig.	Insig.	Insig.
Foreshore reserve	Insig.	Major	Major	Insig.	Insig.	Major	Major	Insig.	Moderate	Minor	Insig.	Insig.
Emu Point Café	Any impact considered full				Insig.	Major	Moderate	Insig.	N/A	N/A	N/A	N/A
Properties on Roe Pde	Insig.	Severe	Severe	Insig.	Insig.	Severe	Severe	Insig.	N/A	N/A	N/A	N/A
Toilets	Any impact considered full				Insig.	Minor	Moderate	Insig.	N/A	N/A	N/A	N/A

4.3 Risk of erosion & inundation

The likelihood and consequence of each hazard can be combined to identify the risk rating of each asset. The combining of likelihood and consequence is undertaken using the risk rating matrix shown in Table 23. The matrix has been taken from CoA (2014) and is similar to examples provided in the CHRMAP guidelines, AS 5334, and HB 203: 2006. Typically the higher the risk level the more controls that are required to reduce the risk to an acceptable or tolerable level. Note the risk rating identified for each asset is the unmitigated risk level as it does not take into consideration the existing control(s) which may already be in place (refer to Section 1.2).

The risk rating for each individual asset is provided in the following section (Tables 28 to 37, Section 5). The risk rating is also included in Appendix D where it can be read alongside the associated likelihood and consequence ratings.

Table 23. Risk rating matrix (after CoA 2014)

	Consequence Rating				
Likelihood Rating	Severe	Major	Moderate	Minor	Insig.
Almost Certain	Extreme	Extreme	High	High	Medium
Likely	Extreme	High	High	Medium	Low
Possible	High	High	Medium	Medium	Low
Unlikely	High	Medium	Medium	Low	Low
Rare	Medium	Low	Low	Low	Low

Table 24. Risk tolerance scale (adapted from CHRMAP guidelines and CoA 2014)

Risk Level	**Action Required**	**Acceptance**
Extreme	Immediate action required to eliminate or reduce risk to acceptable levels.	Unacceptable
High	Immediate to short term action required to eliminate or reduce risk to acceptable levels.	Urgent action is required
Medium	Short to medium term action to reduce risk to acceptable levels, or accept risk.	Monitor
Low	No action required.	Acceptable

5 Vulnerability Analysis

This section provides details of the vulnerability analysis of individual assets, which is the process of evaluating the influence each asset's adaptive capacity has on its relative risk impact from coastal hazards.

5.1 Adaptive Capacity

An asset's adaptive capacity defines its ability to accommodate the potential impacts of coastal hazards with minimum disruption or additional cost (OEH 2011).

The adaptive capacity of each asset has been evaluated using the scale shown in Table 25. The adaptive capacity scale has been adapted from the CHRMAP Guidelines and AS 5334 to increase its relevance to coastal assets within the project area. The scale takes into consideration the design and function or form of the assets. The adaptive capacity of each asset to accommodate the impacts of erosion and inundation have been considered independently. The variation in adaptive capacity overtime was also evaluated for assets within the study area. However, the variation in adaptive capacity over time was found to be negligible due to the rate at which hazards progressively impact assets. It was found that assets with a higher adaptive capacity were still able to maintain a high level of adaptive capacity at later timeframes.

The adaptive capacity of each asset is presented along side the vulnerability rating in Tables 28 to 37.

Assets with the highest adaptive capacity were found to be natural assets, and those with larger footprints – beaches, foreshore reserves, developable land, caravan parks, car parks. Assets with lower adaptive capacity were found to be predominantly buildings, roads and utilities which have a fixed foot print, with little room to move.

Table 25. Adaptive capacity scale (adapted from CHRMAP Guidelines and AS 5334)

Rating	Adaptive Capacity
Very High	Impact of coastal hazard will cause minimal or no reduction in asset's function or performance.
High	Impact of coastal hazard will cause short-term or localized reduction in asset's function or performance. Minor modifications may be required but could be undertaken as part of routine maintenance. Early renewal of infrastructure by 10–20%.
Moderate	Impact of coastal hazard will cause medium-term or moderate reduction in asset's function or performance. Minor modifications will be required. Early renewal of infrastructure by 20–50%.
Low	Impact of coastal hazard will cause long-term or significant reduction in asset's function or performance. Major modifications will be required. Early renewal of infrastructure by 50–90%.
Very Low	Impact of coastal hazard will cause complete loss of asset's function or performance. Asset will require redesign, rebuilding and/or relocating. Early renewal of infrastructure by more than 90%.

5.2 Asset Vulnerability

Vulnerability rating defines the degree to which an asset is susceptible to, and unable to cope with, adverse effects of coastal hazards. The vulnerability rating for each asset has been determined by combining the risk rating (to account for the potential impacts of the coastal hazards - refer to Section 4) and the adaptive capacity rating. This has been done using the vulnerability matrix shown in Table 26. Note the vulnerability rating describes the unmitigated vulnerability of each asset (refer to Section 1.2). The vulnerability rating to erosion for each asset is presented in Tables 28 to 37.

The vulnerability rating and tolerance scale (described in Table 27) provides an early indication of the susceptibility of assets to the impacts of coastal hazards. A low vulnerability level indicates the asset is likely to be able to accommodate the impacts of coastal hazards with minimal or no additional management. Whereas at the other end of the scale assets identified as extremely vulnerable will need to be prioritised for additional analysis as they will require significant adaptation. Discussion on the findings of this assessment are contained in the following Section 6.

Assets with a high or extreme vulnerability rating are less able to cope with the impacts of coastal hazards without additional support. They should be considered a higher priority for future assessment through the subsequent stages of the CHRMAP process. Conversely assets with a low vulnerability rating have a greater ability to adapt to the impacts of coastal hazards and will require less, or no, additional support. These assets are considered to be highly resilient and although they may require ongoing monitoring, can be considered a lower priority for additional assessment.

Table 26. Vulnerability Matrix (adapted from CHRMAP guidelines)

	Adaptive Capacity Rating				
Risk Rating	Very Low	Low	Moderate	High	Very High
Extreme	Extreme	Extreme	Extreme	High	Medium
High	Extreme	Extreme	High	Medium	Low
Medium	Extreme	High	Medium	Low	Low
Low	High	Medium	Low	Low	Low

Table 27. Vulnerability Tolerance Scale (adapted from CHRMAP guidelines and CoA 2012)

Vulnerability Level	Prioritisation	Acceptance
Extreme	Asset has minimal ability to cope with the impacts of coastal hazards without additional support. Adaptation will need to be considered as a priority. Establishment and implementation of controls is likely to be required.	Unacceptable
High	Asset has limited ability to cope with the impacts of coastal hazards. Immediate to short-term adaptation is likely to be required to reduce risk to acceptable levels. Establishment and implementation of controls is likely to be required.	Urgent action is required
Medium	Asset has some ability to cope with the impacts of coastal hazards. However short to medium term actions are likely to be required to reduce risk to acceptable levels. Observing, assessing and improving current controls and procedures is likely to be required.	Monitor
Low	Asset has high resilience, it is able to cope with the impacts of coastal hazards without additional support. No immediate action required. Likely to be adequately managed by routine procedures.	Acceptable

Table 28. MU1 Ellen Cove asset erosion risk and vulnerability

Asset	Erosion Risk						Adaptive Capacity to Erosion	Erosion Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	High	High	Extreme	Extreme	Extreme	Extreme	High	Medium	Medium	High	High	High	High
Foreshore Reserve	High	High	Extreme	Extreme	Extreme	Extreme	Moderate	High	High	Extreme	Extreme	Extreme	Extreme
Toilets	Medium	Medium	High	High	High	High	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Three Anchors	Medium	High	High	Extreme	Extreme	Extreme	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Marine Dr/Adelaide Cr	-	Low	Medium	High	High	Extreme	High	-	Low	Low	Medium	Medium	High
Developable land A	-	-	Low	Medium	High	High	Very High	-	-	Low	Low	Low	Low
Developable land B	-	-	-	Low	Medium	High	Very High	-	-	-	Low	Low	Low
Albany Surf Life Saving Club	High	Extreme	Extreme	Extreme	Extreme	Extreme	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme

Table 29. MU2 Surfers & Golf Course asset erosion risk and vulnerability

Asset	Erosion Risk						Adaptive Capacity to Erosion	Erosion Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Medium	High	High	High	High	High	High	Low	Medium	Medium	Medium	Medium	Medium
Foreshore reserve	Medium	High	High	High	Extreme	Extreme	Moderate	Medium	High	High	High	Extreme	Extreme
Car park (SLSC)	Medium	Medium	High	High	Extreme	Extreme	High	Low	Low	Medium	Medium	High	High
Properties between Barrett St to Middleton Rd	-	-	-	Medium	High	High	Very Low	-	-	-	Extreme	Extreme	Extreme

Asset	Erosion Risk						Adaptive Capacity to Erosion	Erosion Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Properties between north of Middleton Road	-	-	-	Medium	High	High	Very Low	-	-	-	Extreme	Extreme	Extreme
BIG4 Middleton Beach Holiday Park	Low	Medium	Medium	High	Extreme	Extreme	Moderate	Low	Medium	Medium	High	Extreme	Extreme
Flinders Parade (north)	-	-	-	Medium	High	High	Low	-	-	-	High	Extreme	Extreme
Car park (Surfers)	-	-	-	Low	Medium	Medium	High	-	-	-	Low	Low	Low
Toilets (Surfers)	-	-	Low	Medium	Medium	High	Very Low	-	-	High	Extreme	Extreme	Extreme
Golf Course	-	-	-	Low	Low	Low	Very High	-	-	-	Low	Low	Low

Table 30. MU3 Emu Point Beach asset erosion risk and vulnerability

Asset	Erosion Risk						Adaptive Capacity to Erosion	Erosion Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Medium	High	High	High	High	High	High	Low	Medium	Medium	Medium	Medium	Medium
Foreshore reserve	Medium	High	High	High	Extreme	Extreme	Moderate	Medium	High	High	High	Extreme	Extreme
Properties on Barry Court	-	-	Medium	High	High	Extreme	Very Low	-	-	Extreme	Extreme	Extreme	Extreme
Properties on Griffith Street	-	Medium	High	High	Extreme	Extreme	Very Low	-	Extreme	Extreme	Extreme	Extreme	Extreme
Developable land	Low	Low	Low	Low	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
Emu Beach Holiday Park	Low	Medium	Medium	High	Extreme	Extreme	High	Low	Low	Low	Medium	High	High

