



Seashore Engineering



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PLANNING DESIGN ENVIRONMENT

## **Ocean Beach and Peaceful Bay Shire of Denmark**

### **Coastal Hazard Risk Management and Adaptation Plan**



**Seashore Engineering Pty Ltd  
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## Executive Summary

The Shire of Denmark commissioned Seashore Engineering to prepare a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for two coastal areas:

- Ocean Beach: An east facing high-energy beach adjacent to the mouth of the Wilson Inlet. This is the main recreational beach for the town of Denmark.
- Peaceful Bay: A settlement in the west of the Shire with a sheltered pocket beach (Peaceful Bay) and a longer eroding sandy beach to the east (Foul Bay). Facilities are used by locals, holiday makers and commercial fishers.

The CHRMAP process in this report includes:

- Identification and assessment of coastal hazards
- Establishing the context of coastal asset values and community expectations
- Risk assessment of the potential impact of coastal hazards upon coastal assets
- Adaptation planning for both short term and long term planning horizons

### *Coastal Hazards*

Coastal Hazards were evaluated using the methodology outlined in State Planning Policy 2.6, which, for sandy coasts, includes allowances for the current risk of storm erosion (S1), historic shoreline movement (S2), and future sea level rise (S3). The risk of inundation (S4) was also considered.

The highest historic rates of coastal erosion (1.4m/yr.) were identified at Foul Bay adjacent to the RSL Memorial and the Fisherman's Lease. The beach at Peaceful Bay has been relatively stable in the longer term. Ocean Beach demonstrated cycles of coastal erosion and recovery, with a net erosion trend of 0.5m/yr. The relatively high coastal dunes at Ocean Beach, upon which public infrastructure is sited, requires consideration of slope stability following storm erosion and the function of the timber retaining wall. The main consideration regarding coastal inundation is a potential increase in coastal flooding of Ocean Beach Road at Prawn Rock Channel in the longer term.

Total allowances for erosion due to coastal processes were assessed for the 10, 50 and 100-year scenarios at Ocean Beach and at both Peaceful Bay Swimming Beach and Foul Bay at Peaceful Bay. They are planning allowances for coastal hazards. They are not a prediction of the shoreline position at the end of the respective planning periods. In this CHRMAP these planning allowances have been used to assess the relative exposure of coastal assets to coastal processes (i.e. coastal erosion and inundation)



### *Community Consultation*

Community consultation included site visits with the Working Group and a wider community survey to identify values associated with each of the sites.

The community have a good understanding of the issues at Ocean Beach, including the coastal processes affecting the site. An overwhelming response is to keep the area as natural as possible and maintain existing facilities, with some minimal development suggested by some. Most respondents would like the Shire to focus on protecting safe swimming beaching and existing buildings, as well as the environment.

The results from the Peaceful Bay survey indicate that the community are aware of coastal erosion issues as they rated 'beach erosion' as the greatest threat currently and in the future. A majority would like to see the area kept as natural as possible with minimal development. The most popular facilities and uses the community would like to see in the future are pathways, swimming areas and ablution blocks.

### *Risk Assessment*

Assets within coastal nodes at both sites were identified and valued. The risk associated with assets was evaluated using a risk matrix considering the asset cost and asset exposure to coastal processes. The following assets were classified as "high risk" based on relatively high exposure to coastal processes and high economic value:

#### *Ocean Beach*

- Prawn Rock Channel 300m Length of Ocean Beach Road and Adjacent Paths.
- Ocean Beach buildings (SLSC, Boat Shed/Kiosk, Toilet Block).
- Ocean Beach Coastal Stairs and Platforms at the SLSC.

#### *Peaceful Bay*

- Peaceful Bay Finger Jetty.
- Foul Bay 750m Length of Old Peaceful Bay Road and Adjacent Paths.
- Peaceful Bay 2 x Coastal Stairs.

A "high risk" classification does not necessarily imply an immediate risk of damage or need for removal. Rather, it identifies where monitoring and adaptation plans need to be developed to ensure the long-term sustainability of these assets and the community benefit they provide.

The 10-year concept plans developed by the Shire with the Working Group for Ocean Beach and Peaceful Bay, were also evaluated. In general these concept plans provide a reasonable balance between providing amenity at the coast and ensuring exposure of assets to coastal hazards is minimised.



### *Adaptation Options*

Adaptation options for each of the high-risk assets were evaluated based on the adaptation hierarchy in the CHRMAP guidelines of Avoid, Managed Retreat, Accommodate, then Protect. The feasibility of each strategy at the various sites was evaluated using multi criteria and cost benefit analysis, which identified the strategies best suited to the identified high-risk assets. Adaptation options were also assessed for assets with lower economic value but located close to the coast with high exposure to coastal processes.

*Managed retreat* (i.e. the relocation of infrastructure that is threatened by coastal erosion) is feasible at a number of sites. In particular at Foul Bay, where the assets at threat initially are a leasehold property and the RSL Memorial that can feasibly be relocated.

*Managed retreat* is also feasible for the two SLSC buildings at Ocean Beach, however *Protection* (initially maintenance of the timber retaining wall) will be required to retain the present level of beach access and the future provision of landscaped areas and public amenities. In the longer term, coastal monitoring should inform decisions on the location and type of coastal protection required at Ocean Beach that balances beach amenity, access to the beach, public open space and amenities.

Beach access stairs and timber lookouts will require inspections and adaptation to *Accommodate* future coastal change. This may require adaptation of existing structures to better accommodate dune erosion and variable beach levels.

The long term potential for coastal erosion to threaten Old Peaceful Bay Road at Foul Bay requires a better understanding of the cause of the erosion. Coastal adaptation requires consideration of coastal hazards (erosion and inundation), emergency access and wider social and environmental values.

### *Implementation*

A 10-year program of works for Ocean Beach and Peaceful Bay has been developed to allow implementation of coastal adaptation and management strategies in the short term (10 years). Key components of this plan include beach monitoring, geotechnical inspections of cliffs, condition inspections of assets and adaptation strategies. This also allows for works to assist the implementation of the 10-year concept plan developed by the Working Group.

Strategies for the long term (100 year) planning horizon are also outlined that consider potential longer-term coastal response of Ocean Beach and Peaceful Bay to future sea level rise.



## Table of Contents

<b>1. Introduction</b> .....	<b>1</b>
1.1. Background.....	1
1.2. Coastal Management Areas.....	2
1.3. Scope of Works.....	3
<b>2. Coastal Hazard Assessment</b> .....	<b>4</b>
2.1. Coastal Geomorphology.....	5
2.2. Metocean Conditions.....	8
2.3. Ocean Beach Coastal Hazards – Coastal Processes Allowance.....	14
2.4. Peaceful Bay Coastal Hazards – Coastal Processes Allowance.....	17
2.5. Changes to Environmental Variables.....	20
<b>3. Establish the Context</b> .....	<b>21</b>
3.1. Identification of Assets.....	21
3.2. Community Consultation.....	24
<b>4. Coastal Risk Assessment</b> .....	<b>30</b>
4.1. Risk Matrix.....	30
4.2. Asset Valuation.....	30
4.3. Asset Exposure Classification.....	31
4.4. Asset Risk.....	32
4.5. Asset Sensitivity.....	32
4.6. Existing Controls (Risk Management).....	34
<b>5. Adaptation Planning</b> .....	<b>36</b>
5.1. Asset Adaptive Capacity.....	36
5.2. Assessment of Adaptation Options.....	38
5.3. Risk Management and Adaptation Strategies.....	40
5.4. Planning Considerations.....	45
5.5. Future Development.....	52
5.6. Short Term Adaptation (Assets with High Exposure to Coastal Processes).....	56
<b>6. Implementation</b> .....	<b>59</b>
6.1. Short Term (10 year) Planning Horizon.....	59
6.2. Long Term (100 year) Planning Horizon.....	62
6.3. Roles and Responsibilities.....	63
6.4. Funding.....	63
6.5. Approvals.....	64
6.6. Review and Update.....	65
<b>7. Conclusions</b> .....	<b>66</b>
<b>8. References</b> .....	<b>68</b>



**Attachment A Coastal Hazard Mapping ..... I**  
**Attachment B Risk Analysis Table ..... II**  
**Attachment C Adaptation Option Assessment ..... III**  
**Attachment D Community Consultation Feedback ..... IV**

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## List of Figures

Figure 1.1 Shire of Denmark.....	1
Figure 1.2 Ocean Beach (March 2017).....	2
Figure 1.3 Peaceful Bay (March 2016) .....	2
Figure 2.1 Representing Allowance for Erosion on Sandy Coast (incl HSD) S1 + S2 + S3 + FOS 4	
Figure 2.2 Ocean Beach Coastal Landforms.....	6
Figure 2.3 Peaceful Bay Coastal Landforms .....	7
Figure 2.4 Sediment Sample from Ocean Beach (l) Peaceful Bay (c) and Foul Bay (r) .....	7
Figure 2.5 Tide and Wave Gauge Locations near Denmark .....	8
Figure 2.6 Comparison of Wave Roses for Cape Naturaliste (left) and Albany (right) - Annual Wave Climate. ....	9
Figure 2.7 Synoptic Charts for Highest Wave Events 2 <sup>nd</sup> September 2009 (left) and 28 <sup>th</sup> May 2015 (right).....	10
Figure 2.8 Comparison of June (winter) and December (summer) Wave Roses for the Sea Component from Albany Wave Buoy .....	11
Figure 2.9 Refraction of Waves into Ocean Beach (September 2010) .....	12
Figure 2.10 Illustration of Sheltering at Peaceful Bay.....	13
Figure 2.11 Recommended Allowance for Sea Level Rise in Coastal Planning for WA .....	13
Figure 2.12 Ocean Beach During Storm (Sep 2016) – Supplied by Shire of Denmark. ....	14
Figure 2.13 Erosion Event at Ocean Beach Timber Retaining Wall Pre (SE top June 2016) During (SoD left August 2016) and Recovered (SE right March 2017) .....	15
Figure 2.14 Ocean Beach SBEACH Erosion Modelling for 100yrARI erosion event (modelling assumes retaining wall not present) .....	15
Figure 2.15 Ocean Beach – Historic Shoreline Movement Trends .....	16
Figure 2.16 Peaceful Bay (Foul Bay) – Erosion Near Fisherman’s Lease Area (SoD) .....	18
Figure 2.17 Peaceful Bay – Historic Shoreline Movement Trends.....	19
Figure 3.1 Ocean Beach Coastal Nodes.....	21
Figure 3.2 Peaceful Bay Coastal Nodes (Note: northern extent of PB_2 is the reserve boundary, not limit of coastal exposure).....	23
Figure 3.3 Community Use at Ocean Beach (upper) and Peaceful Bay (lower) .....	29
Figure 4.1 Coastal Risk Evaluation Matrix.....	30
Figure 4.2 Potential Impact based on Exposure and Sensitivity for Old Boat Shed at Ocean Beach (a), Beach Access Stair (b) and Leasehold Buildings at Foul Bay (c).....	33
Figure 5.1 Risk Management and Adaptation Hierarchy [3] .....	36
Figure 5.2 Multi-Criteria Analysis for Ocean Beach SLSC and Buildings (left) and Peaceful Bay Road (right).....	39
Figure 5.3 Timber Retaining Wall in front of the Ocean Beach SLSC Buildings (date unknown, courtesy of the Denmark SLSC) .....	46
Figure 5.4 Schematic of Fisherman’s Lease Boundary with Approximate Position of Shoreline in 2016.....	50
Figure 5.5 Ocean Beach 10 year Foreshore Concept Plan .....	52
Figure 5.6 Peaceful Bay 10 year Foreshore Concept Plan .....	53
Figure 5.7 Vehicle Access and Adjacent Turn Around Area at Ocean Beach.....	54
Figure 5.8 Weakly Lithified Sedimentary Rock Coast adjacent to Ocean Beach Lookout .....	54

Figure 5.9 Coastal Adaptation Responses including Sand Nourishment and Dune Rehabilitation ..... 56  
 Figure 5.10 Ocean Beach High Exposure Assets: ..... 57  
 Figure 5.11 Ocean Beach High Exposure Assets: ..... 58  
 Figure 6.1 10 Year Works Program for Short Term Planning Horizon (10 years) ..... 61

**List of Tables**

Table 2.1 Tidal Planes and Extreme Water Level Event Analysis for Albany [5] ..... 9  
 Table 2.2 Allowance for Sea Level Rise for Planning Timeframes ..... 14  
 Table 2.3 Ocean Beach Allowances for Coastal Processes ..... 17  
 Table 2.4 Peaceful Bay - Allowances for Coastal Processes ..... 19  
 Table 2.5 Potential Coastal Response to Changes to Environmental Variables. .... 20  
 Table 3.1 Assets at Ocean Beach ..... 22  
 Table 3.2 Assets at Peaceful Bay ..... 23  
 Table 3.3 Community Survey Results – Ocean Beach ..... 25  
 Table 3.4 Community Survey Results – Peaceful Bay ..... 27  
 Table 4.1 Ocean Beach High Exposure Assets ..... 31  
 Table 4.2 Peaceful Bay High Exposure Assets ..... 31  
 Table 4.3 Ocean Beach High Risk Assets Sensitivity to Coastal Erosion and/or Inundation .... 33  
 Table 4.4 Peaceful Bay High Risk Assets Sensitivity to Coastal Erosion and/or Inundation .... 34  
 Table 5.1 Ocean Beach Adaptation Options ..... 37  
 Table 5.2 Peaceful Bay Adaptation Options ..... 37  
 Table 5.3 Ocean Beach CBA ..... 40  
 Table 5.4 Peaceful Bay CBA ..... 40  
 Table 5.5 Policy Measure and Response ..... 47  
 Table 5.6 Ocean Beach Adaptation Options for High Exposure Assets ..... 57  
 Table 5.7 Peaceful Bay Adaptation Options for High Exposure Assets ..... 58  
 Table 6.1 Ocean Beach Longer Term Coastal Adaptation ..... 62  
 Table 6.2 Peaceful Bay Longer Term Coastal Adaptation ..... 63





### Acknowledgements

Seashore Engineering undertook this report in partnership with specialist planning consultants Landinsights.

### Limitations of this Report

This report and the work undertaken for its preparation, is presented for the use of the client. The report may not contain sufficient or appropriate information to meet the purpose of other potential users. Seashore Engineering does not accept any responsibility for the use of the information in the report by other parties.

### Document Control

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## 1. Introduction

### 1.1. BACKGROUND

The Shire of Denmark (the Shire) is located on the south coast of Western Australia and is bordered to the south by an approximately 84km section of mostly undeveloped coastline. Coastal development in the Shire is focused around the coastal nodes of Ocean Beach, to the south of the town of Denmark, and Peaceful Bay, which is approximately 40km to the west (see Figure 1.1).



**Figure 1.1 Shire of Denmark**

The coastline with relatively natural coastal foreshore areas is a focus for recreation and tourism. The Shire acknowledges the importance of the inlets and coastline to residents, visitors and the local economy.

The Shire of Denmark Coastal Reserves Management Strategy and Action Plan 2010 - 2020 [1] included a number of recommendations for future coastal management to address the increasing demand and use of the coastal assets. Prior to proceeding with any of these recommendations the Shire identified the need to assess the potential impact of coastal hazards on any of the proposed assets.

Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) is recommended by Western Australia Planning Commission [2] [3] to provide strategic guidance on coordinated, integrated and sustainable management and adaptation for land use and development in areas likely to be affected by coastal hazards. It establishes the basis for present and future risk management and adaptation.

The Shire has identified that Ocean Beach and Peaceful Bay are the highest value coastal reserves under their management. As such the CHRMAP process focuses on those portions of the Ocean Beach and Peaceful Bay coastlines with the highest value assets. This includes built assets (coastal infrastructure, Denmark SLSC) and natural assets (the sandy beach, coastal dunes).

Concept planning (10yr) has been undertaken concurrently by the Shire of Denmark with this CHRMAP. This has identified potential future changes to the extent and location of assets in the foreshore reserves.



## 1.2. COASTAL MANAGEMENT AREAS

Ocean Beach is an east facing high-energy sandy beach popular for swimming and surfing and subject to coastal erosion most recently in the late 1990's, 2013 and 2016. Coastal infrastructure and beach access is provided along a 400m section at the southern end of the beach between granite rock outcrops and the entrance to the seasonally open Wilson Inlet. This is the main recreational ocean beach for Denmark and is used for commercial and club based activities.



**Figure 1.2 Ocean Beach (March 2017)**

Peaceful Bay is a smaller settlement further west. It has a lower energy sandy beach, with a small sheltered pocket beach providing a relatively calm swimming beach and beach launching for recreational vessels, and a longer eroding sandy beach to the north. The coastline north of the Peaceful Bay jetty has eroded approximately 15 m between 2002 and 2014, resulting in the retreat of sheds from a Fisherman's lease area. The Shire is concerned about future threats to Peaceful Bay Road, the only means of access to the townsite, if the current rate of coastal erosion continues.



**Figure 1.3 Peaceful Bay (March 2016)**



### 1.3. SCOPE OF WORKS

Seashore Engineering has been commissioned by the Shire of Denmark to undertake a CHRAMP for the Ocean Beach and Peaceful Bay coastal management areas. The scope of works for the CHRMAP includes:

- Coastal Hazard Assessment
  - Assessment of the coastal hazard included
    - Reviewing existing information pertaining to coastal hazards within the coastal management areas, including available water level data and topographical information and previous reports.
    - Evaluating the storm erosion hazard using SBEACH software (S1).
    - Assessing shoreline movements from aerial images to determine historic erosion trends and infer potential future erosion trends (S2).
    - Determining the potential coastal erosion response to sea level rise in accordance with guidelines in SPP2.6 (S3).
    - Mapping of 10, 50 and 100yr allowances for coastal processes.
- Establish the context
  - Consultation with stakeholders, site inspections and a review of the Shire's asset register allowed the assets within the coastal management areas to be defined.
- Risk Identification and Assessment
  - The risk to each asset was defined based on exposure to coastal processes defined in the Coastal Hazard Assessment and assessment of the value of assets identified in the context establishment phase.
- Risk Management and Adaptation
  - Adaptation options to address potential high-risk assets within each coastal management area were developed. Options were evaluated using a multi-criteria analysis technique to define the most suitable adaptation option, together with a cost benefit assessment.
- Implementation
  - Timetables and works programs for implementation of adaptation options have been developed. This includes assessment of planning pathways and management triggers available to allow the implementation of the proposed adaptation options over a 100yr planning period.



## 2. Coastal Hazard Assessment

A coastal hazard assessment for Ocean Beach and Peaceful Bay has been undertaken based on consideration of the coastal geomorphology and local metocean conditions (water levels, waves, storms). Planning allowances for coastal processes have been determined and mapped using the procedures outlined in Schedule 1 of State Planning Policy 2.6 (SPP2.6).

The assumption underlying the mapping for the 10, 50 & 100 year are provided in Attachment B. The method and assumed coastal processes allowances for sandy coasts (S1 + S2 + S3) for the 10, 50 and 100 year planning periods for the project sites are shown in Figure 2.1 and detailed below.



**Figure 2.1 Representing Allowance for Erosion on Sandy Coast (incl HSD) S1 + S2 + S3 + FOS**

*Note: HSD – Horizontal Setback Datum, S1 – Allowance for Current Risk of Storm Erosion, S2 – Allowance for Historic Shoreline Movement Trends, S3 – Allowance for Erosion Caused by Future Sea Level Rise, FoS – Factor of Safety (Allowance for Uncertainty)*

Key assumptions in the allowances for coastal processes, that provide the basis for the risk assessment and adaptation planning in the CHRMAP, are outlined below:

- Allowances for coastal erosion *are not* a prediction of the shoreline position at the end of the respective planning periods. They are planning allowances for coastal hazards. In this CHRMAP these planning allowances have been used to assess the relative exposure of coastal assets to coastal processes (i.e. coastal erosion and inundation).
- Coastal hazards in the vicinity of limestone cliffs require further assessment by a geotechnical engineer.
- Underlying rock has the potential to significantly affect the response of the shoreline to coastal hazards; however, limited information is available on the extent and nature of underlying rock at the study sites.
- Whilst storm erosion (S1) and allowance for historic shoreline movement (S2) are site specific assessments, the allowance for erosion caused by future Sea Level Rise (S3) is a generic allowance specified by SPP2.6 that does not account for the variable response of different shorelines to Sea Level Rise that is likely to occur.



## 2.1. COASTAL GEOMORPHOLOGY

### 2.1.1. Coastal Type

The type of coastline in an area influences its vulnerability to coastal hazards. An initial assessment of the coastal types was undertaken using publicly available information, including Smartline database [4] and information provided by the Shire. Site inspections were then undertaken to confirm the coastal classification as per SPP2.6.

There are broadly 4 coast types at Ocean Beach including:

- Inland reaches of tidal water (Wilson Inlet)
- Weakly lithified sedimentary rock coast (Limestone Cliffs)
- Sandy coastline (Ocean Beach)
- Discontinuous rocky coastline (Wilson Head)

The Peaceful Bay coastline is predominantly classified as 'sandy coastline' however the beaches are controlled by coastal rock.

For sandy coastlines, SPP2.6 specifies allowance for erosion on sandy coastlines as outlined in Figure 2.1. For rocky coastlines, SPP2.6 recommends a geotechnical stability assessment be completed for assessing erosion risk, which is not within the scope of the current report, however, allowances have been made for slumping of vertical erosion scarps.

For the tidal reaches of inland waters, this report assumes the main coastal hazard is from inundation.



### 2.1.1. Coastal Landforms

A brief assessment of the local coastal geomorphology has been undertaken to better understand the landforms in the coastal management areas and how they may respond in the future to changes in metocean conditions (water levels, waves, storms etc.).

Coastal landforms at Ocean Beach are shown in Figure 2.2 and include:

- Sandy beach with a relatively wide flat berm of moderate grade, medium to fine white marine sand with median diameter of 0.35mm (see Figure 2.4) and orientated to the east but exposed to high-energy wave conditions.
- Rocky coast to the south (Wilson Head) that provides a local control and influences the wider platform of the sandy beach.
- Coastal dunes including incipient foredunes subject to cycles of erosion and recovery, and larger primary dunes up to 30m in height. This is the coastal landform south of the inlet entrance where the majority of the coastal infrastructure at Ocean Beach is located.
- Limestone cliffs that control and define the western margin of the entrance channel to Wilson Inlet.
- The entrance bar, channel and associated features of Wilson Inlet. This is a large seasonally open south coast inlet. The Shire open the inlet seasonally to control inland flooding.

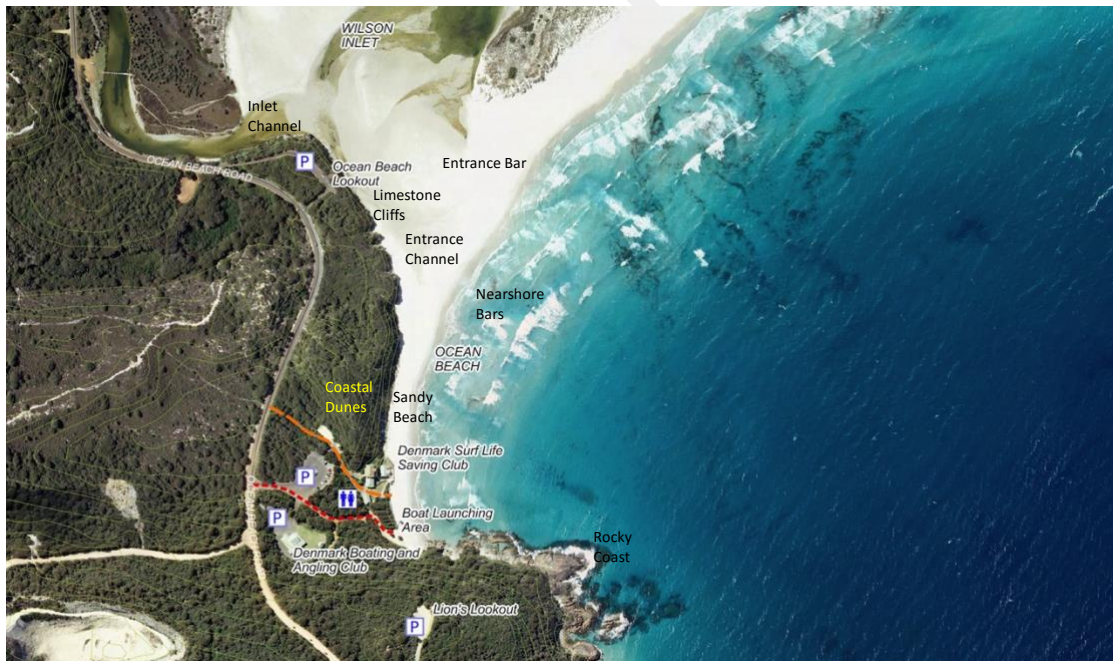


Figure 2.2 Ocean Beach Coastal Landforms



Coastal landforms at Peaceful Bay are shown in Figure 2.3 and include:

- Sandy beach of Peaceful Bay, with a crescent shaped planform. Sand at Peaceful Bay and Foul Bay is predominantly fine white marine sand with a median grain diameter of 0.2mm (see Figure 2.4).
- Rocky coastline to the south, which provides a local control.
- Coastal dunes including:
  - Incipient foredunes along Peaceful Bay subject to cycles of erosion and recovery, and primary dunes up to 5m in height.
  - Eroding primary dune along Foul Bay. The height of the dunes is ~6m AHD, which is 4m above the level of the beach.
- Nearshore rock and reef and an associated large salient or tombolo<sup>1</sup> in the vicinity of the boating facilities, which separates Peaceful and Foul Bays.
- Nearshore reefs which provide sheltering and localised wave refraction, including the shoreline planform locally.



**Figure 2.3 Peaceful Bay Coastal Landforms**



**Figure 2.4 Sediment Sample from Ocean Beach (l) Peaceful Bay (c) and Foul Bay (r)**

<sup>1</sup> A tombolo is a deposition landform in which an island is attached to the mainland by a narrow piece of land such as a spit or bar.





## 2.2. METOCEAN CONDITIONS

### 2.2.1. Water Levels

The south coast of Western Australia experiences mainly diurnal, microtidal conditions. The nearest tidal gauge with real time water level measurements and tidal predictions is at Albany, 50km to the east (Figure 2.5). The highest recorded events at the Albany tide gauge between January 1987 and November 2016, within Princess Royal Harbour, were on 2 September 2007 (0.95 AHD), 16 May 2003 (0.92m AHD), and 20 May 2011 (0.88m AHD).



**Figure 2.5 Tide and Wave Gauge Locations near Denmark**

Table 2.1 summarises the tidal planes and extreme water level distribution at Albany based on data from 1986 to 2012. It is noted that inshore water levels along the Shire of Denmark coast are influenced by wave breaking, refraction and storm surge and the morphology of inshore bays and inlets. Non-tidal water level processes inferred from Albany observations are not considered representative of the fluctuations along the Shire of Denmark coast, yet provide the best available regional data for coastal planning. The Department of Transport (DoT) undertook an extremes analysis on the water level data from Albany for the Augusta Boat Harbour project [5]. Some variance is likely to be experienced between Albany and the Shire of Denmark coast due to the different orientations of the coastline and relative exposure to storm events.

It should be noted that water levels with ARI > 80yrs have a high degree of uncertainty due to limitations in the length of the data set (26yrs), interannual variability of water levels in a microtidal climate and variability of storm type. The extremes analysis gives a 0.06m (6cm) difference between the 10yr ARI and 100yr ARI water levels. This is likely influenced by the interpretation of the annual maxima from the data, which shows most annual maxima events as between 0.8m AHD and 0.9m AHD with a few outliers above 0.9m AHD.



**Table 2.1 Tidal Planes and Extreme Water Level Event Analysis for Albany [5]**

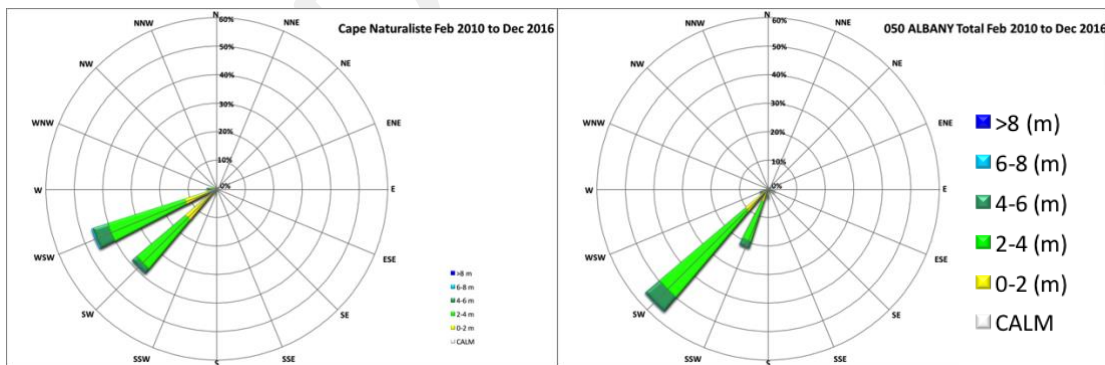
Water Level	Tidal Planes <sup>2</sup>					Extreme Event Analysis			
	LAT	MLLW	MSL	MHHW	HAT	1yr ARI	10yr ARI	25yr ARI	100yr ARI
<b>Albany (m AHD)</b>	-0.72	-0.31	0.0	0.33	0.67	0.87	1.02	1.05	1.08

**2.2.1. Waves**

The regional wave climate has been described in Geoscience Australia Geomorphology and Sedimentology of the South Western Planning Area [6].

Modal deep-water wave conditions along the southern margin are high energy long period swell waves from the southwest. Long period Indian Ocean swell generally finds landfall on the southern coast. Mean wave heights in the order of 2.5m and maximum wave heights in excess of 10m are evident immediately offshore, beyond the influence of wave refraction, diffraction, breaking and shoaling by nearshore reefs and platforms.

Offshore wave conditions are recorded at Albany in 60m water depths (Figure 2.5). Non-directional records are available since June 2005 with directional data available since September 2008. Comparison with the Cape Naturalise wave buoy from the west coast (Figure 2.6) shows a mean wave direction from the southwest, with swells also observed from the south-southwest. This is different to the west coast where the west-southwest swell direction dominates. The Albany data is considered to be representative of offshore wave conditions along the Shire of Denmark coast.



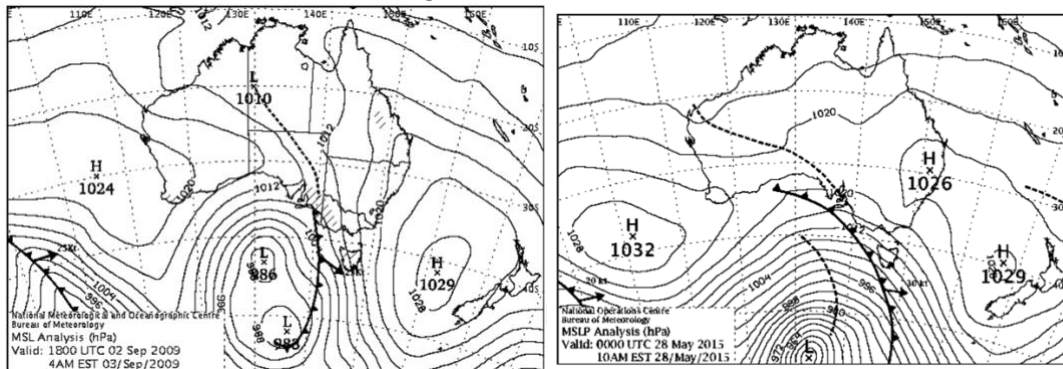
**Figure 2.6 Comparison of Wave Roses for Cape Naturaliste (left) and Albany (right) - Annual Wave Climate.**

<sup>2</sup> LAT: Lowest Astronomic Tide, MLLW: Mean Low Low Water, MSL: Mean Sea Level, MHHW: Mean High High Water, HAT: Highest Astronomic Tide, ARI: Average Return Interval.



Since 2008, the two largest recorded storm events had total significant wave heights of 9.01m (2 September 2009) and 8.51m (28 May 2015) respectively, with a south-south west wave direction. These events are characterised by relatively low-pressure systems (approximately 988 hPa in 2009 and 940 hPa in 2015), and caused regionally high swell waves of 8.57m and 8.29m respectively. These swell waves were also associated with regionally long peak periods of 16.67s in 2009 and 20s in 2015 and their SSW direction suggests potential for large inshore wave heights at the east facing beaches following refraction around headlands.

These events were produced by the storm systems, as represented in Figure 2.7. It is noted that larger wave events along the south coast, generated by low pressure systems tracking a long way offshore, may not necessarily coincide with locally high water levels (storm surges). Beaches may be more vulnerable to less intense low pressure systems that track closer to the coast and result in coincident high water levels and waves.



**Figure 2.7 Synoptic Charts for Highest Wave Events 2<sup>nd</sup> September 2009 (left) and 28<sup>th</sup> May 2015 (right)**

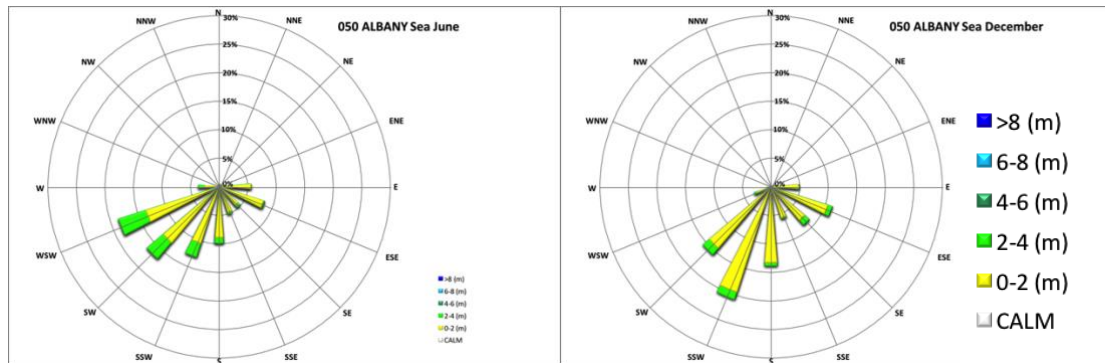
These two events were then used to assess the influence of offshore wave height for modelling during the risk identification phase, with adjusted water levels. Notably, high water levels were not observed to be coincident with the wave events mentioned above, which were 1m AHD in 2009 and 0.68m AHD in 2015.