Table 31. MU4 Emu Point asset erosion risk and vulnerability

Asset	Erosion Risk						Adaptive Capacity to Erosion	Erosion Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Medium	High	High	High	High	High	Moderate	Medium	High	High	High	High	High
Foreshore reserve	Medium	High	High	High	High	High	Low	High	Extreme	Extreme	Extreme	Extreme	Extreme
Toilets	Medium	High	High	High	High	High	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Firth St Pumping Station	-	-	Low	Medium	High	High	Very Low	-	-	High	Extreme	Extreme	Extreme
Rose Gardens Beachside Holiday Park	Medium	Medium	High	High	High	High	High	-	Low	Medium	Medium	Medium	Medium
Properties on Cunningham St	Low	Medium	High	Extreme	Extreme	Extreme	Very Low	High	Extreme	Extreme	Extreme	Extreme	Extreme
Navigation Beacon	Medium	High	High	High	High	High	Moderate	Medium	High	High	High	High	High

Table 32. MU5 Oyster Harbour Beach asset erosion risk and vulnerability

Asset	Erosion Risk						Adaptive Capacity to Erosion	Erosion Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Medium	High	High	High	High	High	High	Low	Medium	Medium	Medium	Medium	Medium
Foreshore reserve	High	High	Extreme	Extreme	Extreme	Extreme	Moderate	High	High	Extreme	Extreme	Extreme	Extreme
Emu Point Café	Low	Medium	High	Extreme	Extreme	Extreme	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Properties on Roe Parade	Medium	High	High	Extreme	Extreme	Extreme	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Toilets (near boat pens)	-	Low	Medium	Medium	High	High	Very Low	-	High	Extreme	Extreme	Extreme	Extreme

Table 33. MU1 Ellen Cove asset inundation risk and vulnerability

Asset	Risk of Inundation						Adaptive Capacity to Inundation	Inundation Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Low	Low	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
Foreshore Reserve	-	Low	Medium	Medium	High	High	Very High	-	Low	Low	Low	Low	Low
Toilets	-	-	Low	Low	Medium	Medium	Low	-	-	Medium	Medium	High	High
Three Anchors	-	-	Low	Medium	Medium	High	Low	-	-	Medium	High	High	Extreme
Developable land A	-	-	Low	Low	Low	Low	Very High	-	-	Low	Low	Low	Low
Albany Surf Life Saving Club	-	-	-	Low	Medium	Medium	Low	-	-	-	Medium	High	High

Table 34 MU2 Surfers & Golf Course asset inundation risk and vulnerability

Asset	Risk of Inundation						Adaptive Capacity to Inundation	Inundation Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Medium	Medium	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
Foreshore reserve	-	-	-	Low	Medium	Medium	Very High	-	-	-	Low	Low	Low
Car park (SLSC)	-	-	-	Low	Medium	Medium	High	-	-	-	Low	Low	Low
Flinders Parade	-	-	-	Low	Medium	High	High	-	-	-	Low	Low	Medium

Table 35. MU3 Emu Point Beach asset inundation risk and vulnerability

Asset	Risk of Inundation						Adaptive Capacity to Inundation	Inundation Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Medium	Medium	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
Foreshore reserve	-	-	-	Low	Low	Medium	Very High	-	-	-	Low	Low	Low

Table 36. MU4 Emu Point asset inundation risk and vulnerability

Asset	Risk of Inundation						Adaptive Capacity to Inundation	Inundation Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Medium	Medium	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
Foreshore reserve	-	-	Low	Low	Medium	Medium	Very High	-	-	Low	Low	Low	Low
Navigation Beacon	-	-	-	Low	Low	Medium	High	-	-	-	Low	Low	Low

Table 37. MU5 Oyster Harbour Beach asset inundation risk and vulnerability

Asset	Risk of Inundation						Adaptive Capacity to Inundation	Inundation Vulnerability					
	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
Beach	Medium	Medium	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
Foreshore reserve	-	Low	Medium	Medium	High	High	Very High	-	Low	Low	Low	Low	Low
Toilets (near boat pens)	-	Low	Low	Medium	Medium	High	Low	-	Medium	Medium	High	High	Extreme

6 Summary of findings

This section provides a summary of the asset's vulnerability and provides recommended short (0-20 years), medium (20-50 years) and long-term (50-100 years) adaptation priorities.

6.1 Vulnerability to erosion

The vulnerability of assets to erosion is summarised for each of the management units:

MU1 Ellen Cove

A summary of the vulnerable assets within the Ellen Cove management unit is as follows:

- The Three Anchors Café, Toilets, and Surf Lifesaving Club were all found to be **extremely vulnerable** now. Mainly due to their immediate exposure to erosion and low adaptive capacity.
- The beach and foreshore were found to have a medium/high vulnerability in the short-term with the foreshore reserve increasing to extreme in the longer term (2090 onwards).
- Marine Dr/Adelaide Cr were only found to become medium/high vulnerable in the longer term (2070 onwards).
- The developable land was found to have a low vulnerability due to its high adaptive capacity.

As a priority, short-term (0-20 years) adaptation planning and implementation is required to address the immediate vulnerability of the Three Anchors Café, Toilets, Surf Lifesaving Club, beach and foreshore reserve. Adaptation planning should consider the vulnerability of these assets as a whole.

MU2 Surfers & Golf Course

A summary of vulnerable assets within the Surfers & Golf course management unit is as follows:

- The beach, foreshore reserve and BIG4 Middleton Beach Holiday Park were found to have the highest short-term vulnerability medium/high by 2030.
- Flinders Parade and the properties north of Barrett St were found to be **extremely vulnerable** only in the longer-term (2070 onwards).
- The car park at SLSC was found to have a medium/high vulnerability only in the medium to long term (2050 onwards) due to it's high adaptive capacity.
- The toilet block at surfers were found to have high/**extreme vulnerability** in the medium term (2050 onwards) due to its very low adaptive capacity
- The golf course although of high significance due to its heritage listing was found to have a low vulnerability due to low exposure to erosion and very high adaptive capacity.

Short-term (0-20 years) adaptation planning and implementation is required to address the vulnerability of the beach, foreshore reserve and BIG4 Middleton Beach Holiday Park. Medium to long-term (20-100 years) adaptation planning is required to address the

vulnerability of Flinders Parade, properties north of Barrett St, and the toilet at Surfers Beach.

MU3 Emu Point Beach

A summary of vulnerable assets within the Emu Point Beach management unit is as follows:

- The properties on Griffith Street and Barry Court are not immediately vulnerable. However, become **extremely vulnerable** by 2030 (Griffith St) and 2050 (Barry Ct). The sudden increase in vulnerability is due to their very low adaptive capacity.
- The beach and foreshore reserve were found to have a medium/high vulnerability in the short-term increasing in the long-term (by 2090) to **extreme** for the foreshore reserve due to their high value.
- The Emu Beach Holiday Park was not found to be vulnerable in the short-term, and only increasing to medium/high in the longer-term due to its high adaptive capacity.
- The developable land was not found to be vulnerable due to its very high adaptive capacity.

As a priority, short-term (0-20 years) adaptation planning and implementation is required to address the vulnerability of the properties on Griffith Street and Barry Court. Medium to long-term (20-100 years) adaptation planning is required to address the vulnerability of the beach, foreshore reserve, and Emu Beach Holiday Park.

MU4 Emu Point

A summary of vulnerable assets within the Emu Point Beach management unit is as follows:

- The properties on Cunningham Street were found to have a high vulnerability now increasing to be **extremely vulnerable** by 2030 due to their very low adaptive capacity.
- The beach and foreshore reserve were found to have a medium/high vulnerability now increasing to high for the beach and **extreme** for the foreshore reserve by 2030. The extreme vulnerability of the foreshore at this location is due to it low adaptive capacity being only a relatively thin strip.
- The toilets were found to be **extremely vulnerable** now due to their close proximity to the shoreline and very low adaptive capacity.
- The Firth St pumping station is not immediately vulnerable. However, becomes highly vulnerable by 2050 and **extremely vulnerable** by 2070. The sudden increase in vulnerability is due to its very low adaptive capacity.
- The Rose Gardens Beachside Holiday Park was found to have a low vulnerability in the short-term, increasing to medium by 2050. The relatively low vulnerability is due to its high adaptive capacity.
- The navigation beacon was found to have a medium vulnerability now increasing to high by 2030.

As a priority, short-term (0-20 years) adaptation planning and implementation is required to address the vulnerability of the foreshore reserve, toilets, properties on Cunningham St and the navigation beacon. Medium to long-term (20-100 years) adaptation planning is required to address the vulnerability of the beach, Firth St Pumping Station and Rose Gardens Beachside Holiday Park.

MU5 Oyster Harbour

A summary of vulnerable assets within the Oyster Harbour Beach management unit is as follows:

- The Emu Point Café and Properties on Roe Parade were found to be **extremely vulnerable** now due to their very low adaptive capacity.
- The foreshore reserve was found to have a high vulnerability now increasing to **extreme** in the medium-term (by 2050) due to it low adaptive capacity and being only a relatively thin strip.
- The toilets near the boat pens were found to have a high vulnerability now increasing to **extreme** in the medium-term (by 2050) due their very low adaptive capacity.
- The beach was found to have a low vulnerability now. However this increases to medium in the short-term (by 2030) due to its high exposure and sensitivity.

As a priority, short-term (0-20 years) adaptation planning and implementation is required to address the vulnerability of the foreshore reserve, Emu Point Café and properties on Roe Parade. Medium-term (20-50 years) adaptation planning is required to address the vulnerability of the beach and toilets.

6.2Vulnerability to inundation

Only a relatively small number of assets were identified as being impacted by inundation over the project timeframes. A summary of the vulnerability of assets to inundation across the study area is as follows:

- All beaches are at immediate vulnerable to inundation and foreshore reserves progressively over the project timeframes. However, these assets have a very high adaptive capacity to temporary inundation and so have been identified as having a low vulnerability to inundation at all timeframes.
- At Ellen Cove the Three Anchors, adjacent toilets and Surf Lifesaving Club are not immediately vulnerable to inundation. However, they become highly vulnerable by 2070 to 2090 and in the case of the Three Anchors **extremely** vulnerably by 2120.
- Flinders Parade is not immediately vulnerable to inundation and only has a medium vulnerable by 2120.
- At Oyster Harbour the toilets near the boat pens start to become vulnerable to inundation by 2030 and increase in vulnerability to be **extremely vulnerably** by 2120.