### 2.2.1.1. Seasonal Variability

Swell wave energy is dominant along the south coast throughout the year. The highest proportion of large waves (over 4m in height) are experienced during the winter months (June to August) with smaller waves in summer (November to March). There is little seasonal variability in wave direction as, throughout the year, over 50% of wave energy comes from the SW with ~20% from the SSW and the remaining energy (~30%) split between the WSW and S to ESE direction sectors



However, assessment of the sea component of the Albany wave data shows that there is seasonal variability in the direction of sea waves. During winter, there is a greater proportion of sea waves over 2m compared to summer. In addition, during winter sea waves are mainly from the SW to WSW, which is likely a result of increased storm activity from the South and West over these months. During summer, there is an increase in the frequency of waves from the E and ESE, likely associated with the land breeze/sea breeze cycle. Whilst these waves are generally smaller (0-2m) they can directly influence east facing beaches. (Figure 2.8)



**Figure 2.8 Comparison of June (winter) and December (summer) Wave Roses for the Sea Component from Albany Wave Buoy**

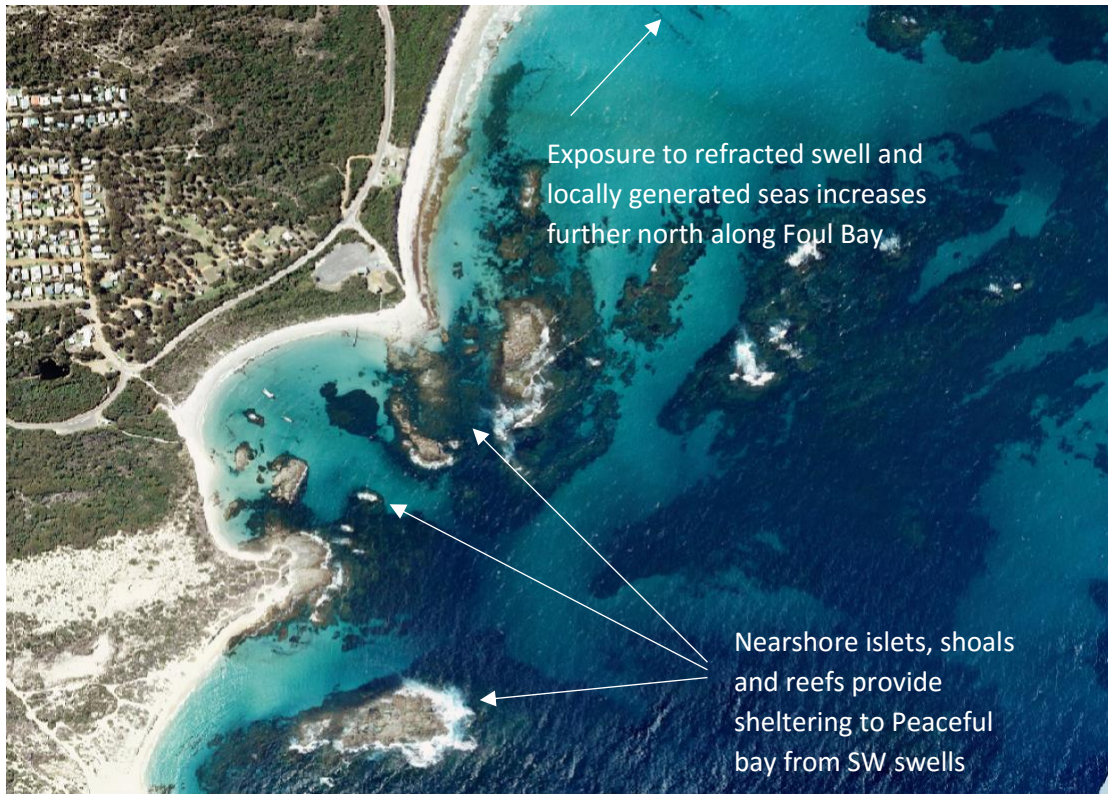
### 2.2.1.2. Nearshore Wave Processes

Ocean Beach is an east facing beach at the western end of an exposed high wave energy beach. Some sheltering is afforded Ocean Beach through dissipation of wave energy from SW and SSW swell energy as it refracts around Wilson Head, which was illustrated by modelling undertaken for the Ocean Beach Alternate Boat Launching Facility Study [7]. However, the beach is exposed to sea waves produced by local winds from the E to S. Figure 2.9 Illustrates the refraction of waves into Ocean Beach.



**Figure 2.9 Refraction of Waves into Ocean Beach (September 2010)**

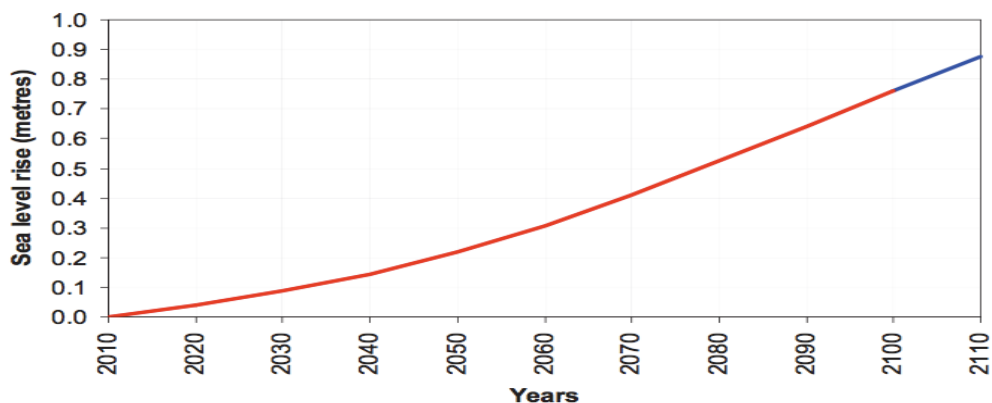
Peaceful Bay is protected from the largest of swell waves by a series of nearshore shoals and reefs, which break up the wave energy before it can make landfall. The southern part of Foul Bay is also largely protected by nearshore islets, shoals and reefs. However, further north along the beach is more exposed to refracted swell energy and locally generated seas from the east. Figure 2.10 highlights the nearshore features at Peaceful Bay that provide sheltering from large SW swells and the relative increase in exposure to locally generated easterly seas further north along Foul Bay.



**Figure 2.10 Illustration of Sheltering at Peaceful Bay**

### 2.2.2. Sea Level Rise (SLR)

Coastal adaptation planning requires consideration of the potential impact of Sea Level Rise (SLR) on the coast. Figure 2.11 shows the recommended allowance when planning for Sea Level Rise in Western Australia based on the report on Sea Level Change in Western Australia - Application to Planning. SPP2.6 Schedule 1 [8]. Section 2.3.3 and 2.4.3 provides a horizontal allowance for Sea Level Rise (SLR) as a component of the coastal setbacks for Ocean Beach and Peaceful Bay respectively.



**Figure 2.11 Recommended Allowance for Sea Level Rise in Coastal Planning for WA**

Note: red line SRES scenario A1FI 95<sup>th</sup> percentile after [9], normalised to 2010, (blue line continuation of scenario to 2110)



The allowance for Sea Level Rise for the 10, 50 and 100 year planning is summarised in Table 2.2.

**Table 2.2 Allowance for Sea Level Rise for Planning Timeframes**

Planning Timeframe	Predicted Sea Level Rise (m)
Present Day (c2017)	0
10 years	0.04
50 years	0.3
100 years	0.9

Note: The 0.9m value for SLR has been adopted for the 100year planning period from 2017.

### 2.3. OCEAN BEACH COASTAL HAZARDS – COASTAL PROCESSES ALLOWANCE

The focus of the coastal hazard assessment at Ocean Beach is on the 400m stretch of coastline between the granite rock outcrops and the entrance to the seasonally open Wilson Inlet where the majority of the coastal assets are located. As outlined in Section 2.2.1.2 this section of Ocean Beach is east facing and is exposed to locally generated easterly seas and refracted swell energy, which is predominantly from the SW and SSW. This makes this stretch of beach vulnerable to periodic erosion events associated with large storms, as was the case in the late 1990's, 2013 and 2016.



**Figure 2.12 Ocean Beach During Storm (Sep 2016) – Supplied by Shire of Denmark.**

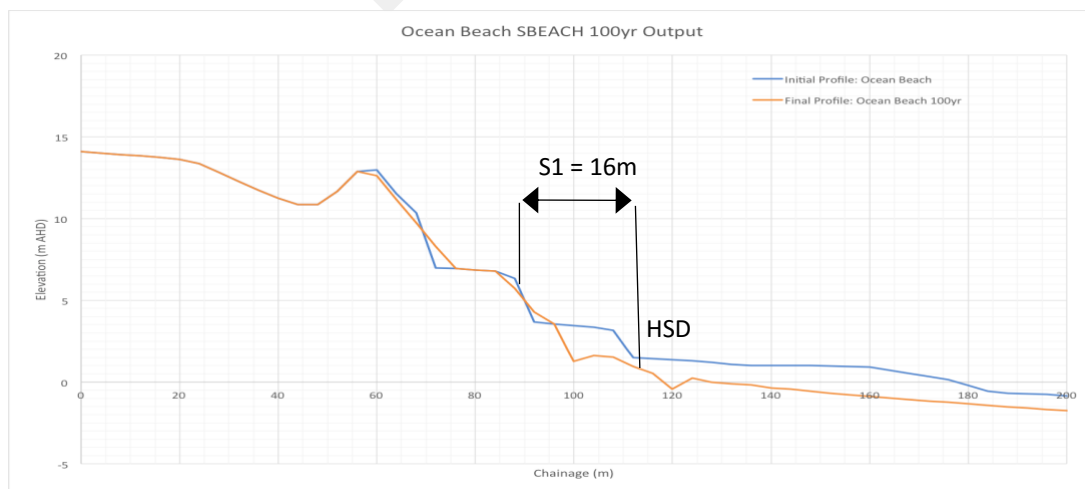
#### 2.3.1. S1 Current Risk of Storm Erosion

The Shire provided site photos from a storm erosion event in August 2016 that damaged beach access ramps and stairs. Meteorological records indicate the storm was associated with a low-pressure system passing directly over the site. Storm erosion of beaches often occurs during elevated water levels (high tide coincident with storm surge). Water level records from Albany identified a moderate storm surge that may have coincided with high tide as it passed over Denmark. Wave heights and directions were not recorded in this event. Based on site photos, near vertical erosion scarps larger than 2 meters in height were observed (Figure 2.13). This provided some local context to the modelling of the current risk of storm erosion, although survey was not available to verify the model for this event.



**Figure 2.13 Erosion Event at Ocean Beach Timber Retaining Wall Pre (SE top June 2016) During (SoD left August 2016) and Recovered (SE right March 2017)**

SPP2.6 [2] requires the S1 Allowance for Current Risk of Storm Erosion to be based on consideration of a 100yr ARI storm event in the region. Available wave and water level data from Albany, the best available regional data, was analysed to develop a data set suitable for modelling storm erosion using the SBEACH software package. The highest recorded water level since monitoring began in 1986 was 1.02m AHD in a storm in 2007. Time series wave and water level data is available for this storm. The time series data from the 2007 storm was modified to provide appropriate input to model the 100yr ARI storm at Ocean Beach. Three runs of the storm event were used to assess the erosion associated with a nominal '100-year' erosion event, and one run for nominal '10 year' event.



**Figure 2.14 Ocean Beach SBEACH Erosion Modelling for 100yrARI erosion event (modelling assumes retaining wall not present)**





A key consideration in the assessment of coastal hazards at Ocean Beach is the slope stability of high vertical erosion scarps at the relatively steep (1:4) and elevated site. An allowance has been made in the modelling for near vertical erosion scarps to slump to a 30 degrees angle of repose. This requires further consideration in the assessment of adaptation options for assets at this site.

### 2.3.2. S2 Historic Shoreline Movement Trends

The historic shoreline movement trends have been assessed based on aerial imagery provided by the Shire from 2002, 2006, 2010, 2014 & 2016. The following was noted based on the assessment of 4 profiles:

- The vegetation line has eroded about 7 meters in the profile south of the surf club since 2002. The nature of this erosion appears to be episodic, and there is capacity for the dunes to recover between events, however historically this represents a net erosion trend in the order of 0.5m/year.
- Net erosion has not occurred at the surf club due to the timber retaining wall.
- The beach to the north near the inlet entrance has been relatively stable due to rock controls along the back of the beach limiting the landward extent of erosion.

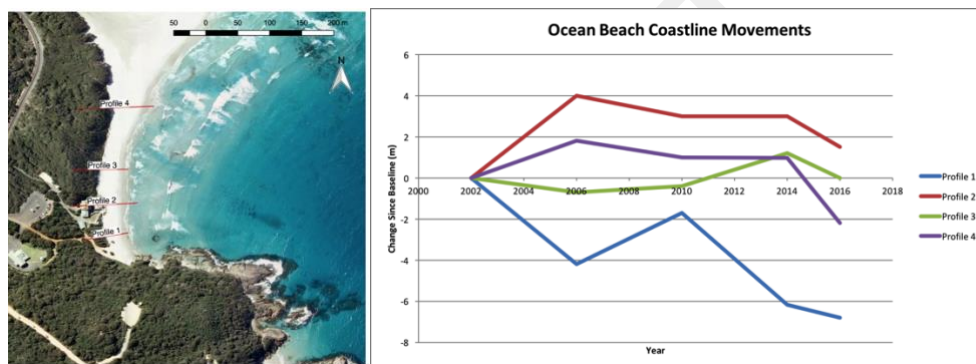


Figure 2.15 Ocean Beach – Historic Shoreline Movement Trends

### 2.3.3. S3 Erosion due to Future Sea Level Rise

The erosion due to future sea level rise is based on the requirements of SPP 2.6 [2] for a sandy coast. These erosion allowances are based on a 100 x multiple of the predicted sea level rise for the planning period (i.e. 90m for 100 years).

The extent of erosion at this location in response to a potential future 0.9m sea level rise is expected to be mitigated by local rock controls, however the planning allowances for S3 are prescribed in SPP2.6 and do not allow local interpretation of future response. This assessment would also be outside the present scope of works.



### 2.3.4. S4 Allowance for Inundation

The assumed peak steady water level from the modelling was in the order of 1.5m AHD, which was based on the 100yr ARI water level plus an allowance for wave setup. The SBEACH model is very conservative in the estimation of wave setup and the water levels were adjusted to allow for a more realistic representation of wave setup at the site. Wave runup is unlikely to inundate high dunes at the site. It is possible there may be some risk of inundation to the existing surf club boat shed (3mAHD) from wave overtopping during future extreme events.

The main inundation risk in the Ocean Beach area, however, is not at Ocean Beach itself. Inundation is the greatest threat to Ocean Beach Road, which is at an elevation of ~1m AHD where it passes close to Prawn Rock channel in Wilson Inlet. Water levels at this point will be controlled by water levels in Wilson Inlet when the bar is closed. When the bar at the mouth of the inlet is opened, currently at 1m AHD [10], water levels in Wilson Inlet will also be directly influenced by ocean levels.

### 2.3.5. Allowance for Coastal Processes

The allowances for Coastal Processes at Ocean Beach are summarised in Table 2.3 and the maps provided in Attachment A.

**Table 2.3 Ocean Beach Allowances for Coastal Processes**

Coastal Processes Allowances	10 year	50 year	100 year
Storm Erosion (S1)	8	16	16
Historic Trend (S2)	5	25	50
Erosion due to SLR (S3)	4	35	90
Factor of Safety	2	10	20
Subtotal (m)	19	86	176
Assumed Allowance (m)	20	85	175

Note: Allowances for coastal erosion *are not* a prediction of the shoreline position at the end of the respective planning periods. They are planning allowances for coastal hazards. In this CHRMAP these planning allowances have been used to assess the relative exposure of coastal assets to coastal processes (i.e. coastal erosion and inundation). Assumed allowance rounded to nearest 5 meters.

## 2.4. PEACEFUL BAY COASTAL HAZARDS – COASTAL PROCESSES ALLOWANCE

Peaceful Bay is a small coastal settlement in the west of the Shire. A small sheltered pocket beach provides a relatively calm swimming beach and beach launching for recreational vessels, and there is a longer eroding sandy beach to the north. There appears to be significant gaps between erosion events as incipient vegetation is evident at the toe of the dune in many site photos.



**Figure 2.16 Peaceful Bay (Foul Bay) – Erosion Near Fisherman’s Lease Area (SoD)**

#### **2.4.1. S1 Current Risk of Storm Erosion**

The Shire provided site photos from historic storm erosion events. Whilst scarping is apparent in the jetty beach following storms, higher and more persistent erosion scarps are apparent along the beach to the north of the boat ramp.

Cross-shore beach erosion modelling was undertaken using the USACE’s SBEACH 2D [11] model and the adjusted July 2007 storm event as per Ocean Beach. However, at Peaceful Bay two typical beach profiles were generated at the main Swimming Beach in Peaceful Bay and the beach north of the boat ramp in Foul Bay (Northern Beach). The results of the erosion modelling are shown in Table 2.4.

#### **2.4.2. S2 Historic Shoreline Movement Trends**

The historic shoreline movement trends have been assessed based on aerial imagery provided by the Shire from 2002, 2006, 2014 & 2016. The following was noted based on the assessment of 5 profiles:

- The jetty/swimming beach has been relatively stable since 2002 due to rock headlands providing a stable shoreline.
- The vegetation line has eroded between 16 and 24 meters north of the boat ramp within Foul Bay since 2002. Erosion and/or removal of a number of structures is evident in the aerial photography. Whilst erosion is expected to be associated with storms, and there is capacity for the dunes to recover between events, a net erosion trend in the order of 1.4m/yr. was observed.