Medium-term (20-50 years) adaptation planning is required to address the vulnerability of the Three Anchors, toilets and Surf Life Saving Club at Ellen Cove and toilets near the boat pens at Oyster Harbour Beach.

6.3 Next steps

It is expected that the outcomes of the vulnerability assessment will assist the City in the prioritisation of future analysis in the subsequent stages of the CHRMAP process. The next steps of the CHRMAP as detailed in Figure 2, are expected to be:

- confirmation that the consequence rating reflects the current community and stakeholder values. This may require further stakeholder and community engagement focused on the assets identified to have the highest vulnerability.
- identification and evaluation of existing controls, in particular the existing coastal protection structures at Emu Point.
- determining tolerable risk levels for each of the assets identified as vulnerable.
- identification and evaluation of adaptation options.
- develop short and long-term implementation plans, with a priority focus on assets identified at being immediately vulnerable.

7 References

AS 5334-2013 **Climate change adaptation for settlements and infrastructure - A risk based approach**. Prepared by Standards Australia

CHRMAP Guidelines (2014) **Guidelines and the Coastal Hazard Risk Management and Adaptation Planning Guidelines**. Prepared by the Government of Western Australia Western Australian Planning Commission. September 2014.

CoA (2010) **Albany Local Planning Scheme**. Prepared by the City of Albany. Final Version – Feb 2017

CoA (2010) **Albany Local Planning Strategy**. Prepared by the City of Albany. Final Version - Aug 2010

CoA (2014) Enterprise Risk Management Framework. Prepared by the City of Albany. Version 017, 30/7/2014

DLG (2013) **Risk Management Resources**. Prepared by Government of Western Australia Department of Local Government. March 2013

Green Skills (2013) **Emu Point to Middleton Beach Coastal Adaptation & Protection Strategy - Study of Coastal Values and Character Emu Point to Middleton Beach**. Prepared by Green Skills Inc. September 2013

HB 203:2006 **Environmental risk management – Principles and process**. Prepared by Standards Australia.

McCarthy, J.J. et al. eds., 2001. **Climate Change 2001: Impacts, Adaptation, and Vulnerability – Contribution of Working Group II to the third Assessment Report of the Intergovernmental Panel on Climate Change**. Cambridge University Press, Cambridge, UK.

MP Rogers and Associates (2015) **Middleton Beach Activity Centre Coastal Hazard Risk Management and Adaptation Plan**

MP Rogers and Associates (2016) **Middleton Beach Activity Centre - Coastal Management Strategy**

OEH (2001) **Guide to Climate Change Risk Assessment for NSW Local Government**. Prepared by the Government of New South Wales Office of Environment and Heritage. December 2011

RHDHV (2017) **Emu Point to Middleton Beach Coastal Adaptation and Protection Strategy - Coastal Vulnerability Study and Hazard Mapping - Part 1 – Coastal Processes and Hazard Mapping.** DRAFT Report for City of Albany (Reference M&APA1558R001D001 Dated 28-4-2017)

SPP2.6 (2013) **State Planning Policy No. 2.6 State Coastal Planning Policy**. Prepared by the Government of Western Australia Western Australian Planning Commission. July 2013.

Appendix A: Methodology

City of Albany

Emu Point to Middleton Beach Coastal Adaptation & Protection Strategy

Coastal Vulnerability Study Methodology

EvoCoast Pty Ltd

EVO-AL-01-R-01

Client: City of Albany

Document Title: Emu Point to Middleton Beach Coastal Adaptation & Protection Strategy – Coastal Vulnerability Study - Methodology

Document Number: EVO-AL-01-R-01
Revision: 0

Revision Description: Final methodology incorporating DoP review

Issued: 15 May 2017

Author: Charlie Bicknell

Reviewer: Karl Ilich

Approver: Charlie Bicknell

Contents

Tables

Figures

1 Introduction

EvoCoast Pty Ltd has been commissioned by the City of Albany (the City) to undertake a coastal vulnerability study as part of the Emu Point to Middleton Beach Coastal Adaptation & Protection Strategy. The vulnerability study will build on the coastal hazard assessment currently being undertaken by Royal HaskoningDHV (RHDHV). The study area extends from Ellen Cove (Middleton Beach) to the Emu Point Boat Pens (refer to Figure 1).

Figure 1. Study Area

This methodology has been prepared to meet the requirements of the RFQ Task 3 Coastal Vulnerability Assessment (refer to Appendix A) taking into account and being consistent with the requirements of State Planning Policy No. 2.6 State Coastal Planning Policy (SPP 2.6), the SPP 2.6 Guidelines and the Coastal Hazard Risk Management & Adaptation Planning Guidelines (CHRMAP).

The objectives of this vulnerability assessment are to:

- List assets at risk from coastal hazards at each project timeframe;
- Assess the potential impacts to assets at each project timeframe; and
- Assess the adaptive capacity of assets at each project timeframe.

The vulnerability assessment will build on a risk analysis to consider each asset's exposure, sensitivity, potential impacts and adaptive capacity in relation to the coastal hazards of erosion and inundation. The vulnerability of each asset will be analysed separately for erosion and inundation over the 100 year planning timeframe and at the following intervals 2017, 2030, 2050, 2070 and 2120.

The study will be broken into the following three parts:

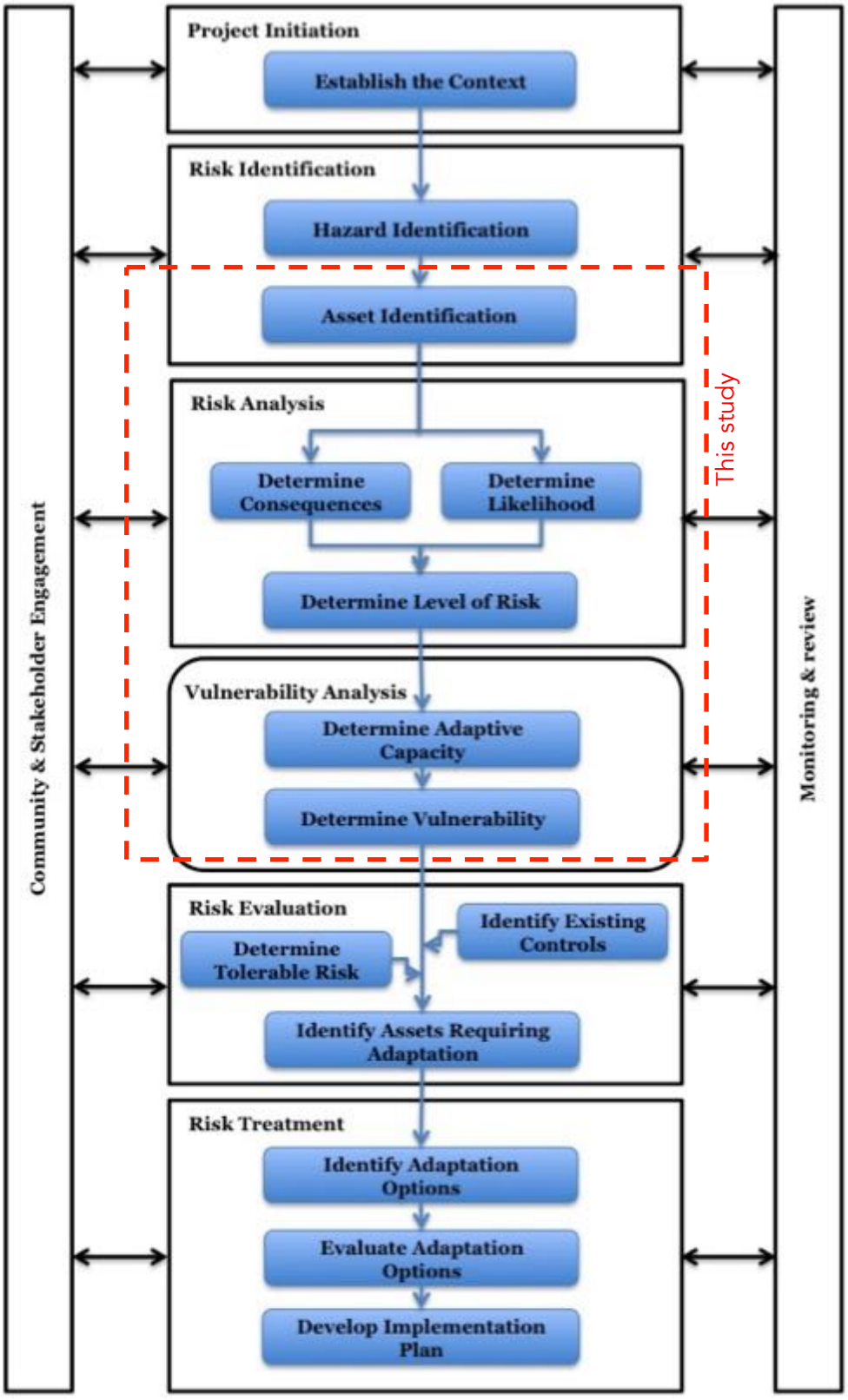
- asset identification

- risk analysis
- vulnerability analysis

It is intended that the outcomes of this vulnerability assessment will form part of the initial stages of the City's Coastal Hazard Risk Management & Adaptation Plan (CHRMAP), the next stage being a detailed risk assessment taking into consideration existing controls and risk tolerances. Figure 2 provides an overview of the CHRMAP process and identifies how the components of this study fit into the larger framework.

Figure 2. Overview of the CHRMAP Process

(Dotted line denotes stages undertaken as part of this study)



2 Methodology

2.1 Risk Identification

2.1.1 Hazard Identification

The predicted extent of coastal erosion and inundation is currently being investigated by RHDHV with hazard maps being prepared for each of the project timeframes. This information will be used as the basis for determining the likelihood of each asset being impacted.

2.1.2 Asset Identification

Assets will be identified based on review of the GIS datasets held by the City, aerial photography and a site inspection completed in March 2017. To date the following assets datasets have been identified and will be used in this study:

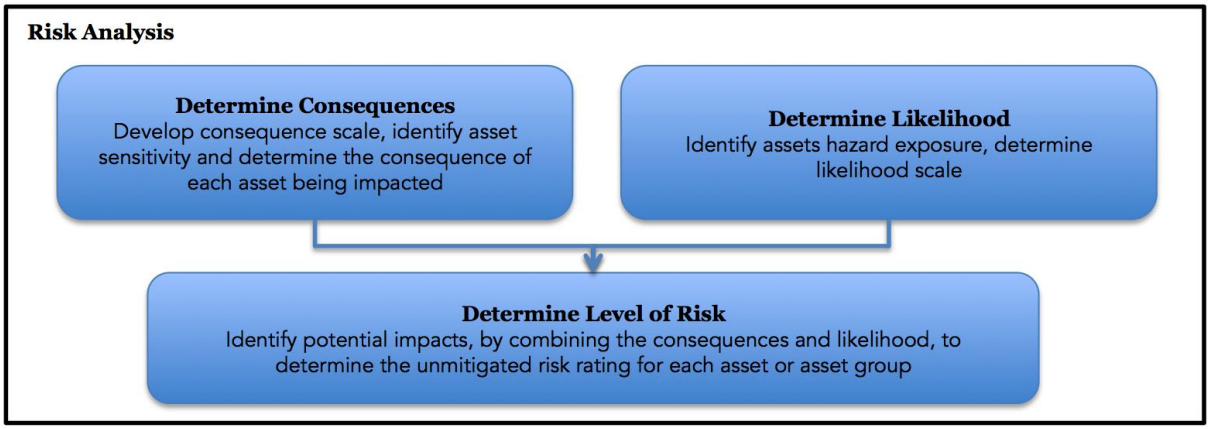
- local planning scheme (LPS) zoning and City lease areas;
- public utilities – Western Power, Water Corporation assets, City utilities;
- public assets – parks, playgrounds, toilets etc.;
- transport networks – roads, car parks, dual use paths.

Where appropriate, in consultation with the City, assets with common values will be grouped for simplicity. For example, where a park is made up of a number of smaller individual assets (bbq, lighting, playground, benches etc.) it may be grouped to be listed as a single asset.

2.2 Risk Analysis

The risk analysis component of the risk assessment will comprise evaluating the level of risk in terms of its likelihood and consequence, then combining these elements to obtain a risk rating (Figure 3). At this stage of the CHRMAP process the risk assessment will not take into consideration existing controls and so the outcome will be an unmitigated risk rating for each asset.

Figure 3. Risk Analysis



2.2.1 Likelihood of Erosion & Inundation

Likelihood is the term used to describe the chance of something happening (AS 5334-2013). For this project the likelihood of the erosion and inundation impacting assets within the coastal zone will be considered at each of the project timeframes (2017, 2030, 2050, 2070 and 2120). The extent of erosion and inundation at each of these timeframes is being mapped by RHDHV using the methodology of SPP 2.6. We will apply this hazard mapping to identify the likelihood of assets being impacted.

In order to take into account the uncertainty associated with hazard mapping and to consider a range of likelihood scenarios we propose to apply the hazard mapping using the likelihood hazard matrix shown in Table 1. RHDHV will prepare hazard maps for each timeframe. The hazard mapping by RHDHV will be assumed as the 'possible' extent of erosion and inundation at the given timeframe. Hazard mapping for the earlier project timeframes is allocated as 'almost certain' or 'likely' and mapping for the later project timeframes as 'unlikely' or 'rare'.

The likelihood rating is shown in Table 2. The use of a likelihood matrix accounts for the uncertainty that more extreme events may occur. It also reflects the likelihood that events found to be extreme today are likely to become more common place in the future as a result of climate change.

Table 1. Likelihood Hazard Matrix

(Adapted from the CHRMAP Guidelines)

Likelihood Rating	Present Day (2017)	2030	2050	2070	2090	2120
Almost Certain	-	-	2017	2030	2050	2070
Likely	-	2017	2030	2050	2070	2090
Possible	2017	2030	2050	2070	2090	2120
Unlikely	2030	2050	2070	2090	2120	-
Rare	2050	2070	2090	2120	-	-

Within Table 1 the column headings show which timeframe is being considered; the row headers show which likelihood rating is allocated for each project timeframe; the cells show which timeframe's hazard map has been used to identify assets impacted.

Table 2. Likelihood Rating

(Adapted from DLG 2013)

Likelihood Rating	Descriptor
Almost Certain	Expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possible	Should occur at some time*
Unlikely	Could occur but not expected
Rare	May occur, only in exceptional circumstances

**Note the 'possible' likelihood rating will be assumed as the hazard defined by the application of SPP 2.6 at the given timeframe as calculated by RHDHV.*

2.2.2 Consequence of Erosion and Inundation

The consequence is the outcome of an event or change in circumstances affecting the achievement of objectives (DLG 2013). The consequences can be both immediate, with outcomes during a storm event, or knock-on with impacts only being realised into the future. In this context it is useful to understand if the consequence will be short-lived and how easily the impacts are reversible, verses persistent long-term impacts. Although consequences of coastal hazards are generally negative it is important to identify positive consequences where they occur.

In order to consider a broad range of consequences, the impacts of erosion and inundation will be evaluated for each asset using the consequence scale shown in Table 3. This includes the consideration of the impacts on:

- public safety;
- social and cultural;
- economic and financial;
- natural environment.

The proposed consequence scale is originally based on the scales presented in the CHRMAP guidelines, AS 5334, and DLG (2013). However, it has been adapted for the study area to take into consideration the objectives of the City's Local Planning Strategy, and the results of the community values consultation undertaken by Green Skills in 2013 which included:

- social values – the area is highly valued for a wide range of family-based recreational activities with suitability for children of all ages.
- natural values – scenic and naturalness of the environment and ecosystem rated strongly through the study area and highest for Dog Beach.
- economic values – personal and commercial economic values at Emu Point and Middleton Beach were relatively high in comparison to other beaches studies in Western Australia. This reflects the relatively high value placed on the close proximity to cafes and other built assets.

The values identified by Green Skills (2013) were found to be fairly consistent across the study area. Consultation with the City internal steering group following the draft assessment

will confirm that the community values previously captured are still an appropriate reflection for each asset. Where they are found to have changed the consequence scale will be updated for individual assets or groups of assets.

Table 3. Consequence Scale

(adapted from CHRMAP guidelines, AS 5334, and DLG 2013)

Rating	Public Safety	Social & Cultural	Economic & Financial	Natural Environment
Insignificant	No injuries	Minimal or no loss or damage to services, recreational activities, employment, wellbeing, culture or heritage. Less than 5% of community affected. Many alternative sites or facilities exist.	Permanent loss or damage to infrastructure, property, or equipment of less than $10,000 or 2% of annual operating budget.	Negligible to no loss of flora, fauna or landform. Scenic, naturalness of the environment unchanged.
Minor	One or more minor injuries such as first aid treatments.	Short-term or localised loss or damage to services, recreational activities, employment, wellbeing, culture or heritage. 5 - 10% of community affected. Alternative sites or facilities exist.	Permanent loss or damage to infrastructure, property, or equipment of less than $10,000 - $100,000 or 2 - 5% of annual operating budget.	Short-term loss of flora, fauna or landform (strong recovery) with local impact. Localised or minor impact on the scenic, naturalness of the environment.
Moderate	One or more injuries, not severe, such as medical treatments.	Medium-term loss or damage to services, recreational activities, employment, wellbeing, culture or heritage. 10 - 25% of community affected. Regional impact, limited alternative sites or facilities exist.	Permanent loss or damage to infrastructure, property, or equipment of less than $100,000 - $2 million or 5 - 10% of annual operating budget.	Medium-term loss of flora, fauna or landform (recovery likely) with regional impact. Moderate loss of scenic, naturalness of the environment.
Major	One or more severe injuries such as temporary or permanent disabilities	Long-term loss or damage to services, recreational activities, employment, wellbeing, culture or heritage. 25 - 50% of community affected. Regional impact, very limited alternative sites or facilities exist.	Permanent loss or damage to infrastructure, property, or equipment of less than $2 - $5 million or 10 - 20% of annual operating budget.	Long-term loss of flora, fauna or landform (limited chance of recovery) with regional impact. Widespread or major loss of scenic, naturalness of the environment.
Severe	One or more fatalities or multiple severe injuries.	Permanent loss of services, recreational activities, employment, wellbeing, culture or heritage. More than 50% of community affected. National impact, no suitable alternative sites or facilities exist.	Permanent loss or damage to infrastructure, property, or equipment of more than $5 million or 20% of annual operating budget.	Permanent loss of flora, fauna or landform (no chance of recovery) with national impact. Total loss of scenic, naturalness of the environment.

2.2.3 Determining the Level of Risk

The likelihood and consequence of erosion and inundation at each timeframe will be combined to identify the risk rating of each asset. This will be undertaken using the risk rating matrix shown in Table 4. The matrix has been adapted from examples provided in the CHRMAP guidelines, AS 5334, and HB 203: 2006. In doing so we will apply the risk tolerance scale shown in Table 5, taken from the CHRMAP Guidelines. Typically the higher the risk level the more controls that are required to reduce the risk to an acceptable or tolerable level.

The risk rating identified for each asset will be an unmitigated risk level as it will not take into consideration the existing control(s) which may already be in place. It is expected that the subsequent stages of the CHRMAP process will review the reduction in risk by existing controls and evaluate in detail the City's tolerable risk levels in order to evaluate adaptation options.

Table 4. Risk Rating Matrix

(adapted from CHRMAP guidelines, AS 5334, and HB 203: 2006)

	Consequence Rating				
Likelihood Rating	Severe	Major	Moderate	Minor	Insignificant
Almost Certain	Extreme	Extreme	High	Medium	Low
Likely	Extreme	High	Medium	Medium	Low
Possible	Extreme	High	Medium	Low	Low
Unlikely	High	Medium	Medium	Low	Low
Rare	Medium	Medium	Low	Low	Low

Table 5. Risk Tolerance Scale

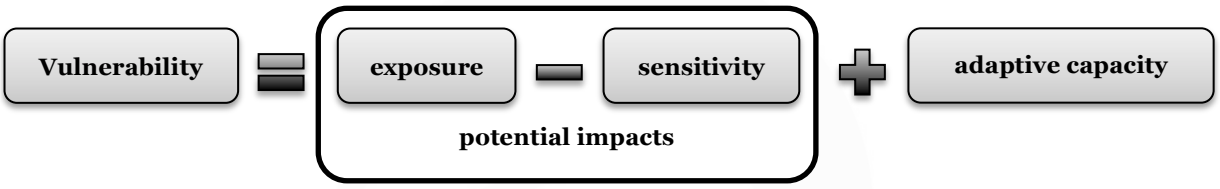
(adapted from CHRMAP guidelines)

Risk Level	**Action Required**	**Acceptance/tolerance**
Extreme	Immediate action required to eliminate or reduce risk to acceptable levels.	Unacceptable/Intolerable
High	Immediate to short-term action required to eliminate or reduce risk to acceptable levels.	Tolerable
Medium	Short to medium term action to reduce risk to acceptable levels, or accept risk.	Tolerable/Acceptable
Low	No action required.	Acceptable

2.3 Vulnerability Analysis

Vulnerability is the degree to which an asset is susceptible to, and unable to cope with, adverse effects of coastal hazards. Vulnerability is defined as a function of the asset's exposure to coastal hazards, its sensitivity and its adaptive capacity (McCarthy 2001).