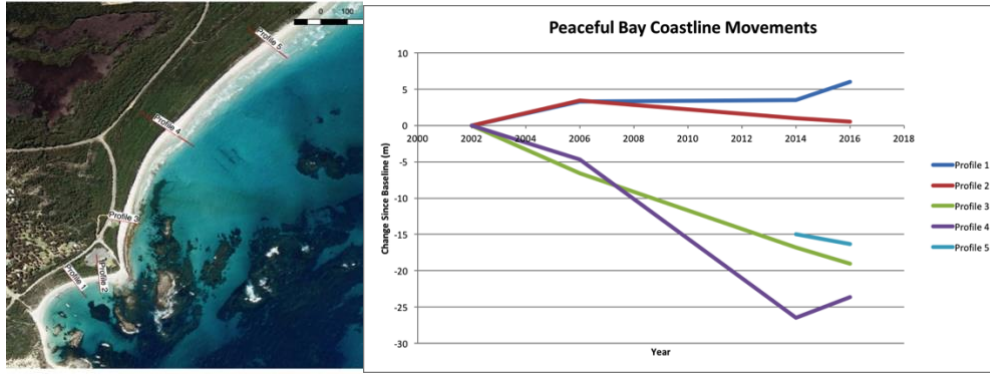


Figure 2.17 Peaceful Bay – Historic Shoreline Movement Trends

**2.4.3. S3 Erosion due to Future Sea Level Rise**

The erosion due to future sea level rise is based on the requirements of SPP 2.6 [2] for a sandy coast. These erosion allowances are based on a 100 x multiple of the predicted sea level rise for the planning period i.e. 90 m.

**2.4.4. S4 Allowance for Inundation**

The assumed peak steady water level from the modelling was in the order of 1.5m AHD. Wave runup is unlikely to inundate high dunes at the site. The boat ramp and memorial site are above 5.0m AHD.

**2.4.5. Allowance for Coastal Processes**

The allowances for Coastal Processes at Peaceful Bay are in Table 2.4 and the maps provided in Attachment A.

Table 2.4 Peaceful Bay - Allowances for Coastal Processes

Coastal Processes Allowances	Peaceful Bay (Swimming Beach)			Foul Bay (Beach North of Boat Ramp)		
	10 year	50 year	100 year	10 year	50 year	100 year
Storm Erosion (S1)	24	46	46	18	24	24
Historic Trend (S2)	0	0	0	14	70	140
Erosion due to SLR (S3)	4	35	90	4	35	90
Factor of Safety	2	10	20	2	10	20
<b>Subtotal (m)</b>	<b>30</b>	<b>91</b>	<b>156</b>	<b>38</b>	<b>139</b>	<b>274</b>
<b>Assumed Allowance (m)</b>	<b>30</b>	<b>90</b>	<b>155</b>	<b>40</b>	<b>140</b>	<b>275</b>

Note: Allowances for coastal erosion are not a prediction of the shoreline position at the end of the respective planning periods. They are planning allowances for coastal hazards. In this CHRMAP these planning allowances have been used to assess the relative exposure of coastal assets to coastal processes (i.e. coastal erosion and inundation). Assumed allowance rounded to nearest 5 meters.



## 2.5. CHANGES TO ENVIRONMENTAL VARIABLES

Engineers Australia provides guidelines for responding to the effects of climate change in coastal and ocean engineering [12]. A method is provided to assess the potential coastal response to changes to key environmental variables, which include mean sea level, ocean currents and temperature, wind climate, wave climate, rainfall / runoff and air temperature. While this assessment is not a requirement of the CHRMAP process, potential implications of changes to these variables on coastal behaviour at Ocean Beach and Peaceful Bay are summarized in Table 2.5. This provides some indication of the potential complexity of future coastal responses to changes in environmental variables and the need for flexible coastal adaptation planning.

**Table 2.5 Potential Coastal Response to Changes to Environmental Variables.**

Environmental Variable	Risk Identification	Potential Coastal Response
<b>Mean Sea Level</b>	Increase in Mean Sea Level of 0.9m over 100 years from 2010 to 2100 as outlined in 2.2.2	-Landward migration of shoreline. -Increased frequency of inundation in low-lying areas. -Increased inshore wave energy as nearshore reefs provide a lower level of protection to beaches particularly at Peaceful Bay. -Change to entrance sand bar heights at Wilson Inlet.
<b>Ocean Currents and Temperature</b>	By 2030 the best estimate of sea surface temperature (SST) change is 0.4-1.0°C using the A1B scenario [13]. Beyond 2030 the SST changes are dependent on the emission scenarios	-Influence on local and Leeuwin Currents uncertain. -Potential secondary response to mean sea level, primary production and sediment supply.
<b>Wind Climate</b>	Mean wind speeds are predicted to increase in southwest WA in summer and autumn by 2-5% under median scenarios and decrease in winter by 2-5%, with no changes in spring. Overall, the net effect is no less than +/- 2% change in annual means [13].	-Influence on local sea breezes and extreme wind events uncertain. -Changes to sea breeze regime may result in changes to presently observed seasonal variability of sea wave climate.
<b>Wave Climate</b>	There are no recent scenarios of the implications of climate change on local or swell- driven waves. However, climate change scenarios move the swell-wave generation zone further south	-Increased inshore wave energy associated with increase in Mean Sea Level due to Sea Level Rise. -Beach planform response to changes in mean wave direction.
<b>Rainfall Runoff</b>	Rainfall changes projected as a result of climate change suggest a continuing drying climate.  Increases in the frequency of occurrence of high intensity precipitation events are possible.	-Potential changes to seasonal river and creek entrance openings. -Potential changes to Wilson Inlet flooding regime. -Secondary response to stability of weakly lithified sedimentary rock coast.
<b>Air Temperature</b>	Rise in land surface air temperature.	-Secondary response to coastal vegetation.



### 3. Establish the Context

#### 3.1. IDENTIFICATION OF ASSETS

Assets that are potentially exposed to coastal processes over a 100 year planning timeframe were identified at Ocean Beach between Prawn Rock Channel and Lion's Lookout, and at Peaceful Bay. The identified assets were generally public infrastructure and lease holdings. These assets were grouped according to the coastal nodes shown in the maps in Attachment 1 to allow for a strategic risk assessment to be carried out at both locations. Coastal nodes were identified according to their coastal type [2] and any relevant fixed boundaries (e.g. rock formations dividing Peaceful Bay and Foul Bay).

It is acknowledged that the sandy beach and coastal dunes are also assets that are highly valued by coastal communities and are not specifically 'valued' in this approach. Coastal adaptation planning requires careful consideration of the risk of beach and coastal dune erosion, and of the potential for responses to protect public infrastructure having adverse impacts on the beach and dunes. However, the focus of the risk assessment in this CHRMAP is on planning for the future provision of public infrastructure at the coast and the economic value of both existing and planned infrastructure.

##### 3.1.1. Ocean Beach Nodes and Assets

Four coastal nodes were identified at Ocean Beach based on coastal type and the location of public infrastructure. These coastal nodes are Prawn Rock in the north, Ocean Beach Lookout, Ocean Beach and Lion's Lookout in the south. The delineation of the coastal nodes is shown in Figure 3.1.



Figure 3.1 Ocean Beach Coastal Nodes



Coastal assets were identified within each coastal node based on a review of available aerial imagery, the assessment of existing information (including site photographs and studies relevant to the area) and site inspections. A summary of the coastal nodes with a description of the relevant assets at Ocean Beach is presented in in Table 3.1.

**Table 3.1 Assets at Ocean Beach**

ID	Coastal Type (from [4])	Coastal Node	Length (m)	Description of Assets
OB_1	Tidal reaches of inland waters	Prawn Rock Channel	300	Seaward end of Prawn Rock Channel, including gravel car park and Ocean Beach Road.
OB_2	Weakly lithified sedimentary rock coast	Ocean Beach Lookout	350	Bitumen car park with path leading to Ocean Beach Lookout, Ocean Beach Road.
OB_3	Sandy coast	Ocean Beach	300	Ocean Beach SLSC (top and lower), toilet block, Denmark Boating and Angling Club and sealed car park, bitumen car park (SLSC), stairs to beach (rail and no rail), ramp to beach (pedestrian), viewing platform fronting lower SLSC, viewing platform at railed stairs, Ocean Beach Road, vehicle access to beach, path to railed stairs, surf club shower and grassed area, and Denmark Boating and Angling Club grassed area and gazebo.
OB_4	Discontinuous rocky shoreline	Lion's Lookout	100	Lion's lookout with gravel car park and Ocean Beach Road.

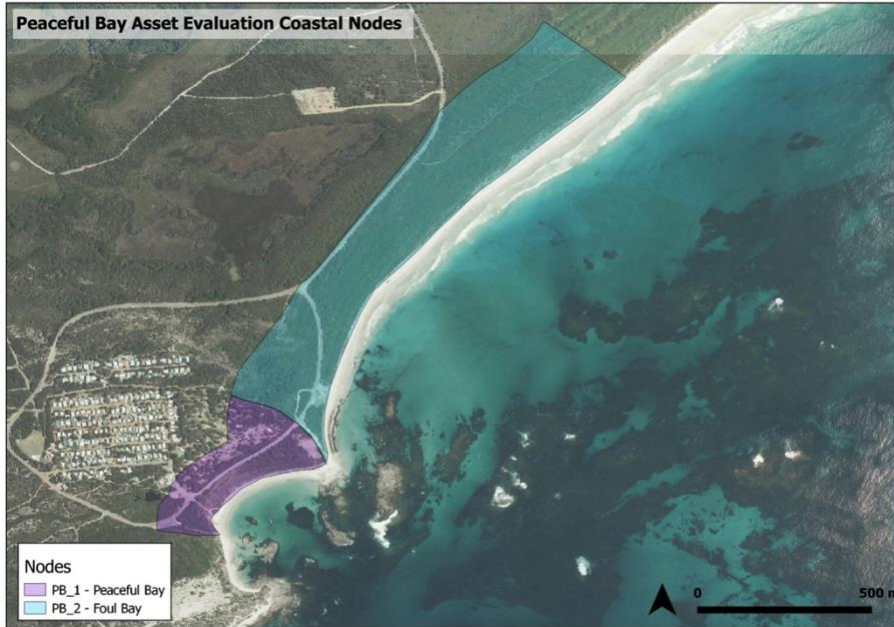
Note:

1. Allowances for coastal processes were not assessed for Prawn Rock channel, as they are within the tidal reaches of inland waters. However, assets including Ocean Beach Road and public infrastructure at Prawn Rock channel were identified due to their potential exposure to coastal inundation.
2. Allowances for coastal processes were not assessed for Ocean Beach lookout, as this would require a geotechnical assessment of cliff stability. However, assets including Ocean Beach road, the carpark and lookout were identified due to their proximity to the coast and the potential instability of weakly lithified sedimentary rock coast.



### 3.1.2. Peaceful Bay Townsite Nodes and Assets

Two coastal nodes were identified at Peaceful Bay Townsite, being Peaceful Bay and Foul Bay, based on changes in exposure. The boundary was taken as the vehicular beach access track adjacent to the Sea Rescue Group buildings and the delineation of coastal nodes is shown in Figure 3.2.



**Figure 3.2 Peaceful Bay Coastal Nodes (Note: northern extent of PB\_2 is the reserve boundary, not limit of coastal exposure)**

As with Ocean Beach, coastal assets were identified from all available sources of information and site inspections. These have been listed in Table 3.2 below.

**Table 3.2 Assets at Peaceful Bay**

ID	Coastal Type	Coastal Node	Length (m)	Description of Assets
PB_1	Sandy Coast	Peaceful Bay	550	Stairs with attached ramp and boardwalk (from Sea Rescue building), bitumen car park (Sea Rescue), western beach access point with bitumen car park, toilet, boardwalk path and stairs, Peaceful Bay Sea Rescue Group (boat shed and building), Old Peaceful Bay Road, caravan park with grassed area (BBQ and gazebo) and gravel/sand path from caravan park, and finger jetty.
PB_2	Sandy Coast	Foul Bay	1,500	Lookout landward of Old Peaceful Bay Road with gravel car park, Old Peaceful Bay Road, section of Bibbulmun track, vehicle beach access track, RSL memorial and Fisherman's lease area.





## 3.2. COMMUNITY CONSULTATION

### 3.2.1. Introduction

A comprehensive consultation process was followed during the preparation of this CHRMAP, following the requirements outlined in the endorsed *Stakeholder and Community Engagement Strategy* [14]. It included the following:

- Notice in the local newspaper regarding a community survey
- Notice/s on the Shire's website
- Meetings with the Steering Group
- Stakeholder meeting
- Ongoing discussion with the Shire and Department of Planning, Heritage and Lands (at various stages)
- Media release
- Letters to stakeholders

The consultation program aimed to provide several opportunities for involvement, and provided several ways in which community and stakeholders could provide comment and feedback. The outcomes of the consultation program are outlined below.

### 3.2.2. Past Consultation

Consultation was undertaken during the preparation of the Coastal Reserves Management Strategy (CMS) and Action Plan 2010 - 2020 [1]. Public consultation included a community workshop, survey and advertising (including a Public Information Evening). Targeted consultation occurred with a range of community groups. The outcomes of this consultation are contained within the CMS/Action Plan and provided the context for further discussion with the community during this CHRMAP process.

### 3.2.3. Working Group Consultation

A Working Group was formed to guide the project and to review elements of the CHRMAP as it was prepared and concurrently develop foreshore concept plans for both areas. The terms of reference for the Working Group were "To develop concept plans, taking into account coastal adaptation planning factors, for the Ocean Beach and Peaceful Bay Foreshore areas to guide the future development of these key recreational nodes".

The first meeting of the Working Group was on 14-September-2016 to develop the project. Seashore Engineering presented the outcome of the initial coastal hazard assessment to the Working Group was on the 3<sup>rd</sup> March 2017. The meeting was to introduce the Group to the project, to discuss the project methodology and timeframe in more detail and to discuss issues needing consideration. Site visits of both Ocean Beach and Peaceful Bay occurred following the meeting with participation from external stakeholders.

Members of the Steering Group include:

- 1 x Denmark Surf Life Saving Club Representative
- 1 x Peaceful Bay Progress Association Representative
- 1 x South Coast Natural Resource Management Representative



- 2 x Community Members
- Director of Planning & Sustainability
- Director of Infrastructure Services
- Sustainability Officer
- 2 x Councillors.
- 2 x Department of Planning, Lands and Heritage Representatives

Progress reports were provided to the Working Group during the project for review and comment. The draft CHRMAP was issued to the Shire of Denmark on 03/11/2017 and presented to the Working Group by Seashore Engineering on 28/11/2017.

### 3.2.4. Community Survey

A community survey was prepared to test and identify values associated with each of the sites. Given the differing issues and user groups at each of the sites, two specific community surveys were prepared to provide individual focus on each. It was made available from the mid-May 2017 to 5 June 2017. The survey was published online and was also available in hardcopy form (available from the Shire or on request). It comprised 11 multi-choice questions and one final open-ended question. Respondents were also asked whether they wished to be kept informed as the project progressed.

A total of 64 responses were received to the Ocean Beach survey, with 24 being received for Peaceful Bay. The response rate is not statistically significant however provided useful information regarding key issues and values at each of the sites.

Top two responses for each question are summarised in the table below. A copy of the survey results is provided in Attachment D.

**Table 3.3 Community Survey Results – Ocean Beach**

Question	Response
<b>Do you live in the Shire of Denmark</b>	Majority Yes (86%) compared to No (14%)
<b>How well informed do you consider yourself to be on coastal impacts (erosion, storm surges) that may happen due to rising sea levels?</b>	Majority <ul style="list-style-type: none"> <li>• ‘Well Informed’ (38%)</li> <li>• ‘Have some Idea’ (33%).</li> </ul> Only one respondent replied ‘Expert’ and none replied ‘Uninformed’.
<b>How much do you agree with the following statements?</b>	Majority strongly agreed with the statement: <ul style="list-style-type: none"> <li>• ‘The coast is an important part of the Shire of Denmark lifestyle’</li> </ul> Majority disagreed with the statement: <ul style="list-style-type: none"> <li>• ‘access should be provided to all parts of the coast’</li> </ul> More strongly agreed that: <ul style="list-style-type: none"> <li>• ‘access should only be provided to specific areas of the coast’.</li> </ul>
<b>What are your main activities at the Ocean Beach and foreshore?</b>	Majority responses: <ul style="list-style-type: none"> <li>• ‘Swimming’ (24%)</li> <li>• ‘walking’ (24%).</li> </ul>



Question	Response
	<p>The least common responses were:</p> <ul style="list-style-type: none"> <li>• 'sandboarding' (0%)</li> <li>• BBQ (3.5%).</li> </ul> <p>Some additional uses included birdwatching, surf club and dog exercise.</p>
<p><b>How often to you visit the beach and foreshore at Ocean Beach?</b></p>	<p>Majority 'weekly' (61%). The least common responses were 'never' (0%) and 'yearly' (3%).</p>
<p><b>Which of these threats/activities currently impact your use of the coastal areas of Ocean Beach?</b></p>	<p>All options received a similar rating, however</p> <ul style="list-style-type: none"> <li>• 'development on or close to the beach'</li> <li>• 'beach erosion'</li> <li>• 'vehicle access to the beach'</li> </ul> <p>received slightly more votes as a greater threat than:</p> <ul style="list-style-type: none"> <li>• 'flooding'</li> <li>• 'population pressure'.</li> </ul> <p>Overall, 'beach erosion' is identified as the greatest threat.</p> <p>Other threats identified included dogs in habitat areas and jet skis.</p>
<p><b>Which activities do you think are likely to impact the coastal areas of Ocean Beach in the future?</b></p>	<p>Activities identified as the greatest threat in the future are:</p> <ul style="list-style-type: none"> <li>• 'development on or close to the beach'</li> <li>• 'beach erosion'.</li> </ul>
<p><b>Which of these uses or assets do you think should be safeguarded so they continue to be available at Ocean Beach and foreshore?</b></p>	<p>The use with the majority vote was:</p> <ul style="list-style-type: none"> <li>• 'safe swimming areas with seasonal patrols and swimming lessons' (24.5%)</li> <li>• 'buildings (cafes, clubs, SLSC), ablution blocks, parking and playgrounds' (22%)</li> <li>• 'important environmental sites and plant and animal communities (22%).</li> </ul>
<p><b>What facilities, uses or assets would you like to see at the beach and foreshore at Ocean Beach over the next 10 years?</b></p>	<p>Majority response were:</p> <ul style="list-style-type: none"> <li>• 'ablution blocks' (13%)</li> <li>• 'safe swimming areas with seasonal patrols and swimming lessons' (12.5%)</li> <li>• 'club buildings, surf lifesaving clubs' (12%).</li> </ul> <p>The least common response was 'playgrounds' (4%).</p> <p>Other responses were 'BBQ facilities' and 'an alternative boat launching area'.</p>
<p><b>Do you think erosion of the coast at Ocean Beach is</b></p>	<p>Majority responded 'the result of normal coastal processes' followed by 'likely to get worse in the future'.</p>
<p><b>What options would you like the Shire to consider to adapt to coastal erosion over the next 50 years?</b></p>	<p>Majority responded 'adaption of structures to accommodate erosion (e.g. beach access stairs)' followed by 'avoid development in coastal areas of potential future coastal erosion'.</p>



**Table 3.4 Community Survey Results – Peaceful Bay**

Question	Response
<b>Do you live in the Shire of Denmark</b>	Majority Yes (62.5%) compared to No (37.5%)
<b>How well informed do you consider yourself to be on coastal impacts (erosion, storm surges) that may happen due to rising sea levels?</b>	Majority <ul style="list-style-type: none"> <li>• ‘Have some Idea’ (42%)</li> <li>• ‘Well Informed’ (29%)</li> </ul> Only one respondent replied ‘Uninformed’ and no respondents replied with ‘not well informed’ or ‘expert’.
<b>How much do you agree with the following statements?</b>	Majority strongly agreed with the statement: <ul style="list-style-type: none"> <li>• ‘The coast is an important part of the Shire of Denmark lifestyle’</li> </ul> Majority disagreed with the statement: <ul style="list-style-type: none"> <li>• ‘access should be provided to all parts of the coast’</li> </ul> More agreed that: <ul style="list-style-type: none"> <li>• ‘access should only be provided to specific areas of the coast’.</li> </ul>
<b>What are your main activities at the Peaceful Bay and foreshore?</b>	Majority responses: <ul style="list-style-type: none"> <li>• ‘Swimming’ (15%)</li> <li>• ‘walking’ (14%).</li> </ul> The least common responses were: <ul style="list-style-type: none"> <li>• ‘horse-riding’ (0.6%)</li> <li>• ‘sandboarding’ (3%).</li> </ul> Some additional uses included camping, snorkelling, scuba diving and memorial services.
<b>How often do you visit the beach and foreshore at Peaceful Bay?</b>	Majority ‘monthly’ (25%). The least common responses were ‘never’ (0%) and ‘daily’ (12.5%).
<b>Which of these threats/activities currently impact your use of the coastal areas of Peaceful Bay?</b>	All options received a similar rating, however activities resulting in the greatest threat were identified as: <ul style="list-style-type: none"> <li>• ‘beach erosion’</li> </ul> The activities identified as least threat were: <ul style="list-style-type: none"> <li>• ‘flooding’</li> <li>• ‘vehicle access to the beach and dunes’.</li> </ul>
<b>Which activities do you think are likely to impact the coastal areas of Peaceful Bay in the future?</b>	Activities identified as the greatest threat in the future are: <ul style="list-style-type: none"> <li>• ‘beach erosion’</li> <li>• ‘development on or close to the beach’.</li> </ul> The least threat identified for the future is: <ul style="list-style-type: none"> <li>• ‘flooding’</li> <li>• ‘population pressure’.</li> </ul>
<b>Which of these uses or assets do you think should be safeguarded so they continue to be available at Peaceful Bay and foreshore?</b>	The use with the majority vote was: <ul style="list-style-type: none"> <li>• ‘safe swimming areas with seasonal patrols and swimming lessons’ (19.5%)</li> <li>• ‘places to safely launch recreational boats’ (18%)</li> <li>• ‘Buildings, ablution blocks, parking and</li> </ul>



Question	Response
	playgrounds' (17%).
<b>What facilities, uses or assets would you like to see at the beach and foreshore at Peaceful Bay over the next 10 years?</b>	<p>Majority response were:</p> <ul style="list-style-type: none"> <li>• 'pathways, cycleways etc.' (14.5%)</li> <li>• 'safe swimming areas with seasonal patrols and swimming lessons' (14.5%)</li> <li>• 'ablution blocks' (14%).</li> </ul> <p>The least common responses were:</p> <ul style="list-style-type: none"> <li>• 'more parking' (4%).</li> <li>• 'club buildings, surf lifesaving club' (4.4%)</li> </ul>
<b>Do you think erosion of the coast at Peaceful Bay is</b>	Majority responded 'the result of normal coastal processes'.
<b>What options would you like the Shire to consider to adapt to coastal erosion over the next 50 years?</b>	Majority responded 'adaption of structures to accommodate erosion (e.g. beach access stairs)' and 'avoid development in coastal areas of potential future coastal erosion'.

### 3.2.5. Key direction

#### 3.2.5.1. Ocean Beach

The survey also asked respondents to add anything else about what they value of the beach and foreshore at Ocean Beach. The most popular responses were:

- Keep Ocean Beach as natural as possible
- Minimal development
- Maintain existing development and keep managing the area
- Ocean Beach is an important environmental and tourism asset
- Better facilities for the SLSC
- Development of a restaurant or café
- Erosion issues
- Erosion is part of the natural coastal processes so ensure separation distances are maintained and the area well managed.

As can be seen from the above, the community have a good understanding of the issues at Ocean Beach, including the coastal processes affecting the site. An overwhelming response is to keep the area as natural as possible and maintain existing facilities, with some minimal development suggested by some. Most respondents would like the Shire to focus on protecting safe swimming beaching and existing buildings, as well as the environment.



### 3.2.5.2. Peaceful Bay

The survey also asked respondents to add anything else about what they value of the beach and foreshore at Peaceful Bay. The most popular responses were:

- Keep Peaceful Bay as is
- Minimal development
- Protect environmental and coastal assets where possible

Some other responses include:

- Do not install groynes
- Retain fishermen shacks
- Better boat launching facilities required for boats larger than dinghy size
- Disabled access required
- Install a marina similar to Augusta
- Restrict vehicle access in sensitive dune areas.

The results from the Peaceful Bay survey indicate that the community are aware of coastal erosion issues as they rated 'beach erosion' as the greatest threat currently and in the future. A majority would like to see the area kept as natural as possible with minimal development. The most popular facilities and uses the community would like to see in the future are pathways, swimming areas and ablution blocks.



Figure 3.3 Community Use at Ocean Beach (upper) and Peaceful Bay (lower)



## 4. Coastal Risk Assessment

### 4.1. RISK MATRIX

The asset risk has been assessed based on the Asset Cost and the Asset Exposure and the matrix shown in Figure 4.1, which includes a Very High Risk category (assets >\$500K value in high exposure (10 year) area).

		Exposure to Coastal Processes (Likelihood)		
		High (within 10 yr. area)	Medium (10-50yr area)	Low (50-100yr area)
Asset Cost (Consequence)	High	Very High	High	Med
	Medium	High	Med	Low
	Low	Med	Low	Low

**Figure 4.1 Coastal Risk Evaluation Matrix**

This process provides a strategic assessment of the relative investment in coastal infrastructure throughout the Shire and its relative exposure to coastal processes. Much of this infrastructure is an integral part of providing access to the coast (e.g. beach access stairs) and/or is required to be located at or near the coast (jetties/boat ramps, SLSC etc.).

As noted previously the focus of the risk assessment in this CHRMAP is on planning for the future provision of public infrastructure at the coast and the economic value of both existing and planned infrastructure. It is acknowledged that the sandy beach and coastal dunes are also assets that are highly valued by coastal communities, however a socio economic assessment of beach value is not within the present scope of works.

The identification of assets as very high risk or high risk does not necessarily mean they are at immediate risk of damage and/or should be removed. As is discussed in section 5, coastal adaptation measures may include prioritizing inspections, maintenance and strategic planning regarding long term use and maintenance of these assets. It is also noted that lower value high exposure assets, such as beach access, RSL memorial, Fisherman’s lease sites etc., require special consideration in the short term.

The tables in Attachment B provides a summary of the high risk assets

### 4.2. ASSET VALUATION

Asset were valued according to the estimates provided by the Shire, where available, or on assumed rates and quantities for typical assets [15]. The assets were then grouped according to nine categories, including eight categories of public infrastructure and a separate category for private assets, either residential property or private leases. This allowed each category to be assigned an asset cost rank of *High* (>\$500,000), *Moderate*, or *Low* (<\$100,000).



These nine asset categories were:

- Coastal stairs and platforms;
- Car parks;
- Buildings (large structures, toilets, change rooms etc.);
- Roads and adjacent paths;
- Coastal walkways;
- Coastal access paths;
- Public marine structures (e.g. boat ramps/jetties);
- Private assets (leasehold or residential), and;
- Landscaping, playgrounds and shelters.

### 4.3. ASSET EXPOSURE CLASSIFICATION

The overall exposure to coastal processes of the different assets was identified in accordance with the allowances mapped in the previous stage for the 10, 50 and 100 year timeframes (Attachment A). Assets were subject to *High* coastal exposure if they were sited within the 10-year planning allowance for coastal processes, *Moderate* coastal exposure within the 10-50 year planning area, and *Low* coastal exposure within the 50-100 year planning area. When an asset (such as a ramp or road) was located across the boundary of two areas, the higher exposure level was used for the whole asset.

**Table 4.1 Ocean Beach High Exposure Assets**

Coastal Node	High Exposure Assets	Description
<b>Prawn Rock Channel</b>	<ul style="list-style-type: none"> <li>• Coastal Stairs and Platforms.</li> <li>• Carparks.</li> <li>• Roads and Adjacent Paths.</li> </ul>	<ul style="list-style-type: none"> <li>• Floating walkway.</li> <li>• Gravel carpark.</li> <li>• Ocean Beach Rd (X00m).</li> </ul>
<b>Ocean Beach Lookout</b>	<ul style="list-style-type: none"> <li>• Coastal Stairs and Platforms.</li> <li>• Carparks</li> <li>• Coastal Access Paths</li> </ul>	<ul style="list-style-type: none"> <li>• Timber lookout platform.</li> <li>• Bitumen carpark.</li> <li>• Access path to lookout platform.</li> </ul>
<b>Ocean Beach</b>	<ul style="list-style-type: none"> <li>• Coastal Stairs and Platforms,</li> <li>• Coastal Access Paths</li> </ul>	<ul style="list-style-type: none"> <li>• Timber stairs and ramps.</li> <li>• Access paths to stairs.</li> </ul>
<b>Lions Lookout</b>	n/a	

**Table 4.2 Peaceful Bay High Exposure Assets**

Coastal Node	High Exposure Assets	Description
<b>Peaceful Bay</b>	<ul style="list-style-type: none"> <li>• Coastal Stairs and Platforms,</li> <li>• Coastal Access Paths</li> <li>• Public Marine Structures</li> </ul>	<ul style="list-style-type: none"> <li>• Timber stairs</li> <li>• Access paths to stairs.</li> <li>• Finger jetty</li> </ul>
<b>Foul Bay</b>	<ul style="list-style-type: none"> <li>• Coastal Access Paths</li> <li>• Leasehold or Residential Property</li> <li>• Landscaping</li> </ul>	<ul style="list-style-type: none"> <li>• Vehicle access track.</li> <li>• Fisherman's Lease</li> <li>• RSL memorial.</li> </ul>





#### 4.4. ASSET RISK

High risk assets for Ocean Beach and Peaceful Bay have been assessed using the coastal risk evaluation matrix (Figure 4.1). These are generally assets with high exposure to coastal processes with a value greater than \$100,000, or higher value assets (>\$500,000) with medium exposure to coastal processes (i.e. located further from the coast).

Beach access infrastructure at Ocean Beach and Peaceful Bay has also been identified for further analysis due to the high value placed on access to the coast in the community survey. In summary, the high risk assets identified for further analysis have been identified as:

##### *Ocean Beach*

- Prawn Rock Channel 300m Length of Ocean Beach Road and Adjacent Paths.
- Ocean Beach buildings (SLSC Building, Boat Shed/Kiosk, Toilet Block).
- Ocean Beach Coastal Stairs and Platforms at the SLSC.

##### *Peaceful Bay*

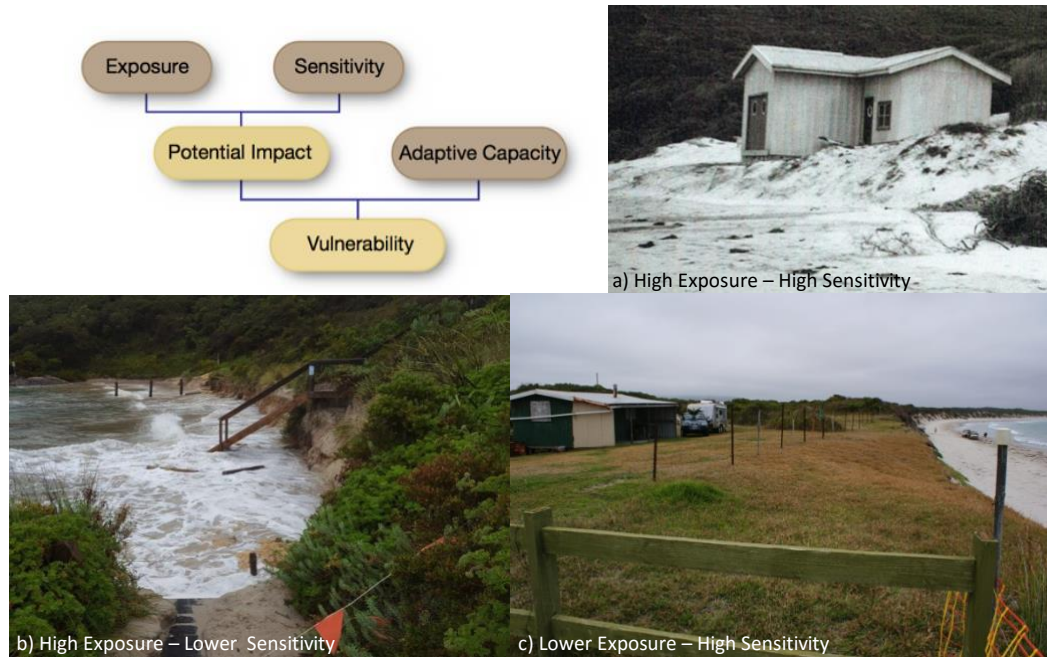
- Peaceful Bay Finger Jetty.
- Foul Bay 1,200m Length of Old Peaceful Bay Road and Adjacent Paths.
- Peaceful Bay 2 x Coastal Stairs.

#### 4.5. ASSET SENSITIVITY

The CHRMAP Guidelines [3] provide a flowchart for assessing the potential impact on coastal assets based on their exposure and sensitivity. Different assets may be expected to sustain differing degrees of damage should they be affected by coastal erosion or coastal inundation. Buildings on concrete slab foundations, for example, may be more sensitive to erosion than beach access stairs (Section 4.2).

The general *sensitivity* of the high risk coastal assets to coastal erosion or coastal inundation has been assessed. The sensitivity of high risk assets to coastal erosion/inundation is limited to a qualitative assessment based on visual inspection and interpretation of available information regarding the assets. This assessment classifies the sensitivity as very high, high or no sensitivity. The sensitivity analysis is outlined in Table 4.3 for Ocean Beach and Table 4.4 for Peaceful Bay.

It should be noted there is rarely enough design information on public infrastructure (i.e. as-constructed design drawings), or historic beach survey, to assess the sensitivity of individual assets to coastal erosion or inundation. For example, the sensitivity of beach access stairs to erosion requires design details including the depth of vertical supports and regular historic beach survey. Similarly, the vulnerability of individual assets cannot presently be assessed with confidence due to limited information on their sensitivity to erosion/inundation. However, this should be assessed in the future at a project scale where beach survey and design information is collected or collated.