Figure 4. Vulnerability
(after McCarthy 2001)



Assessment of the asset's exposure and sensitivity (potential impacts) is comparable to the risk analysis process of considering likelihood and consequence, discussed in the previous Section 2.2:

- **Exposure** refers to the degree to which an asset is exposed to coastal hazards (McCarthy 2001). For the purpose of this assessment the exposure is represented by the likelihood step of the risk assessment process.
- **Sensitivity** refers to the degree to which an asset is affected, either adversely or beneficially, by coastal hazards (McCarthy 2001). For the purpose of this assessment the sensitivity is represented by the consequence step of the risk assessment process.

The vulnerability of each asset will be analysed separately for erosion and inundation over the 100 year planning at the timeframes 2017, 2030, 2050, 2070 and 2120.

2.3.1 Determining the adaptive capacity

An asset's adaptive capacity defines its ability to accommodate the potential impacts of coastal hazards with minimum disruption or additional cost (OEH 2011). We will apply the adaptive capacity scale shown in Table 6, to each of the coastal assets, at each of the timeframes. The adaptive capacity scale has been adapted from CHRMAP Guidelines and AS 5334 to increase its relevance to coastal assets within the project area. The scale takes into consideration the design and function or form of the assets. Similar to the risk analysis (refer to Section 2.2) it will not consider the mitigating impact of existing controls.

Table 6. Adaptive Capacity Scale

(adapted from CHRMAP Guidelines and AS 5334)

Rating	Adaptive Capacity
Very High	Impact of coastal hazard will cause minimal or no reduction in asset's function or performance.
High	Impact of coastal hazard will cause short-term or localized reduction in asset's function or performance. Minor modifications may be required but could be undertaken as part of routine maintenance. Early renewal of infrastructure by 10–20%.
Moderate	Impact of coastal hazard will cause medium-term or moderate reduction in asset's function or performance. Minor modifications will be required. Early renewal of infrastructure by 20–50%.
Low	Impact of coastal hazard will cause long-term or significant reduction in asset's function or performance. Major modifications will be required. Early renewal of infrastructure by 50–90%.
Very Low	Impact of coastal hazard will cause complete loss of asset's function or performance. Asset will require redesign, rebuilding and/or relocating. Early renewal of infrastructure by more than 90%.

2.3.2 Determining the vulnerability rating

The vulnerability rating for each asset will be determined by combining the risk rating (refer to Section 2.2) to account for the potential impacts of the coastal hazards; and the adaptive capacity rating. This will be done using the vulnerability matrix shown in
Table 7. As both the risk analysis and adaptive capacity analysis will not consider existing controls the vulnerability rating will describe the unmitigated vulnerability of each asset.

It is expected that the outcomes of the vulnerability assessment will assist the City in the prioritisation of future analysis in the subsequent stages of the CHRMAP process. Assets with a high vulnerability rating are less able to cope with the impacts of coastal hazards without additional support. They should be considered a higher priority for future assessment through the subsequent stages of the CHRMAP process. Conversely assets with a low vulnerability rating have a greater ability to adapt to the impacts of coastal hazards and will require less, or no, additional support. These assets are considered to be highly resilient and although they may require ongoing monitoring, can be considered a lower priority for additional assessment. The asset tolerance scale is shown in Table 8.

The vulnerability rating assessment will be undertaken independently for erosion and inundation hazards for each of the project timeframes 2017, 2030, 2050, 2070 and 2120. In doing so trigger timeframes will be identified when asset vulnerability significantly increases.

Table 7. Vulnerability Matrix

(adapted from CHRMAP guidelines)

	Adaptive Capacity Rating				
Risk Rating	Very Low	Low	Moderate	High	Very High
Extreme	Extreme	Extreme	Extreme	High	Medium
High	Extreme	Extreme	High	Medium	Low
Medium	Extreme	High	Medium	Low	Low
Low	High	Medium	Low	Low	Low

Table 8. Vulnerability Tolerance Scale
(adapted from CHRMAP guidelines)

Vulnerability Level	Prioritisation	Acceptance/tolerance
Extreme	Asset has minimal ability to cope with the impacts of coastal hazards without additional support. Adaptation will need to be considered as a priority.	Unacceptable/Intolerable
High	Asset has limited ability to cope with the impacts of coastal hazards. Immediate to short-term adaptation is likely to be required to reduce risk to acceptable levels.	Tolerable
Medium	Asset has some ability to cope with the impacts of coastal hazards. However short to medium term actions are likely to be required to reduce risk to acceptable levels.	Tolerable/Acceptable
Low	Asset has high resilience, it is able to cope with the impacts of coastal hazards without additional support. No immediate action required.	Acceptable

3 References

- CoA (2010) **Albany Local Planning Strategy**. Prepared by the City of Albany. Final Version - August 2010
-
- AS 5334-2013 **Climate change adaptation for settlements and infrastructure - A risk based approach**. Prepared by Standards Australia.

- HB 203:2006 **Environmental risk management – Principles and process**. Prepared by Standards Australia.

- McCarthy, J.J. et al. eds., 2001. **Climate Change 2001: Impacts, Adaptation, and Vulnerability – Contribution of Working Group II to the third Assessment Report of the Intergovernmental Panel on Climate Change**. Cambridge University Press, Cambridge, UK.

- SPP2.6 (2013) **State Planning Policy No. 2.6 State Coastal Planning Policy**. Prepared by the Government of Western Australia Western Australian Planning Commission. July 2013.

- CHRMAP Guidelines (2014) **Guidelines and the Coastal Hazard Risk Management and Adaptation Planning Guidelines**. Prepared by the Government of Western Australia Western Australian Planning Commission. September 2014.

- DLG (2013) **Risk Management Resources**. Prepared by Government of Western Australia Department of Local Government. March 2013

- Green Skills (2013) **Emu Point to Middleton Beach Coastal Adaptation & Protection Strategy - Study of Coastal Values and Character Emu Point to Middleton Beach**. Prepared by Green Skills Inc. September 2013.

- OEH (2001) **Guide to Climate Change Risk Assessment for NSW Local Government**. Prepared by the Government of New South Wales Office of Environment and Heritage. December 2011

Appendix B: Hazard Mapping (RHDHV 2017)

Appendix C: Assets

M/Unit: MU1 Ellen Cove

Asset: **Beach**

LPS Zoning: Parks & recreation

Description: Recreational area, includes volleyball courts, jetty, shark barrier, swimming pontoon

M/Unit: MU1 Ellen Cove

Asset: **Foreshore reserve**

LPS Zoning: Parks & Recreation SU25 Special use area (Public Open Space)

Description: Park area south from SLSC to jetty. Incorporates area of public open space identified in TPSZ SU25. Includes – grassed areas, retic, playground, amphitheatre, lighting, utilities water, outdoor showers, bbqs, mature trees, shared pathway, stormwater drainage, portion of Flinders Pd.

M/Unit: MU1 Ellen Cove

Asset: **Toilets**

LPS Zoning: Parks & Recreation

Description: Public toilets

M/Unit: MU1 Ellen Cove

Asset: **Three Anchors Café**

LPS Zoning: Parks & Recreation

Description: Café/restaurant

M/Unit: MU1 Ellen Cove

Asset: Marine Drive/Adelaide Crescent

LPS Zoning: Priority road

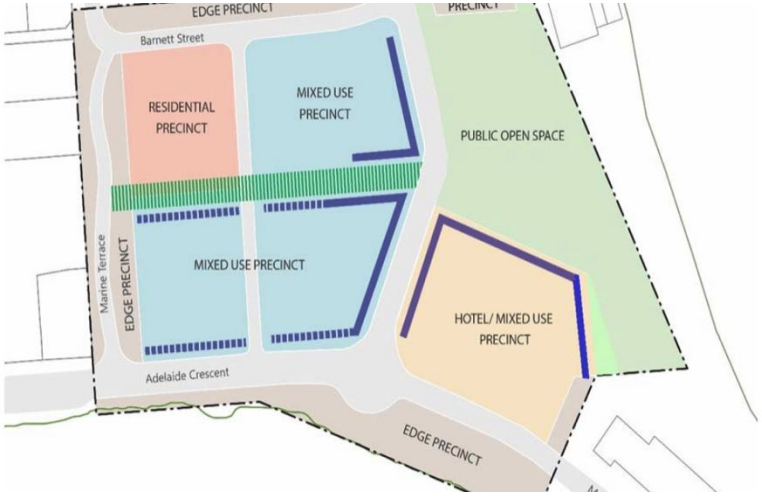
Description: Road - includes street lighting, adjacent car park

M/Unit: MU1 Ellen Cove

Asset: Developable land **A & B**

LPS Zoning: SU25 Special use area (Hotel / Mixed Use Precinct)

Description: Proposed development site



M/Unit: MU1 Ellen Cove

Asset: Albany Surf Life Saving Club

LPS Zoning: Parks & Recreation

Description: Surf life saving club

M/Unit: MU2 Surfers & Golf Course

Asset: **Beach**

LPS Zoning: Parks & recreation

Description: Beach

M/Unit: MU2 Surfers & Golf Course

Asset: **Foreshore reserve**

LPS Zoning: Parks & recreation

Description: Park area north of SLSC and established dunes. Includes: grassed area, established tress, lighting, water, bbq, park furniture, dual use path, established dunes, access paths, viewing decks.

M/Unit: MU2 Surfers & Golf Course

Asset: **Car park (SLSC)**

LPS Zoning: Parks & recreation

Description: Large car park adjacent to SLSC

M/Unit: MU2 Surfers & Golf Course

Asset: **Flinders Parade**

LPS Zoning: Local road, parks & recreation

Description: Barnett St northwards. Includes street lighting, power and water utilities.