**Figure 4.2 Potential Impact based on Exposure and Sensitivity for Old Boat Shed at Ocean Beach (a), Beach Access Stair (b) and Leasehold Buildings at Foul Bay (c)**

**Table 4.3 Ocean Beach High Risk Assets Sensitivity to Coastal Erosion and/or Inundation**

Coastal Node	Asset Type	Description	Sensitivity	
			Coastal Erosion	Coastal Inundation
Prawn Rock Channel	Roads and Adjacent Paths	Coastal road and footpath along channel, including wooden bridge	x	xx
Ocean Beach	Buildings	SLSC, Boat shed and toilet block	xx	x
Ocean Beach	Coastal Stairs and Platforms	Wooden stairs, ramps and viewing platforms	x	x

The following is noted regarding the sensitivity of assets:

- **x** - coastal asset is moderately sensitive to coastal erosion and/or inundation.
- **xx** - coastal asset is highly sensitive to coastal erosion and/or inundation



**Table 4.4 Peaceful Bay High Risk Assets Sensitivity to Coastal Erosion and/or Inundation**

ID	Asset Type	Description	Sensitivity	
			Coastal Erosion	Coastal Inundation
PB_1	Public Marine Structures	Finger jetty	x	
PB_2	Roads and Adjacent Paths	Coastal road with section leading to Sea Rescue Group car park	xx	x
PB_3	Coastal Stairs and Platforms	Wooden stairs and ramp	x	x

The following is noted regarding the sensitivity of assets:

- x - coastal asset is moderately sensitive to coastal erosion and/or inundation.
- xx - coastal asset is highly sensitive to coastal erosion and/or inundation

#### 4.6. EXISTING CONTROLS (RISK MANAGEMENT)

An assessment of the existing planning and coastal management controls has been undertaken for both sites. Further detail is provided in Section 5.4. The existing controls are summarized in the following sections for each site.

##### 4.6.1. Ocean Beach

- The main erosion control measures are the timber retaining wall adjacent to the Surf Club and the rock revetment along Ocean Beach road at Prawn Rock Channel.
- The surf club building is located in R24913, a large A-Class Reserve for the purpose of Parks and Recreation. The Management Order is with the Shire, which has power to lease for a maximum 21-year term.
- The existing lease for the surf club still has 13 years left until expiry. The Club is required to maintain the premises, however the Shire is responsible for repairs to structural components of the building (including footings/foundations, concrete slabs and masonry). There have already been some structural repairs required to the retaining structures on the seaward boundary of the lease.
- Both parties can provide written notice to terminate the lease. Termination of the lease does not waive the rights of either party to seek a payment for compensation should the lease be terminated early. This may require consideration should the surf club site be relocated.
- The 10-yr Concept Plan is effectively a Managed Retreat control for the risk to the surf club building. This is discussed further in Section 5.



#### 4.6.2. Peaceful Bay

- There are no existing erosion control measures along the coastline.
- Peaceful Bay is located within R24510, an A-Class Reserve with the purpose of Recreation, Camping Caravan Park and Holiday Cottages. The Management Order is with the Shire, which has power to lease for a maximum 21-year term.
- There are two leases in operation within the Peaceful Bay area. The most pertinent for the purposes of this project is for the Peaceful Bay Fishing Camp.
- The Fishing Camp lease was made on in July 2011 for a period of 10 years.
- Special Conditions relating to the lease required the Lessee to relocate all Building and Structures at least 10m from the top of the dune cliff, and furthermore maintain a 10m separation from the dune cliff at all times (notwithstanding degradation of the dune cliff). The initial relocation appears to have been achieved in 2012. It is unclear how the Lessee could continue to comply with the requirement to continually maintain a minimum 10m separation distance in the case of continual erosion or significant one-off event.
- Both parties can provide written notice to terminate the lease. Termination of the lease does not waive the rights of either party to seek a payment for compensation should the lease be terminated early.
- The lease contains a clause entitled 'Total Destruction of the Premises'. While not specifically mentioning coastal processes as a mechanism to *render the Premises substantially unfit for use and occupation* it could be argued that continued erosion of the reserve could invoke the options of the Lessee to terminate the lease under this clause.
- Realignment of Old Peaceful Bay road will require land to be excised from the existing A-Class Reserve (R24510) and dedicated as a road under the Land Administration Act.



## 5. Adaptation Planning

### 5.1. ASSET ADAPTIVE CAPACITY

Feasible adaptation options for each of the high risk assets were developed based on the adaptation hierarchy outlined in CHRMAP guidelines, which are summarized in Figure 5.1.



**Figure 5.1 Risk Management and Adaptation Hierarchy [3]**

- **Avoid** the presence of new development within an area identified to be affected by coastal hazards.
- **Planned or Managed Retreat** or the relocation or removal of assets within an area identified as likely to be subject to intolerable risk of damage from coastal hazards over the planning time frame.
- **Accommodation**: design and/or management strategies that render the risks from the identified coastal hazards acceptable.
- **Coastal Protection** works may be proposed for areas where there is a need to preserve the foreshore reserve, public access and public safety, property and infrastructure that is not expendable.

For this assessment, the **avoid** option has been interpreted as avoiding new development within the coastal areas where feasible. However, there is a community expectation that the Shire will continue to provide and improve public infrastructure in these coastal areas. This will require suitable planning to ensure any new assets are appropriately sited and suitably designed to accommodate future coastal erosion.

The **managed retreat** option requires the Shire, where there is existing infrastructure exposed to coastal processes, to remove or relocate the asset, thereby avoiding the risk associated with that asset. This requires consideration of *when* managed retreat should occur (i.e. management triggers) and *where* assets may be relocated if they continue to be required at the coast. This option is technically feasible for all assets although community consultation highlighted that these assets had a high social value and removal may not be favourable.

The **accommodation** option is primarily available to beach access and marine infrastructure (timber stairs, ramps, jetties) where these structures could be designed or adapted to allow for beach erosion or inundation.



**Coastal protection** is already in place at Ocean Beach (timber retaining wall) and Prawn Rock Channel (rock revetment) and plays a significant role providing public infrastructure and beach access at the coast. This option considers both the inspection and maintenance of existing coastal protection structures, and the siting, design and construction of new coastal protection works.

A summary of the adaptive capacity of existing high risk assets at Ocean Beach and Peaceful Bay is presented in the tables below with more detail outlined in Attachment C.

**Table 5.1 Ocean Beach Adaptation Options**

Asset	Adaptive Capacity			
	Avoid	Managed Retreat	Accommodate	Protect
Prawn Rock Channel 300m Length of Ocean Beach Road and Adjacent Paths			✓	✓
Ocean Beach buildings (SLSC, Boat Shed/Kiosk, Toilet Block)		✓	✓	✓
Ocean Beach Coastal Stairs and Platforms at the SLSC		✓	✓	✓

Note: The 300m length for Ocean Beach Road is based on the length of road between the Prawn Rock channel and the turnoff to the Ocean Beach lookout.

**Table 5.2 Peaceful Bay Adaptation Options**

Asset	Adaptive Capacity			
	Avoid	Managed Retreat	Accommodate	Protect
Peaceful Bay Finger Jetty			✓	
Foul Bay 1,200m Length of Old Peaceful Bay Road and Adjacent Paths		✓		✓
Peaceful Bay 2 x Coastal Stairs		✓	✓	✓

Note: The 1,200m for Peaceful Bay is based on the length of road within the 100yr allowance for coastal processes at Foul Bay.



## 5.2. ASSESSMENT OF ADAPTATION OPTIONS

### 5.2.1. Multi Criteria Analysis

A Multi Criteria Analysis (MCA) was undertaken on the feasible adaptation options defined for each high risk asset to determine the most suitable adaptation option for the asset. This considered:

- Functional requirements (performance)
- Physical conditions and technical data
- Constructability
- Maintenance requirements
- Economic considerations (including capital and maintenance expenditure)
- Environmental impacts
- Social Considerations

Details of the MCA are outlined in the tables in Attachment C. The MCA for the Ocean Beach Buildings, and the Peaceful Bay Road is shown in Figure 5.2. The MCA identified preferred adaptation options for the high risk assets as follows:

#### *Ocean Beach*

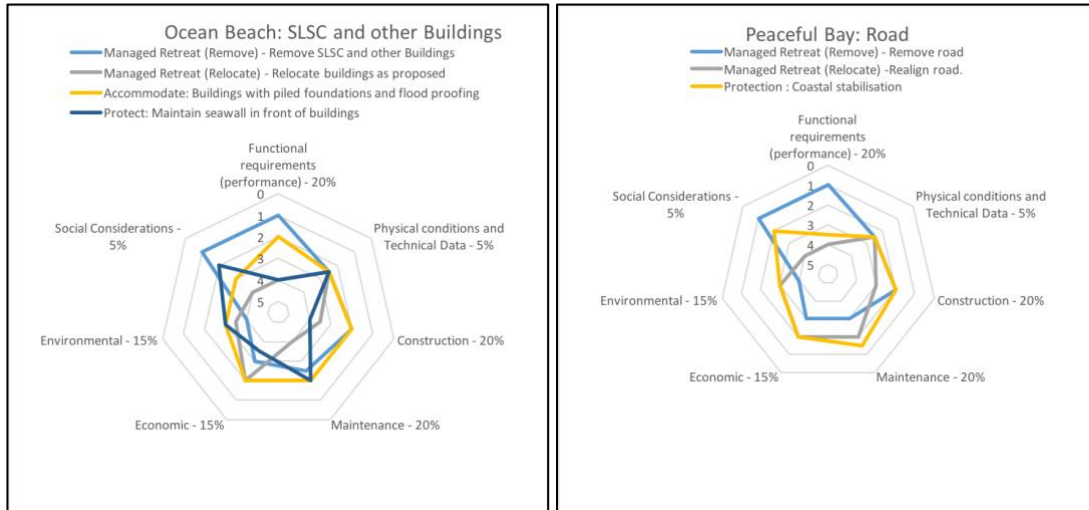
- Prawn Rock Channel 300m Length of Ocean Beach Road and Adjacent Paths – **Accommodate**
- Ocean Beach Building (SLSC, Boat Shed/Kiosk, Toilet Block) – **Managed Retreat (Relocate)/Protect\***
- Ocean Beach Coastal Stairs and Platforms at the SLSC – **Accommodate**

\*It should be noted that whilst managed retreat/protect is the preferred long term adaptation option, in the short term protection of the existing buildings is required through strategic monitoring and maintenance of the timber retaining wall. The trigger to change from protection to managed retreat may occur when the SLSC buildings are redeveloped or when it is no longer financially viable to continue to protect the buildings (either through the indirect cost of managing impacts on wider coastal area or through the direct cost associated with maintaining the retaining wall). However, the timber retaining wall may still be required to protect public open space and beach access.

#### *Peaceful Bay*

- Peaceful Bay Finger Jetty – **Accommodate**
- Foul Bay 1,200m Length of Old Peaceful Bay Road and Adjacent Paths – **Managed Retreat (Relocate)**
- Peaceful Bay 2 x Coastal Stairs – **Accommodate**

It should be noted however that this analysis identifies the broad approach to managing the risk of coastal erosion. The timeframe for implementation will vary between high risk assets, and the preferred management approach may also vary over time.



**Figure 5.2 Multi-Criteria Analysis for Ocean Beach SLSC and Buildings (left) and Peaceful Bay Road (right)**

Note: 5 = excellent; 4 = good; 3 = satisfactory; 2 = below average; 1 = poor. A value of 2.5 is used where the condition is not applicable, i.e. constructability for "Do Nothing" is not applicable

### 5.2.2. Cost Benefit Assessment

The Cost Benefit Assessment (CBA) was undertaken to provide financial analysis of potential adaptation costs and the resultant benefit. The cost was determined as the cost of implementing the adaptation option. Where the adaptation option was for managed retreat (relocate), the assumed cost was the cost of replacement of the asset. The cost for accommodate and protect are nominal estimates and representative of scale of cost only, but are based on the likely works required and previous experience with such works.

The benefit of each asset was taken as the value of the asset as outlined in the previous stage. This benefit only assumes the replacement cost and does not consider other values that may be attributed to the asset such as social, community and tourist revenue value. To quantify these values would require a specific economic study of the assets. The CBA ratios are summarized in the following tables and outlined in Attachment C, with a higher ratio representing a greater benefit relative to cost.

The following is noted:

- The highest CBA ratio is associated with an option to manage the risk of occasional inundation to the Ocean Beach adjacent to the Prawn Rock Channel road with traffic management.
- The maintenance and adaptation of the Peaceful bay finger jetty and beach access stairs at Ocean Beach have CBA ratios of 2 to 3.
- The managed retreat options have a CBA ratio of 1, as the new asset is located to avoid future exposure to coastal processes, and the Shire can realise the full benefit of the new asset.
- None of the options have a CBA ratio less than 1.





- Further economic analysis is required to assess the additional economic value of any proposals beyond the value of the new asset (e.g. lease value, economic revenue) and the potential implication on the socio economic value of the beach and coastal dune.

**Table 5.3 Ocean Beach CBA**

Asset	Cost	Benefit	CBA Ratio
<b>Prawn Rock Channel 300m Length of Ocean Beach Road and Adjacent Paths</b>	\$50,000.00	\$292,300	6
<b>Ocean Beach buildings (SLSC, Boat Shed/Kiosk, Toilet Block)</b>	\$2,392,800.00	\$2,392,800.00	1
<b>Ocean Beach Coastal Stairs and Platforms at the SLSC</b>	\$100,000.00	\$338,100.00	3

Note: The assumed cost for regular inundation of the Ocean Beach road at Prawn Rock channel is based on traffic management for regular road closures.

**Table 5.4 Peaceful Bay CBA**

Asset	Cost	Benefit	CBA Ratio
<b>Peaceful Bay Finger Jetty</b>	\$200,000.00	\$438,900.00	2
<b>Foul Bay 1,200m Length of Old Peaceful Bay Road and Adjacent Paths</b>	\$724,100.00	\$724,100.00	1
<b>Peaceful Bay 2 x Coastal Stairs</b>	\$97,620.00	\$100,000.00	1

### 5.3. RISK MANAGEMENT AND ADAPTATION STRATEGIES

The coastal areas of Ocean Beach and Peaceful Bay are complex and dynamic systems. As with many areas of the south coast of Western Australia, there are significant limitations to understanding how these coastal systems behave, and how they may respond in the future, as they have not been comprehensively monitored in the past.

Risk management and adaptation will require a program of systematic coastal monitoring including detailed beach survey and regular beach profile surveys, to complement existing photo monitoring, and inform future decision making. More detailed surveys would also assist with understanding coastal response in the future and help with adaptation and management planning.

Management and adaptation strategies specific to each coastal management area are outlined in the following sections.



### 5.3.1. Management and Adaptation at Ocean Beach

The infrastructure at Ocean Beach provides highly valued community assets. Community concerns centre on the continued function of these assets with minimal impact on the natural environment. Most assets are well cited away from the coastline and there is no immediate need for management actions. However, the timber retaining wall provides local protection to many of the public assets at the steep site by preventing erosion of the toe of the site and allowing beach access to be provided. Over time these assets will become increasingly vulnerable to coastal processes. In addition, the stability of the cliffs on which the Ocean Beach Lookout car park is situated have not been inspected for nearly 20 years [16].

The Shire should develop and implement a coastal monitoring plan for the Ocean Beach coastal management area with a detailed baseline survey and regular beach profile surveys south of Wilson Inlet as a first step in coastal adaptation planning. The initial monitoring should also include a geotechnical assessment of the cliffs on which the Ocean Beach Lookout car park is situated and inspections of the timber retaining wall protecting the SLSC buildings. Development and implementation of further coastal adaptation works will then be contingent upon observations from this monitoring exercise. An example is outlined below for Ocean Beach SLSC, working through the adaptation hierarchy, to demonstrate how suitable adaptation can be achieved.

**Example:** The Ocean Beach SLSC buildings are key community assets with high economic and social value. These facilities allow for the local community and visitors to safely use the beach. The SLSC boat shed is an older structure located at the toe of the primary dune in an area with high exposure to coastal processes. The main two story SLSC building is elevated on a relatively steep primary dune in an area with moderate exposure to coastal processes. A timber retaining wall, constructed in 1988 [17] and maintained by the SLSC, affords protection to the buildings and adjacent landscaped areas, and allows beach access either side of the wall. The timber retaining wall has piles to the limestone rock and horizontal sleepers to the “lowest water level possible” [17]. The Multi Criteria Analysis identified MANAGED RETREAT as the preferred coastal adaptation response for the two SLSC buildings at this site.

Beach monitoring will allow the Shire to better understand coastal behaviour and monitor exposure of the SLSC buildings to coastal processes. Historic shoreline behaviour is based on limited information but suggests cycles of erosion and recovery. However, better understanding of this behaviour is required to inform management decisions.



The implementation of coastal adaptation at this site requires consideration of the following:

- The SLSC boat shed structure was built in 1958 **[17]** and continues to provide a valuable service as a boat shed, patrol room and beach kiosk. The building is nearing 60 years old and inspections of the building and adjacent retaining walls are required to ensure it remains safe and fit for purpose. MANAGED RETREAT of this structure could be initiated by various *management triggers*, including:
  - At the end of the serviceable building life
  - Following significant storm damage
  - At the time of wider foreshore redevelopment, or
  - If beach monitoring shows unacceptable beach widths.
- Removal or relocation of the SLSC boat shed would AVOID future exposure to coastal processes however boats would need to be stored elsewhere in the SLSC building and transported to the beach, and kiosk facilities would also need to be provided elsewhere should the Shire seek to maintain this amenity.
- The main two-story SLSC building was built in 1987 **[18]**. Planning is being undertaken by the SLSC to upgrade this facility, with the preferred approach being the construction of a new building. This is a MANAGED RETREAT response that is identified in the 10-year concept plan developed by the Shire, with the new site located on the primary dune but slightly further from the coast. MANAGED RETREAT could be initiated by various *management triggers*, including:
  - At the end of the serviceable building life.
  - Following damage associated with slope instability or significant storm damage.
  - At the time of wider foreshore redevelopment.
- The new SLSC building site is setback 40m from the coast. However, subject to ground investigations, it may be possible to ACCOMMODATE the risks of future coastal erosion by pinning the foundations to underlying competent rock.



- Inspection and maintenance of the timber retaining wall is required to provide COASTAL PROTECTION to the SLSC boat shed and adjacent landscape areas, and allow the Shire to provide beach access either side of the wall. Whilst the relocation of buildings reduces the value of assets exposed to coastal processes, PROTECTION in some form is likely to be required in the longer term. In particular:
  - Should the Shire wish to retain this area as open space, as identified in the 10-year concept plan, the timber retaining wall would need to be maintained. This would also allow existing beach access stairs and ramps to be maintained.
  - Should the retaining wall fail at some time in the future, it would need to be reconstructed to protect the public open space and maintain beach access. The adjacent eroded dunes provide an indication of the extent of erosion that may rapidly occur with removal or failure of this structure. The capacity for the Shire to provide reasonable beach access in the present locations would be difficult with removal or failure of the timber retaining wall.
  - The feasibility of locating any new coastal protection structure further back from the beach would require further investigation. This may increase beach width locally if the Shire and community can accept a reduced area of public open space behind the new wall. The location, type and potentially high cost of any new coastal protection structure would need to be informed by coastal monitoring, geotechnical considerations, the 10-year concept plan and further community consultation.

### 5.3.2. Management and Adaptation at Peaceful Bay

The majority of assets at Peaceful Bay are set back from the coastline and are within the moderate to low coastal exposure areas. The assets within the high coastal exposure area have a relatively low replacement cost value, however they provide access for enjoyment of the coast and beaches and as such have a high social value.



Coastal monitoring at Peaceful Bay should focus on the erosion at the base of the dune adjacent to the RSL memorial and Fisherman's Lessee sites, which are immediately adjacent to the Peaceful Bay Road, and the seaward end of coastal access points. The coastal adaptation and management of Peaceful Bay would then be informed by the coastal monitoring outcomes. An example of coastal adaptation for the Peaceful Bay road and adjacent Fisherman's Lessee sites is outlined below, to demonstrate how suitable adaptation can be achieved by working through the adaptation hierarchy.

**Example:** The Fisherman's Lease site in Peaceful Bay is within the area with high exposure to coastal processes. Aerial photographs have identified that the dunes adjacent to the sites are eroding at about 1.4m/yr. Beach profile monitoring would better define the rate of erosion, improve understanding of potential causes (i.e. realignment of wider beach planform, limited sediment for post storm recovery) and would highlight the timeframes for implementation of coastal adaptation options (i.e. when a management action would be triggered).



The Shire would then undertake planning to determine the most suitable adaptation strategy based on the monitoring data and the adaptation hierarchy, which may be as follows:

- For the Fisherman's Lease site to continue to function as intended it is assumed it would need to be located at a new site in reasonable proximity to Peaceful Bay and the coast. Therefore, it may not possible to AVOID the risk by removing the lease site all together.
- Depending on local planning controls and discussions with the lessees, it may be possible to undertake MANAGED RETREAT of the site and relocate them to a lower exposure area. Based on the present buffers to the building (15m) and rates of erosion (1.4m/yr.), and the lease requirement to maintain a 10m buffer from the top of the erosion scarp, this may be required within 3 years. However, should the erosion continue, this would also progressively reduce the erosion buffer to the Peaceful Bay road, which is presently 33m from the road, but only about 20m from the seaward road reserve boundary. Future MANAGED RETREAT of the road may then be required within 10 years.
- To ACCOMMODATE the risk would require adapting the existing buildings and roads to withstand inundation and erosion. It is considered that this approach is not practical in this instance.



- It may be possible to stabilise the base of the dunes and PROTECT the asset with a seawall or groynes. This would be a relatively high cost option for protection of the leases that could be relocated and may have adverse impacts on the adjacent beaches. However, should the Peaceful Bay road become threatened by erosion, and removal or relocation of this section of the road either not be feasible or supported by the community, coastal protection works may be required to maintain the present level of road access to residential areas. Planning should ensure suitable coastal monitoring data is available at this time to better assess the present and future rates of erosion, likely causes and a suitable design response.

## 5.4. PLANNING CONSIDERATIONS

### 5.4.1. Ocean Beach

#### 5.4.1.1. Lease and management responsibilities

The surf club building is located in R24913, a large A-Class Reserve for the purpose of Parklands and Recreation. The Management Order is with the Shire, which has power to lease for a maximum 21-year term. The existing lease for the surf club still has 13 years left until expiry.

The Club is required to repair and maintain the premises, however the Shire is responsible for *Structural Building Repairs*. This term is defined in the lease as:

*substantial and major repairs or replacement of essential structures relating to all loads, internal actions, material properties and foundation conditions that significantly affect structural sufficiency or serviceability including but not limited to:*

- Floors
- Concrete Slab
- Masonry
- Roof Covering and Roof Structure
- Footings and Foundations
- Painting of External Surfaces
- Outer Walls of any construction but does not include windows, doors, doorframes and door furniture
- Ceilings
- Sewerage, drainage and water supply but does not include taps and other visible water fittings.

Arguably, it will become the responsibility of the Shire to physically support the premises via the 'footings/foundation' clause of the lease should erosion continue and the integrity of the building is affected as a result.



It is acknowledged that work has been undertaken by the club over many years to stabilise the grassed area in front of the original club building with the installation of a timber retaining wall constructed from timber piles, horizontal boards and rock spalls at the toe. From initial inspection and review of historic photographs this structure appears to be in reasonable condition. However, further engineering consideration is required to determine longevity of this solution, with this type of vertical structure generally being dependent upon the adjacent beach levels for its stability. An engineering inspection and maintenance regime is required for this structure going forward.



**Figure 5.3 Timber Retaining Wall in front of the Ocean Beach SLSC Buildings (date unknown, courtesy of the Denmark SLSC)**

Consideration is currently being given to the possible future relocation of the surf club further away from the beach to a more stable location. Given the nature of the Club a location close to, and with easy access to, the beach is necessary.

In an extreme scenario, both the Shire and the surf club can terminate the lease early, for whatever reason. Such a termination would not waive the rights of either party to seek a payment for compensation in such a scenario. Prior to taking such action, it would be recommended that the Shire and the Club seek to progress with relocation of the club or another amenable solution.

#### **5.4.1.2. Implications of SPP2.6**

State Planning Policy 2.6 – State Coastal Planning Policy contains a raft of policy provisions relating to planning around the coasts. Of relevance to the Shire of Denmark in this current context are Policy Measures 5.2, 5.4 and 5.5, relating particularly to the surf club facilities. These are addressed below.



Table 5.5 Policy Measure and Response

Policy Measure	Clause	Response
<b>Measure 5.2 – Development and Settlement</b>	Ensure that use of the coast, including the marine environment, for recreation, conservation, tourism, commerce, industry, housing, ocean access and other appropriate activities, is sustainable and located in suitable areas.	The Shire is currently undertaking a Precinct Planning approach to the relocation of the surf club building and associated infrastructure and use.
<b>Measure 5.4 – Building Height Limits</b>	<p>Maximum height limits should be specified as part of controls outlined in a local planning scheme and/or structure plan, to achieve outcomes that respond to the desired character, built form and amenity of the locality.</p> <p>The amenity of the coastal foreshore is not detrimentally affected by any significant overshadowing of the foreshore</p> <p>There is overall visual permeability of the foreshore and ocean from nearby residential areas, roads and public spaces.</p>	<p>Future relocation of the surf club to a higher point in the landscape will require visual assessment. The current Town Planning scheme does not include any height provisions that would apply in this locality and thus the onus will be on the Shire to ensure that these requirements are met.</p> <p>Clause 5.4 of the SPP provides a mechanism to specify building height limits in a local planning scheme and/or a structure plan. In this instance, the Shire is not intending to prepare a Structure Plan, however guide development on the site via a Foreshore Concept Plan. The Foreshore Concept Plan should consider building height limits that ensure visual amenity is maintained.</p>
<b>Measure 5.5 – Coastal Hazard Risk Management and Adaptation Planning</b>	<p>Where risk assessments identify a level of risk that is unacceptable to the affected community or proposed development, adaptation measures need to be prepared to reduce those risks down to acceptable or tolerable levels. Adaptation measures should be sought from the following coastal hazard risk management and adaptation planning hierarchy on a sequential and preferential basis:</p> <ul style="list-style-type: none"> <li>• Avoid</li> </ul>	The 100-year Coastal Process Allowance for Ocean Beach encompasses the area proposed for the development of a new surf club to replace the existing facility. The facility will be developed further back from the coast, and higher in the landscape, however the preferred option for dealing with this scenario under SPP2.6 is to AVOID the development.





Policy Measure	Clause	Response
	<ul style="list-style-type: none"> <li>• Retreat</li> <li>• Accommodate</li> <li>• Protect</li> </ul>	A variation to this policy requirement may apply – refer to text below.

More general policy measures relating to environmental impacts, access and water management are also applicable.

**5.4.1.3. Variations to SPP2.6**

Section 7 of SPP2.6 identifies several situations where variations to the policy may apply. In this instance, Policy Clause 7.6 can be considered:

*It is recognised that in the circumstances described below development may need to occur within an area identified to be potentially impacted by physical coastal processes within the planning time frame. Such development should always be considered within a coastal hazard risk management and adaptation planning process and should only proceed once adequate management and adaptation planning measures have been agreed, and which accord with the Avoid – Planned or Managed Retreat - Accommodate – Protect hierarchy stipulated in the policy General Measures.*

**7.6 Surf lifesaving clubs**

*Where there is a demonstrable need for coastal surf lifesaving club facilities including surf life saver lookouts in the public interest, preference should be given to clubs that are identified in a strategic plan and co-located with other facilities such as those described in sections 7.1 and 7.5.*

In this instance, there is a demonstrable need for a coastal surf lifesaving club in this locality, due to the popular nature of this section of beach and the frequent use it receives for various recreational purposes. The existing club also has a strong history on this site, which should be recognised. As such, the Shire, in conjunction with the club, are adopting a managed retreat from the existing site, followed by an accommodate/protect pathway once the new building is constructed.

**5.4.2. Peaceful Bay**

**5.4.2.1. Leases**

Peaceful Bay is located within R24510, an A-Class Reserve with the purpose of Recreation, Camping Caravan Park and Holiday Cottages. The Management Order is with the Shire, which has power to lease for a maximum 21-year term. There are two main leases in operation within the Peaceful Bay coastal area, being the Peaceful Bay Caravan Park and the Fisherman’s Lease. The most pertinent for the purposes of this project is for the Fisherman’s Lease (Peaceful Bay Fishing Camp,), which is within the 10-year coastal processes allowance.

The caravan park is largely non-affected by coastal process allowances.



#### **5.4.2.2. Fisherman's lease**

The Fishing Camp lease was made on in July 2011 for a period of 10 years.

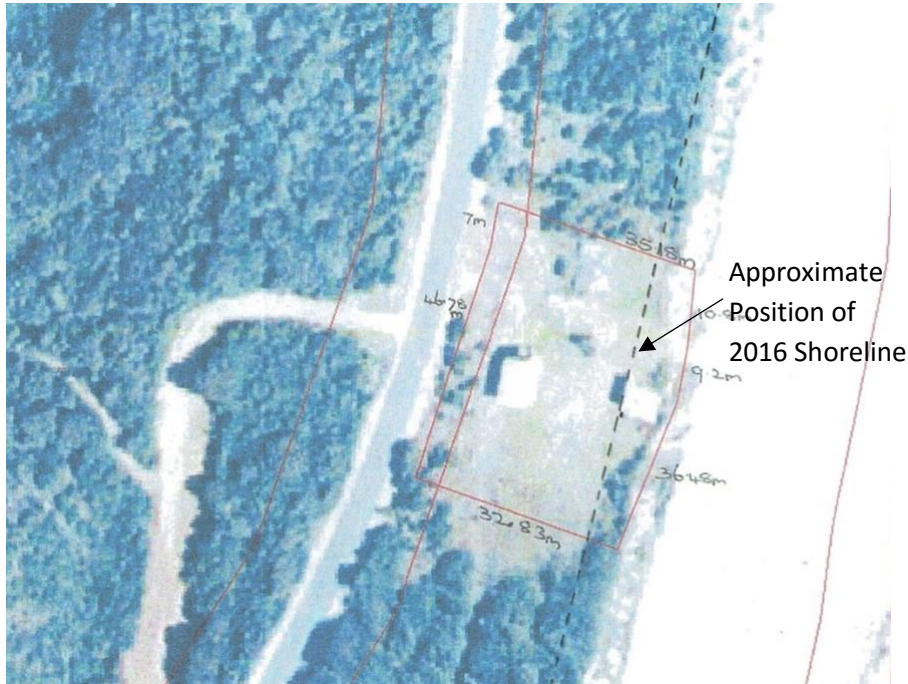
Special Conditions relating to the lease required the Lessee to relocate all Building and Structures at least 10m from the top of the dune cliff, and furthermore maintain a 10m separation from the dune cliff at all times (notwithstanding degradation of the dune cliff). The initial relocation appears to have been achieved prior to 2012. There was a 15m buffer as of March 2016.

The section of coast adjoining the lease is subject to active erosion processes (for further details refer to Section 2.4 of CHRMAP), with significant erosion of the dune cliff having occurred since 2002. It will likely be difficult for the Lessee to could continue to comply with the requirement to continually maintain a minimum 10m separation distance should erosion of the dune face continue, or following a significant one-off erosion event.

It should be noted that both parties can provide written notice to terminate the lease. Termination of the lease does not waive the rights of either party to seek a payment for compensation should the lease be terminated early.

Furthermore, the lease contains a clause entitled 'Total Destruction of the Premises'. While not specifically mentioning coastal processes as a mechanism to '*render the Premises substantially unfit for use and occupation*' it could be argued that continued erosion of the reserve could invoke the options of the Lessee to terminate the lease under this clause.

The lease currently has approximately 3.5 years to run. Renewing the lease after that date is not recommended, and it is suggested that measures be taken earlier than the lease expiry date to identify a new location for the lease to be transferred to. Given the rate of erosion at the current lease site, the Shire may need to take a conciliatory approach to enforcement of the 10m setback requirement.



**Figure 5.4 Schematic of Fisherman's Lease Boundary with Approximate Position of Shoreline in 2016**

#### 5.4.2.3. Road access

Old Peaceful Bay road is affected by the 50 and 100-year coastal process allowance. A pinch-point exists adjacent to the fishing camp lease, which, as explained above (and in Section 2.4), is located near an actively eroding coast. It is anticipated that road access at this particular point may become compromised at some point in the medium term.

Old Peaceful Bay Road provides access to the Fisherman's Lease as well as access to the caravan park and beach. It forms part of a loop road that connects back into Peaceful Bay Road and Rame Head Road, providing access to the residential properties in that area.

As Old Peaceful Bay Road becomes compromised by coastal processes a decision will need to be made to either:

- Protect the road in its current location
- Retreat: Relocate the road further inland
- Abandon the road.

**Protecting** the road in its current location requires further planning consideration and would be informed by coastal monitoring and investigations, and the implications and community support for relocating or removing the road.

**Relocating** the road to a position further inland is possible, however the cost of doing so may outweigh the benefits. Should the road be realigned to a position further inland, consideration will need to be given to a range of design and associated issues as outlined below.



*5.4.2.3.1. Amending the A-Class Reserve to excise a portion for road reserve*

A portion of the reserve will need to be excised and converted to road. Given the A-Class status of the reserve a more onerous process is required for road excision. The Minister for Lands is required to initiate this process and must:

- 1. Advertise this intention in a State newspaper*
- 2. No sooner than 30 days later, table the proposal before Parliament with an explanation.*

*Either House of Parliament then has 14 sitting days to pass a notice of disallowance.*

*5.4.2.3.2. Determining the most appropriate route given topographic variation*

A significant ridge is located to the immediate east of the caravan park, with varying topography beyond that. Construction of a road through this area would likely involve some engineering solutions (cut/fill) to create appropriate gradients.

*5.4.2.3.3. Considering environmental and biodiversity values*

The A-Class reserve in the location where a road realignment would occur is vegetated. Clearing Permits would be required. An environmental assessment of the vegetation and habitat values would also be required, which may identify the need for further assessment of any vegetation removal or modification under the Commonwealth Environmental Protection and Biodiversity Conservation Act.

*5.4.2.3.4. Consideration of heritage matters.*

The area is broadly affected by a registered Aboriginal Heritage site, named Little Groper Rock. Any development would need to consider the implications on this site.

The entire location bounded by Peaceful Bay Road/Old Peaceful Bay Road is included on the Shire's Municipal Inventory (Peaceful Bay Settlement – Original).

On reviewing the coastal process allowances for Peaceful Bay anything other than a major realignment would still result in the road being within either the 50 or 100-year allowance, which to some extent will always be a requirement for a coastal access road.

**Abandoning** the eastern half of the road in the longer term may have merit, particularly if the Fisherman's Lease is relocated to a more appropriate location. Access to the beach and caravan park can still be provided via the existing Peaceful Bay Road that extends behind the caravan park, and which are unlikely to be affected by coastal processes.