M/Unit: MU2 Surfers & Golf Course

Asset: Properties between Barrett St to Middleton Rd & North of Middleton Road

LPS Zoning: R60/R80 Tourist residential

Description: Mixture of residential and tourist properties

M/Unit: MU2 Surfers & Golf Course

Asset: BIG4 Middleton Beach Holiday Park

LPS Zoning: Caravan and camping

Description: Caravan park with chalets

M/Unit: MU2 Surfers & Golf Course

Asset: **Car park & Toilets**

LPS Zoning: Parks & recreation

Description: Car park and toilets at Surfers

M/Unit: MU2 Surfers & Golf Course

Asset: **Golf Course**

LPS Zoning: Parks & recreation

Description: Heritage listed golf course

M/Unit: MU3 Emu Point Beach

Asset: **Beach & Foreshore reserve**

LPS Zoning: Parks & recreation

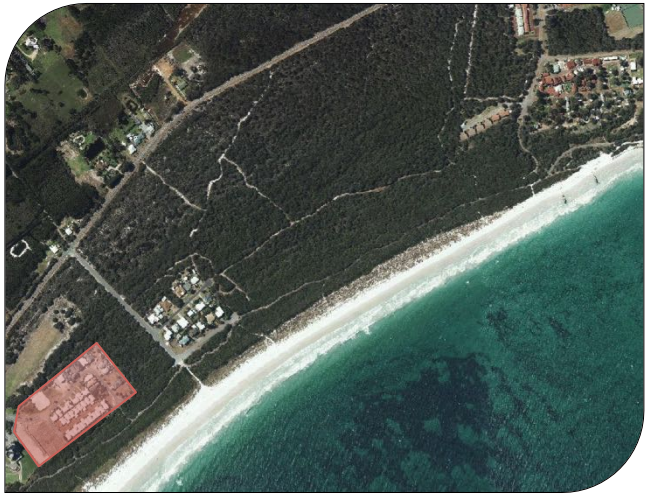
Description: Beach & established dunes and bush, includes dual use path

M/Unit: MU3 Emu Point Beach

Asset: **Properties on Barry Court**

LPS Zoning: R30/R50 Tourist residential, Hotel/motel

Description: Mixture of residential and tourist developed land and undeveloped lots. Includes local roads and utilities within the road reserve.

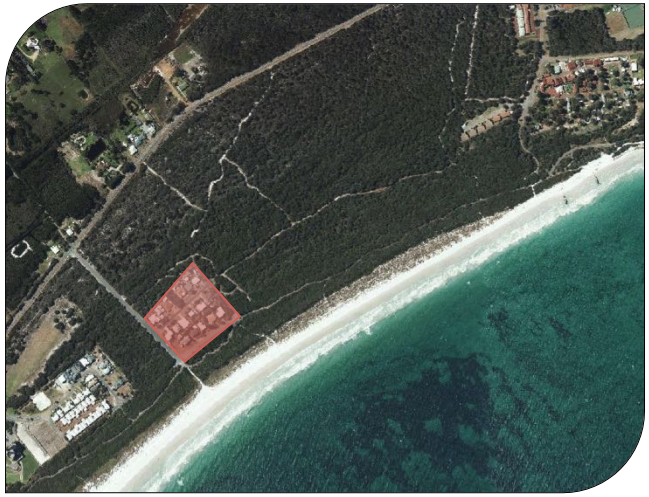


M/Unit: MU3 Emu Point Beach

Asset: **Properties on Griffith Street**

LPS Zoning: R17.5 Residential

Description: Residential buildings. Includes local roads and utilities within the road reserve.



M/Unit: MU3 Emu Point Beach

Asset: **Emu Beach Holiday Park**

LPS Zoning: Tourist residential

Description: Caravan park with chalets

M/Unit: MU4 Emu Point

Asset: **Beach & Foreshore**

LPS Zoning: Parks & recreation

Description: Artificial beach formed by the detached breakwater & foreshore reserve which includes grassed area, shared path playground, parking, Boongarrie St. local utilities (power and water)

M/Unit: MU4 Emu Point

Asset: **Toilets**

LPS Zoning: Parks & recreation

Description: Toilets behind revetment seawall

M/Unit: MU4 Emu Point

Asset: **Firth St Pumping Station**

LPS Zoning: Parks & recreation

Description: Sewage pumping station

M/Unit: MU4 Emu Point

Asset: **Rose Gardens Beachside Holiday Park**

LPS Zoning: Tourist residential

Description: Caravan park with chalets

M/Unit: MU4 Emu Point

Asset: **Navigation Beacon**

LPS Zoning: Port industry

Description: Navigation mark, major light

M/Unit: MU4 Emu Point

Asset: **Properties on Cunningham St**

LPS Zoning: R20 Residential, Local road

Description: Residential buildings and portion of Cunningham St, Boongarrie St, Burgess St, includes local roads and utilities within the road reserve.

M/Unit: MU5 Oyster Harbour

Asset: **Beach**

LPS Zoning: Parks & recreation

Description: Beach, includes swimming area

M/Unit: MU5 Oyster Harbour

Asset: **Foreshore reserve**

LPS Zoning: Parks & recreation

Description: Includes grassed area, playground, lighting, water, include turn around and parking at the end of the Cunningham St., swimming jetties, navigation aids.

M/Unit: MU5 Oyster Harbour

Asset: **Emu Point Cafe**

LPS Zoning: SU14 Restaurant, convenience Store, Parks & recreation

Description: Café including toilets

M/Unit: MU5 Oyster Harbour

Asset: **Properties on Roe Parade**

LPS Zoning: R20 Residential, Local road

Description: Residential buildings and portion of Roe Parade, Mermaid Ave, Hunter St, Bedwell St. Includes utilities within the road reserve (power, water , sewage).

M/Unit: MU5 Oyster Harbour

Asset: **Toilets**

LPS Zoning: Parks & recreation

Description: Toilets at the end of Bendwell St

Appendix D: Tables

#	Management Unit	Asset	Local Planning Scheme Zoning	Description	Potential Extent of Erosion						Likelihood of Erosion						Consequence of Erosion Partial Impact (<50% of asset impacted)				Consequence of Erosion Full Impact (>50% of asset impacted)				Consequence of Erosion						Erosion Risk						Adaptive Capacity to Erosion	Erosion Vulnerability					
					2017	2030	2050	2070	2090	2120	2017	2030	2050	2070	2090	2120	People Health & Safety	Social & Cultural	Property & Financial	Natural Environment	People Health & Safety	Social & Cultural	Property & Financial	Natural Environment	2017	2030	2050	2070	2090	2120	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
1	Ellen Cove	Beach	Parks & recreation	Sand area - includes volleyball courts	Partial loss	Partial loss	Partial loss	Partial loss	Partial loss	Partial loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Major	Insignificant	Insignificant	N/A	N/A	N/A	N/A	Major	Major	Major	Major	Major	Major	High	High	Extreme	Extreme	Extreme	Extreme	High	Medium	Medium	High	High	High	High
1	Ellen Cove	Foreshore Reserve	Parks & Recreation SU25 Special use area (Public Open Space)	Park area south from SLSC to jetty. Incorporates area of public open space identified in TPSZ SU25. Includes – grassed areas, retic, playground, amphitheatre, lighting, utilities water, showers, bbqs, mature trees, shared pathway, stormwater drainage, portion of Flinders Pd.	Partial loss	Partial loss	Partial loss	Partial loss	Full loss	Full loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Major	Major	Moderate	Insignificant	Severe	Major	Moderate	Major	Major	Major	Major	Severe	Severe	High	High	Extreme	Extreme	Extreme	Extreme	Moderate	High	High	Extreme	Extreme	Extreme	Extreme
1	Ellen Cove	Toilets	Parks & recreation	Toilet block		Partial loss - impacts on building	Partial loss ~50%	Full loss	Full loss	Full loss	Unlikely	Possible	Likely	Almost certain	Almost certain	Almost certain	N/A	N/A	N/A	N/A	Insignificant	Moderate	Moderate	Insignificant	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	Medium	High	High	High	High	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
1	Ellen Cove	Three Anchors	Parks & recreation	Café/restaurant			Partial loss ~50m	Partial loss ~135m	Partial loss ~180m	Partial loss ~250m	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain	N/A	N/A	N/A	N/A	Insignificant	Severe	Major	Insignificant	Severe	Severe	Severe	Severe	Severe	Severe	Medium	High	High	Extreme	Extreme	Extreme	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
1	Ellen Cove	Marine Dr/Adelaide Cr	Priority road	Road - includes street lighting, adjacent car park				Partial loss	Partial loss	Full loss	-	Rare	Unlikely	Possible	Likely	Almost certain	Insignificant	Major	Major	Insignificant	Insignificant	Severe	Severe	Insignificant	Major	Major	Major	Major	Major	Severe	-	Low	Medium	High	High	Extreme	High	-	Low	Low	Medium	Medium	High
1	Ellen Cove	Developable land A	SU25 Special use area (Hotel / Mixed Use Precinct)	Proposed hotel site					Partial loss	Partial loss	-	-	Rare	Unlikely	Possible	Likely	Insignificant	Major	Major	Insignificant	Insignificant	Major	Major	Insignificant	Major	Major	Major	Major	Major	Major	-	-	Low	Medium	High	High	Very High	-	-	Low	Low	Low	Low
1	Ellen Cove	Developable land B	SU25 Special use area (Mixed Use Precinct)	Proposed development site						Partial loss	-	-	-	Rare	Unlikely	Possible	Insignificant	Major	Major	Insignificant	Insignificant	Major	Major	Insignificant	Major	Major	Major	Major	Major	Major	-	-	-	Low	Medium	High	Very High	-	-	-	Low	Low	Low
1	Ellen Cove	Albany Surf Life Saving Club	Parks & recreation	Surf life saving club	Full loss	Full loss	Full loss	Full loss	Full loss	Full loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	N/A	N/A	N/A	N/A	Insignificant	Severe	Major	Insignificant	Severe	Severe	Severe	Severe	Severe	Severe	High	Extreme	Extreme	Extreme	Extreme	Extreme	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
2	Surfers & Golf Course	Beach	Parks & recreation	Beach	Full loss	Full loss	Partial loss	Partial loss	Partial loss	Partial loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Moderate	Insignificant	Insignificant	N/A	N/A	N/A	N/A	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	High	High	High	High	High	High	Low	Medium	Medium	Medium	Medium	Medium
2	Surfers & Golf Course	Foreshore reserve	Parks & recreation	Park area north of SLSC and established dunes. Includes: grassed area, established tress, lighting, water, bbq, park furniture, dual use path, established dunes, access paths, viewing decks.	Partial loss	Partial loss	Partial loss	Partial loss	Full loss	Full loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Moderate	Insignificant	Moderate	Insignificant	Major	Insignificant	Major	Moderate	Moderate	Moderate	Moderate	Major	Major	Medium	High	High	High	Extreme	Extreme	Moderate	Medium	High	High	High	Extreme	Extreme
2	Surfers & Golf Course	Car park (SLSC)	Parks & recreation	Large car park adjacent to SLSC		Partial loss ~ 9 bays	Partial loss ~52 bays	Partial loss ~103 bays	Full loss ~162 bays	Full loss	Unlikely	Possible	Likely	Almost certain	Almost certain	Almost certain	Insignificant	Moderate	Moderate	Insignificant	Insignificant	Major	Major	Insignificant	Moderate	Moderate	Moderate	Moderate	Major	Major	Medium	Medium	High	High	Extreme	Extreme	High	Low	Low	Medium	Medium	High	High
2	Surfers & Golf Course	Properties between Barrett St to Middleton Rd	R60/R80 Tourist residential	Mixture of residential and tourist properties						Full - loss of road access, water & power connection, and partial loss of lots	-	-	-	Rare	Unlikely	Possible	N/A	N/A	N/A	N/A	Insignificant	Severe	Severe	Insignificant	Severe	Severe	Severe	Severe	Severe	Severe	-	-	-	Medium	High	High	Very Low	-	-	-	Extreme	Extreme	Extreme
2	Surfers & Golf Course	Properties between north of Middleton Road	R60/R80 Tourist residential	Mixture of residential and tourist properties						Full - loss of road access, water & power connection, and partial loss of lots	-	-	-	Rare	Unlikely	Possible	N/A	N/A	N/A	N/A	Insignificant	Severe	Severe	Insignificant	Severe	Severe	Severe	Severe	Severe	Severe	-	-	-	Medium	High	High	Very Low	-	-	-	Extreme	Extreme	Extreme
2	Surfers & Golf Course	BIG4 Middleton Beach Holiday Park	Caravan and camping	Caravan park with chalets			Partial loss - buildings impacted	Partial loss - buildings impacted	Full loss	Full loss	Rare	Unlikely	Possible	Likely	Almost Certain	Almost certain	Insignificant	Minor	Moderate	Insignificant	Insignificant	Moderate	Major	Insignificant	Moderate	Moderate	Moderate	Moderate	Major	Major	Low	Medium	Medium	High	Extreme	Extreme	Moderate	Low	Medium	Medium	High	Extreme	Extreme
2	Surfers & Golf Course	Flinders Parade (north)	Local road, parks & recreation	Barnett St northwards. Includes street lighting power and water utilities.					Partial loss ~60m	Full loss	-	-	-	Rare	Unlikely	Possible	N/A	N/A	N/A	N/A	Insignificant	Severe	Major	Insignificant	Severe	Severe	Severe	Severe	Severe	Severe	-	-	-	Medium	High	High	Low	-	-	-	High	Extreme	Extreme
2	Surfers & Golf Course	Car park (Surfers)	Parks & recreation	Car park at Surfers						Full loss	-	-	-	Rare	Unlikely	Possible	N/A	N/A	N/A	N/A	Insignificant	Moderate	Minor	Insignificant	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	-	-	-	Low	Medium	Medium	High	-	-	-	Low	Low	Low
2	Surfers & Golf Course	Toilets (Surfers)	Parks & recreation	Toilets at Surfers					Full loss	Full loss	-	-	Rare	Unlikely	Possible	Likely	N/A	N/A	N/A	N/A	Insignificant	Minor	Minor	Insignificant	Minor	Minor	Minor	Minor	Minor	Minor	-	-	Low	Low	Medium	Medium	Very Low	-	-	High	Extreme	Extreme	Extreme
2	Surfers & Golf Course	Golf Course	Parks & recreation	Heritage listed golf course						Partial loss - does not impact on club building	-	-	-	Rare	Unlikely	Possible	N/A	Minor	Minor	N/A	N/A	N/A	N/A	N/A	Minor	Minor	Minor	Minor	Minor	Minor	-	-	-	Low	Low	Low	Very High	-	-	-	Low	Low	Low
3	Emu Point Beach	Beach	Parks & recreation	Beach							Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Moderate	Insignificant	Insignificant	N/A	N/A	N/A	N/A	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	High	High	High	High	High	High	Low	Medium	Medium	Medium	Medium	Medium
3	Emu Point Beach	Foreshore reserve	Parks & recreation	Established dunes and bush. Includes dual use path.							Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Moderate	Insignificant	Moderate	Insignificant	Major	Insignificant	Major	Moderate	Moderate	Moderate	Moderate	Major	Major	Medium	High	High	High	Extreme	Extreme	Moderate	Medium	High	High	High	Extreme	Extreme
3	Emu Point Beach	Properties on Barry Court	R30/R50 Tourist residential, Hotel/motel	Mixture of residential and tourist developed land and undeveloped lots. Includes local roads and utilities within the road reserve.					Partial loss ~16 lots	Partial loss ~29 lots	-	-	Rare	Unlikely	Possible	Likely	Insignificant	Severe	Major	Insignificant	Insignificant	Severe	Severe	Insignificant	Severe	Severe	Severe	Severe	Severe	Severe	-	-	Medium	High	High	Extreme	Very Low	-	-	Extreme	Extreme	Extreme	Extreme
4	Emu Point Beach	Properties on Griffith Street	R17.5 Residential	Residential buildings. Includes local roads and utilities within the road reserve.				Partial - loss of road access, power & water	Partial loss ~5 lots	Partial loss ~11 lots	-	Rare	Unlikely	Possible	Likely	Almost Certain	Insignificant	Severe	Major	Insignificant	Insignificant	Severe	Severe	Insignificant	Severe	Severe	Severe	Severe	Severe	Severe	-	Medium	High	High	Extreme	Extreme	Very Low	-	Extreme	Extreme	Extreme	Extreme	Extreme
4	Emu Point Beach	Developable land	Rural small lot holdings	Site of proposed Landcorp subdivision			Partial loss	Partial loss	Partial loss	Partial loss	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain	Insignificant	Minor	Minor	Insignificant	N/A	N/A	N/A	N/A	Minor	Minor	Minor	Minor	Minor	Minor	Low	Low	Low	Low	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
4	Emu Point Beach	Emu Beach Holiday Park	Tourist residential	Caravan park with chalets			Partial - small corner of lot	Partial loss	Full - buildings impacted	Full - buildings impacted	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain	Insignificant	Minor	Moderate	Insignificant	Insignificant	Moderate	Major	Insignificant	Moderate	Moderate	Moderate	Moderate	Major	Major	Low	Medium	Medium	High	Extreme	Extreme	High	Low	Low	Low	Medium	High	High
4	Emu Point	Beach	Parks & recreation	Artificial beach formed by the detached breakwater	Full loss	Full loss	Full loss	Full loss	Full loss	Full loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Moderate	Insignificant	Insignificant	Insignificant	Moderate	Insignificant	Insignificant	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	High	High	High	High	High	Moderate	Medium	High	High	High	High	High
4	Emu Point	Foreshore reserve	Parks & recreation	Includes grassed area, shared path playground, parking, portion of Boongarrie St, local utilities (power and water).	Partial loss	Partial loss	Full loss	Full loss	Full loss	Full loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Moderate	Insignificant	Insignificant	Insignificant	Moderate	Insignificant	Insignificant	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	High	High	High	High	High	Low	High	Extreme	Extreme	Extreme	Extreme	Extreme
4	Emu Point	Toilets	Parks & recreation	Toilets behind revetment seawall	Full loss	Full loss	Full loss	Full loss	Full loss	Full loss	Possible	Likely	Almost Certain	Almost Certain	Almost Certain	Almost Certain	N/A	N/A	N/A	N/A	Insignificant	Minor	Moderate	Insignificant	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	High	High	High	High	High	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
4	Emu Point	Firth St Pumping Station	Parks & recreation	Sewage pumping station					Full loss	Full loss	-	-	Rare	Unlikely	Possible	Likely	N/A	N/A	N/A	N/A	Insignificant	Insignificant	Major	Insignificant	Major	Major	Major	Major	Major	Major	-	-	Low	Medium	High	High	Very Low	-	-	High	Extreme	Extreme	Extreme
4	Emu Point	Rose Gardens Beachside Holiday Park	Tourist residential	Caravan park with chalets		Partial loss <50%	Partial loss <50%	Partial loss <50%	Partial loss <50%	Partial loss <50%	Unlikely	Possible	Likely	Almost Certain	Almost Certain	Almost Certain	Insignificant	Minor	Moderate	Insignificant	N/A	N/A	N/A	N/A	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	Medium	High	High	High	High	High	Low	Low	Medium	Medium	Medium	Medium
4	Emu Point	Properties on Cunningham St	R20 Residential, Local road	Residential buildings and portion of Cunningham St, Boongarrie St Burgess Street, Includes local roads and utilities within the road reserve.			Loss of access and utilities, ~110m of road	Partial loss of 5 lots, loss of buildings, access and utilities, ~230m of road	Partial loss of 13 lots, loss of buildings, access and utilities, ~420m of road	Full ~16 lots, loss of buildings, access and utilities, ~470m of road	Rare	Unlikely	Possible	Likely	Almost Certain	Almost certain	Insignificant	Major	Moderate	Insignificant	Insignificant	Severe	Severe	Insignificant	Major	Major	Major	Severe	Severe	Severe	Low	Medium	High	Extreme	Extreme	Extreme	Very Low	High	Extreme	Extreme	Extreme	Extreme	Extreme
4	Emu Point	Navigation Beacon	Port industry	Navigation mark, major light	Partial loss of lot	Full loss of beacon	Full loss of lot	Full loss of lot	Full loss of lot	Full loss of lot	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	N/A	N/A	Minor	N/A	N/A	N/A	Moderate	N/A	Minor	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	High	High	High	High	High	Moderate	Medium	High	High	High	High	High
5	Oyster Harbour Beach	Beach	Parks & recreation	Beach	Full loss	Full loss	Full loss	Full loss	Full loss	Full loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Moderate	Insignificant	Insignificant	N/A	N/A	N/A	N/A	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Medium	High	High	High	High	High	High	Low	Medium	Medium	Medium	Medium	Medium
5	Oyster Harbour Beach	Foreshore reserve	Parks & recreation	Includes grassed area, playground, lighting, water, turn around and parking at the end of the Cunningham St., swimming jetties, navigation aids.	Partial loss	Partial loss	Partial loss	Full loss	Full loss	Full loss	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain	Insignificant	Major	Major	Insignificant	Insignificant	Major	Major	Insignificant	Major	Major	Major	Major	Major	Major	High	High	Extreme	Extreme	Extreme	Extreme	Moderate	High	High	Extreme	Extreme	Extreme	Extreme
5	Oyster Harbour Beach	Emu Point Café	SU14 Restaurant, convenience Store, Parks & recreation	Café including toilets			Partial loss - building impacted	Full loss	Full loss	Full loss	Rare	Unlikely	Possible	Likely	Almost Certain	Almost certain	N/A	N/A	N/A	N/A	Insignificant	Major	Moderate	Insignificant	Major	Major	Major	Major	Major	Major	Low	Medium	High	Extreme	Extreme	Extreme	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
5	Oyster Harbour Beach	Properties on Roe Parade	R20 Residential, Local road	Residential buildings and portion of Roe Parade, Mermaid Ave, Hunter St, Bedwell St. Includes utilities within the road reserve (power, water, sewage).			Full loss, multiple lots, road ~340m	Full loss, multiple lots, road ~490m	Full loss, multiple lots, road ~600m	Full loss, multiple lots, road ~740m	Rare	Unlikely	Possible	Likely	Almost Certain	Almost certain	Insignificant	Severe	Severe	Insignificant	Insignificant	Severe	Severe	Insignificant	Severe	Severe	Severe	Severe	Severe	Severe	Medium	High	High	Extreme	Extreme	Extreme	Very Low	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
5	Oyster Harbour Beach	Toilets (near boat pens)	Parks & recreation	Toilets at the end of Bendwell St				Full loss	Full loss	Full loss	-	Rare	Unlikely	Possible	Likely	Almost Certain	N/A	N/A	N/A	N/A	Insignificant	Minor	Moderate	Insignificant	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	-	Low	Medium	Medium	High	High	Very Low	-	High	Extreme	Extreme	Extreme	Extreme

#	Management Unit	Asset	Local Planning Scheme Zoning	Description	Likelihood of Inundation						Consequence of Inundation (Temporary)				Consequence of Inundation	Risk of Inundation						Adaptive Capacity to Inundation	Inundation Vulnerability					
					2017	2030	2050	2070	2090	2120	People Health & Safety	Social & Cultural	Property & Financial	Natural Environment	2120	2017	2030	2050	2070	2090	2120		2017	2030	2050	2070	2090	2120
1	Ellen Cove	Beach	Parks & recreation	Sand area - includes volleyball courts	Possible	Likely	Almost Certain	Almost certain	Almost certain	Almost certain	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Low	Low	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
1	Ellen Cove	Foreshore Reserve	Parks & Recreation SU25 Special use area (Public Open Space)	Park area south from SLSC to jetty. Incorporates area of public open space identified in TPSZ SU25. Includes – grassed areas, retic, playground, amphitheatre, lighting, utilities water, showers,		Rare	Unlikely	Possible	Likely	Almost Certain	Moderate	Minor	Insignificant	Insignificant	Moderate	-	Low	Medium	Medium	High	High	Very High	-	Low	Low	Low	Low	Low
1	Ellen Cove	Toilets	Parks & recreation	Toilet block			Rare	Unlikely	Possible	Likely	Insignificant	Insignificant	Minor	Minor	Minor	-	-	Low	Low	Medium	Medium	Low	-	-	Medium	Medium	High	High
1	Ellen Cove	Three Anchors	Parks & recreation	Café/restaurant			Rare	Unlikely	Possible	Likely	Minor	Minor	Moderate	Insignificant	Moderate	-	-	Low	Medium	Medium	High	Low	-	-	Medium	High	High	Extreme
1	Ellen Cove	Marine Dr/Adelaide Cr	Priority road	Road - includes street lighting, adjacent car park							N/A	N/A	N/A	N/A														
1	Ellen Cove	Developable land A	SU25 Special use area (Hotel / Mixed Use Precinct)	Proposed hotel site			Rare	Unlikely	Possible	Likely	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	-	-	Low	Low	Low	Low	Very High	-	-	Low	Low	Low	Low
1	Ellen Cove	Developable land B	SU25 Special use area (Mixed Use Precinct)	Proposed development site							N/A	N/A	N/A	N/A														
1	Ellen Cove	Albany Surf Life Saving Club	Parks & recreation	Surf life saving club				Rare	Unlikely	Possible	Insignificant	Minor	Moderate	Insignificant	Moderate	-	-	-	Low	Medium	Medium	Low	-	-	-	Medium	High	High
2	Surfers & Golf Course	Beach	Parks & recreation	Beach	Possible	Likely	Almost Certain	Almost certain	Almost certain	Almost certain	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Medium	Medium	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
2	Surfers & Golf Course	Foreshore reserve	Parks & recreation	Park area north of SLSC and established dunes. Includes: grassed area, established tress, lighting, water, bbq, park furniture, dual use path, established dunes, access paths, viewing decks.				Rare	Unlikely	Possible	Moderate	Minor	Insignificant	Insignificant	Moderate	-	-	-	Low	Medium	Medium	Very High	-	-	-	Low	Low	Low
2	Surfers & Golf Course	Car park (SLSC)	Parks & recreation	Large car park adjacent to SLSC				Rare	Unlikely	Possible	Insignificant	Minor	Moderate	Insignificant	Moderate	-	-	-	Low	Medium	Medium	High	-	-	-	Low	Low	Low
2	Surfers & Golf Course	Flinders Parade	R60/R80 Tourist residential	Mixture of residential and tourist properties				Rare	Unlikely	Possible	Major	Moderate	Minor	Insignificant	Major	-	-	-	Low	Medium	High	High	-	-	-	Low	Low	Medium
2	Surfers & Golf Course	Properties between Barrett St to Middleton Rd	R60/R80 Tourist residential	Mixture of residential and tourist properties							N/A	N/A	N/A	N/A														
2	Surfers & Golf Course	Properties between north of Middleton Road	Caravan and camping	Caravan park with chalets							N/A	N/A	N/A	N/A														
2	Surfers & Golf Course	BIG4 Middleton Beach Holiday Park	Local road, parks & recreation	Barnett St northwards. Includes street lighting power and water utilities.							N/A	N/A	N/A	N/A														
2	Surfers & Golf Course	Car park (Surfers)	Parks & recreation	Car park at Surfers							N/A	N/A	N/A	N/A														
2	Surfers & Golf Course	Toilets (Surfers)	Parks & recreation	Toilets at Surfers							N/A	N/A	N/A	N/A														
2	Surfers & Golf Course	Golf Course	Parks & recreation	Heritage listed golf course							N/A	N/A	N/A	N/A														
3	Emu Point Beach	Beach	Parks & recreation	Beach	Possible	Likely	Almost Certain	Almost certain	Almost certain	Almost certain	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Medium	Medium	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
3	Emu Point Beach	Foreshore reserve	Parks & recreation	Established dunes and bush. Includes dual use path.				Rare	Unlikely	Possible	Insignificant	Minor	Insignificant	Insignificant	Minor	-	-	-	Low	Low	Medium	Very High	-	-	-	Low	Low	Low
3	Emu Point Beach	Properties on Barry Court	R30/R50 Tourist residential, Hotel/motel	Mixture of residential and tourist developed land and undeveloped lots. Includes local roads and utilities within the road reserve.							N/A	N/A	N/A	N/A														
3	Emu Point Beach	Properties on Griffith Street	R17.5 Residential	Residential buildings. Includes local roads and utilities within the road reserve.							N/A	N/A	N/A	N/A														
3	Emu Point Beach	Developable land	Rural small lot holdings	Site of proposed Landcorp subdivision							N/A	N/A	N/A	N/A														
3	Emu Point Beach	Emu Beach Holiday Park	Tourist residential	Caravan park with chalets							N/A	N/A	N/A	N/A														
4	Emu Point	Beach	Parks & recreation	Artificial beach formed by the detached breakwater	Possible	Likely	Almost Certain	Almost certain	Almost certain	Almost certain	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Medium	Medium	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
4	Emu Point	Foreshore reserve	Parks & recreation	Includes grassed area, shared path playground, parking, portion of Boongarrie St, local utilities (power and water).			Rare	Unlikely	Possible	Likely	Insignificant	Minor	Insignificant	Insignificant	Minor	-	-	Low	Low	Medium	Medium	Very High	-	-	Low	Low	Low	Low
4	Emu Point	Toilets	Parks & recreation	Toilets behind revetment seawall							N/A	N/A	N/A	N/A														
4	Emu Point	Firth St Pumping Station	Parks & recreation	Sewage pumping station							N/A	N/A	N/A	N/A														
4	Emu Point	Rose Gardens Beachside Holiday Park	Tourist residential	Caravan park with chalets							N/A	N/A	N/A	N/A														
4	Emu Point	Properties on Cunningham St	R20 Residential, Local road	Residential buildings and portion of Cunningham St, Boongarrie St Burgess Street, Includes local roads and utilities within the road reserve.							N/A	N/A	N/A	N/A														
4	Emu Point	Navigation Beacon	Port industry	Navigation mark, major light				Rare	Unlikely	Possible					Minor	-	-	-	Low	Low	Medium	High	-	-	-	Low	Low	Low
5	Oyster Harbour Beach	Beach	Parks & recreation	Beach	Possible	Likely	Almost Certain	Almost certain	Almost certain	Almost certain	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Medium	Medium	Medium	Medium	Medium	Medium	Very High	Low	Low	Low	Low	Low	Low
5	Oyster Harbour Beach	Foreshore reserve	Parks & recreation	Includes grassed area, playground, lighting, water, turn around and parking at the end of the Cunningham St., swimming jetties, navigation aids.		Rare	Unlikely	Possible	Likely	Almost Certain	Moderate	Minor	Insignificant	Insignificant	Moderate	-	Low	Medium	Medium	High	High	Very High	-	Low	Low	Low	Low	Low
5	Oyster Harbour Beach	Emu Point Café	SU14 Restaurant, convenience Store, Parks & recreation	Café including toilets							N/A	N/A	N/A	N/A														
5	Oyster Harbour Beach	Properties on Roe Parade	R20 Residential, Local road	Residential buildings and portion of Roe Parade, Mermaid Ave, Hunter St, Bedwell St. Includes utilities within the road reserve (power, water, sewage).							N/A	N/A	N/A	N/A														
5	Oyster Harbour Beach	Toilets	Parks & recreation	Toilets at the end of Bendwell St		Rare	Unlikely	Possible	Likely	Almost Certain					Minor	-	Low	Low	Medium	Medium	High	Low	-	Medium	Medium	High	High	Extreme