It should be noted that fire management and emergency access options will need to be considered in any future action.

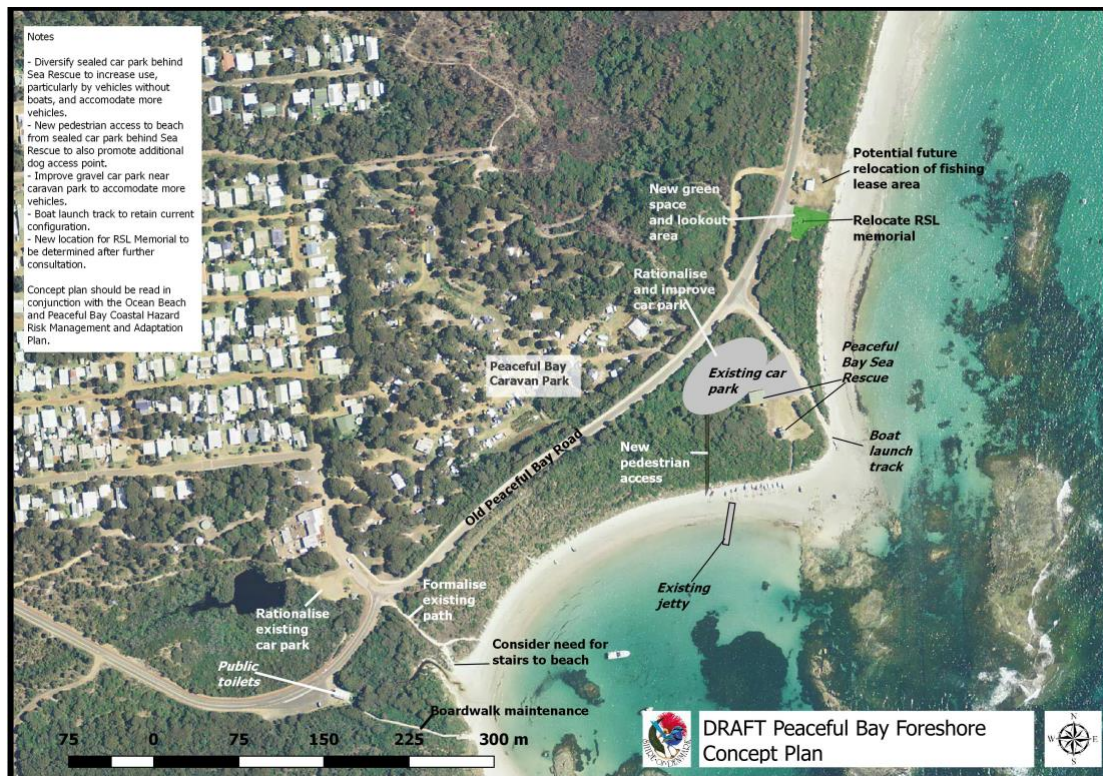
### 5.5. FUTURE DEVELOPMENT

A 10 year concept plan has been developed by the Shire in consultation with the stakeholder reference group for Ocean Beach and Peaceful Bay for development of future coastal assets. This precinct plan follows previous coastal planning work for the Coastal Reserves Management Strategy in 2011 [1] and an earlier Coastal Management Plan 2003 – 2008 [19]. These are illustrated in Figure 5.5 and Figure 5.6 for Ocean Beach and Peaceful Bay respectively.

In general, the principles of the State Coastal Planning Policy should guide future development. The future provision of *public recreational facilities with a finite lifespan* is accepted under SPP2.6 provided adequate hazard risk planning has been undertaken and that new structures are removed or modified if threatened by erosion. The general principle would be to, where practicable, avoid the potential future impact of coastal processes for the design life of the asset. This would generally preference siting of assets in the areas with lower exposure to coastal process where practicable. However, the suitable design and monitoring of beach access will continue to be required.



Figure 5.5 Ocean Beach 10 year Foreshore Concept Plan



**Figure 5.6 Peaceful Bay 10 year Foreshore Concept Plan**

The CHRMAP has focussed on existing assets, however the 10-year concept plans provide for both the provision of a small number of additional assets, and the relocation of some existing assets to reduce coastal hazards. A summary of the works proposed under the 10-year concept plan and an appropriate coastal adaptation strategy is outlined below.

#### *Ocean Beach*

- **New SLSC Building** – the concept positions the new SLSC building further inland from the coast, which is effectively managed retreat. The relocated building is still within the moderate coastal exposure area and will still require appropriate design and monitoring of erosion buffers, however it is considered that this is an appropriate adaptation strategy for a public leasehold building of this nature. Coastal monitoring and local geotechnical investigations of rock levels and slope stability should inform the siting and location of this new building.
- **Expanded parking** – Whilst this does not increase the exposure to coastal processes there will be a slight increase in the value of the asset. However, it is not anticipated to greatly influence the risk to the asset or change the proposed adaptation strategy from that proposed for the existing asset. The previous Reserves Management Strategy showed a larger carpark to the west of the existing, which would also be acceptable in terms of coastal exposure.
- **Widened gravel track** – widening the gravel vehicular access track to the beach will also increase the value of the asset, which increase the risk rating of this asset to a high risk asset. As with other access paths the main adaptation strategy for this type of asset is to realign the front edge of the track in line with coastline recession.



- Reinforced Entry point to beach – This would require careful design. However, the use of flexible materials (crushed limestone) and temporary structures would be preferable in the interim, to allow the access point to be removed during storm events and relocated following recession of the coastline. Any permanent solution for vehicular beach access should carefully consider the extent of underlying rock and impact on adjacent coast and dunes. Suitable temporary surfaces for reinforced entry points may include Durabase units (bog mats) used for seasonal beach launching of small boats in Geographe Bay, subject to further consideration of the potential loading and use of this entry point.
- Improvements to gravel car park layout and provision of drop-off and commercial parking – the extent of the parking and drop-off zones will need to carefully consider their proximity to the coast and potential to relocate in the future in line with coastline recession. Reinstatement of the foredune buffer between the vehicle beach access point and the surf club would be preferable, provided turning circles and amenity can be maintained. For example, we understand the dune in this area has previously been reinstated by sand nourishment (refer Figure 5.9).
- Lookout Beach Access – The Shire planned to install stairs to provide access to the beach from the Ocean Beach Lookout car park. This will require consideration of the stability of the limestone cliffs and appropriate siting of the access stairs to reduce the risk of failure of the stairs due to cliff collapse or beach erosion.



**Figure 5.7 Vehicle Access and Adjacent Turn Around Area at Ocean Beach**



**Figure 5.8 Weakly Lithified Sedimentary Rock Coast adjacent to Ocean Beach Lookout**



### *Peaceful Bay*

- Rationalising the existing car parking area adjacent to Sea Rescue Group buildings – The site is reasonable and the management and adaptation strategy would remain the same as previously, such that the car park is relocated as and when required and as identified by monitoring.
- New pedestrian access paths to Peaceful Bay beach – initial design will require consideration of the ability to accommodate the erosion risk. This may include piling supports of any stairs sufficiently deep to prevent collapse during erosion events. In addition, consideration will need to be given to the ability to realign the front edge of the access path in line with coastal erosion. This would be informed by beach monitoring.
- Relocation of the RSL memorial – this is effectively managed retreat of this asset, which is in line with the recommendations of this CHRMAP. A new site would need to be identified in consultation with the RSL and the community.

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## 5.6. SHORT TERM ADAPTATION (ASSETS WITH HIGH EXPOSURE TO COASTAL PROCESSES)

The 10-year concept plans include a number of short-term adaptation responses to assets with high exposure to coastal processes, including the Peaceful Bay Fisherman's Lease and RSL Memorial. Adaptation options for the assets with high exposure to coastal processes but lower economic value (i.e. they are not identified as high risk assets) are outlined in the following tables.

These assets were identified in Section 4.3. In general, the preferred adaptation options for these types of assets are accommodation and managed retreat. These assets generally have a lower economic value than the high-risk assets and greater capacity for accommodation (i.e. minor works to maintain functionality, or accept occasional flooding of low lying carparks) and relocation (e.g. Fisherman's Lease, RSL Memorial).

There are also a range of short-term adaptation options that can be considered by the Shire. These include beach nourishment as has occurred previously at Ocean Beach to reinstate foredunes at the back of the beach. Management of pedestrian access of coastal dunes also ensures existing dune buffers are maintained or enhanced prior to coastal storms.



**Figure 5.9 Coastal Adaptation Responses including Sand Nourishment and Dune Rehabilitation**



**Table 5.6 Ocean Beach Adaptation Options for High Exposure Assets**

Asset	Adaptive Capacity			
	Avoid	Managed Retreat	Accommodate	Protect
Prawn Rock Channel – Floating Walkway			✓	
Prawn Rock Channel – Gravel Carpark			✓	✓
Ocean Beach – Vehicle Access				
Ocean Beach Lookout – Timber Lookout Platform and Access Path		✓	✓	



**Figure 5.10 Ocean Beach High Exposure Assets:**

(a) Floating Walkway and (b) Carpark subject to occasional flooding at Prawn Rock Channel, (c) Ocean Beach Timber Lookout adjacent to limestone cliffs and in poor condition and (d) Vehicle beach access at Ocean Beach.



**Table 5.7 Peaceful Bay Adaptation Options for High Exposure Assets**

Asset	Adaptive Capacity			
	Avoid	Managed Retreat	Accommodate	Protect
Foul Bay – Vehicle Access			✓	
Foul Bay – Fisherman’s Lease		✓	✓	
Foul Bay – RSL Memorial		✓		



**Figure 5.11 Ocean Beach High Exposure Assets:**

(a) Vehicle Beach Access, (b) RSL Memorial and (c) Fisherman’s Lease.



## 6. Implementation

### 6.1. SHORT TERM (10 YEAR) PLANNING HORIZON

A 10-year program of works for Ocean Beach and Peaceful Bay has been developed to allow implementation of coastal adaptation and management strategies in the short term (10 years) and includes both Ocean Beach and Peaceful Bay (Figure 6.1). This has been developed in line with local government budgeting timeframes. Indicative costs have been included and implementation will be subject to available funding.

Key components of the plan include:

- Beach Monitoring: Detailed baseline beach and cliff surveys, annual beach monitoring (survey/photos) at all sites and 5-yearly detailed surveys.
- Inspections: Annual engineering inspections of coastal assets including buildings, beach access stairs and ramps, retaining walls and Peaceful Bay jetty.
- Prawn Rock Channel: Installation of tide board to monitor inundation of the road.
- Ocean Beach Lookout: Geotechnical inspections of limestone cliff stability and planning and construction of new access stairs.
- Ocean Beach SLSC Area: There are a number of works proposed including:
  - Monitoring and coastal erosion study after collection of 2-years initial data, including a detailed baseline survey of the beach (aerial scanning), photo monitoring and beach profile surveys.
  - Review of coastal protection options prior to relocation of the Boat Shed, in particular the feasibility and potential impacts relocating coastal protection further back on the beach.
  - Planning for building relocations.
  - Inspections of beach access infrastructure and adaptation.
  - Inspections and maintenance of timber retaining wall.
- Peaceful Bay: Monitoring and coastal erosion study after collection of 2-years initial data (photo monitoring, beach profiles). Planning and implementation for relocations of Fisherman's lease and RSL Memorial. Planning for adaptation options for Old Peaceful Bay road including consideration of coastal risk, emergency access, social and environmental values.

The program is informed by the coastal hazard assessment, with higher priority tasks being undertaken in the first few years. It is noted however that the program needs to be flexible. Management triggers for coastal hazards are expected to be refined following the first few years of coastal monitoring. However, management actions may also occur prior to being required in response to coastal hazards, such as at the time of wider foreshore redevelopment or the end of an assets design life.



The budget amounts are AACE Class 5 estimates [20] suitable for concept planning. These budget estimates should be reviewed and refined as part of the normal annual budgeting process for local government. The budget amounts are estimates for the particular item or projects, however it is acknowledged that parties other than the Shire of Denmark (e.g. SLSC fund raising, state funding bodies) may contribute funding towards particular items, which is discussed further in Section 6.4. In the program the “task cost” represents the budget amount for the 10 year planning period.

The following should also be noted:

- Pricings are indicative and they may vary depending on the capability of the Shire to undertake works in-house or within existing budgets.
- Funding opportunities are identified in Section 6.4
- Engineering inspections may be undertaken as part of Asset Management Plan requirements.
- Cost for some items may be for other organisations (not the Shire).
- Timing and budgets for concept plan works provided by the Shire.

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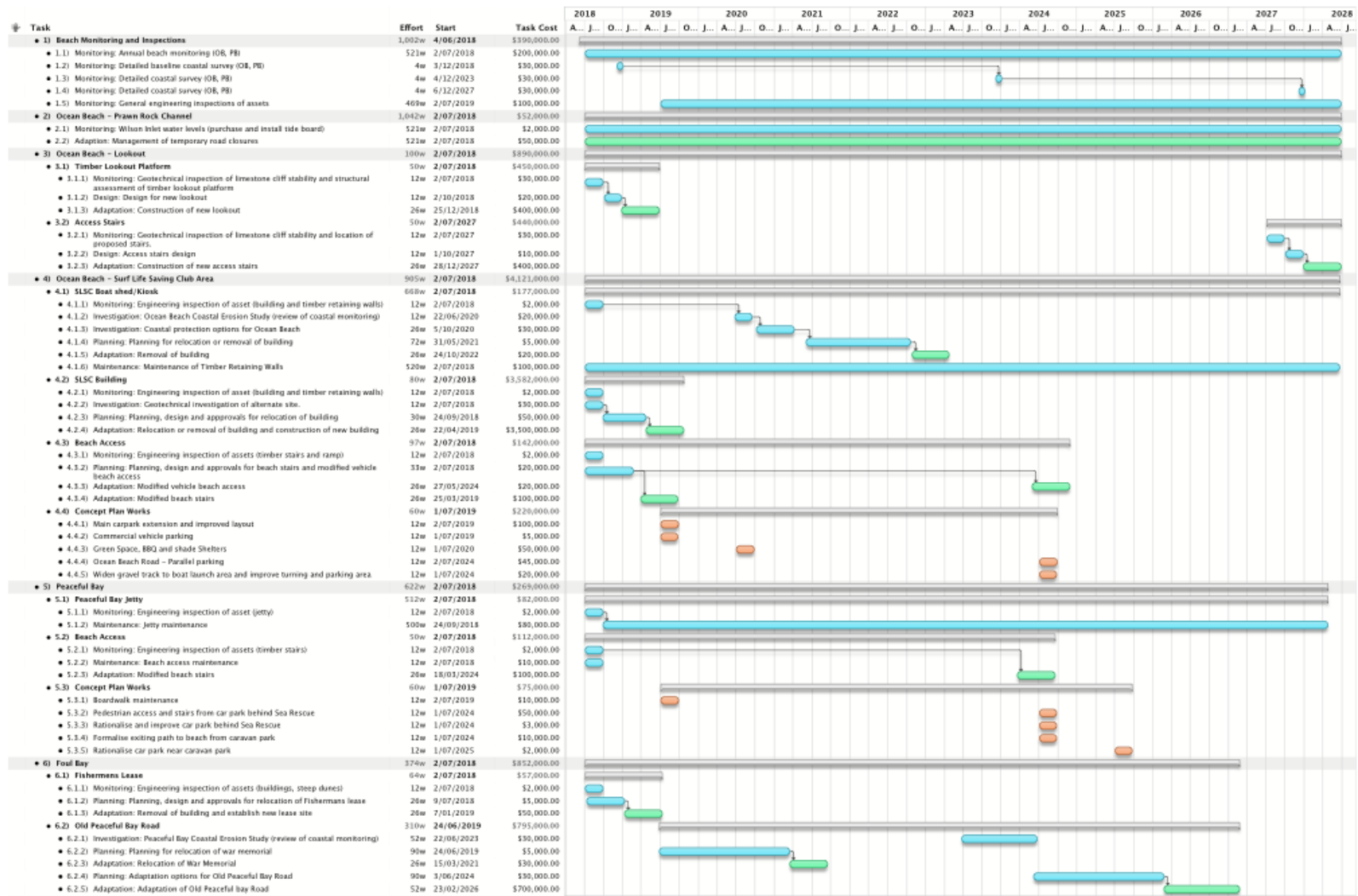


Figure 6.1 10 Year Works Program for Short Term Planning Horizon (10 years)



## 6.2. LONG TERM (100 YEAR) PLANNING HORIZON

The 10-year works plan addresses coastal management and adaptation over the short/medium term planning horizon. However, as the coastline changes in the future, the approach to coastal adaptation may need to change in the long term. For example, whilst the erosion risk to beach access stairs can be *accommodated* in the short term, should beach monitoring and inspections identify an ongoing beach erosion trend, stairs may need to be relocated in the future, which is a *managed retreat* strategy.

Similarly, whilst the coastal adaptation approach for SLSC buildings in the short/medium term is *managed retreat*, maintenance of the existing timber retaining wall at the back of the beach may be required in the longer term (*coastal protection*) to maintain POS and beach access once buildings are relocated. Potential management triggers have been identified for the SLSC Buildings but require closer consideration following the first two years of beach monitoring, and in the planning/design phase of particular projects. Potential management triggers have been identified for the Old Peaceful Bay road.

The management and adaptation strategies and approximate timeframes for the longer term planning period are outlined in Table 6.1 for Ocean Beach and Table 6.2 for Peaceful Bay. Ultimately, this will require the Shire and local community to better understand the unique behaviour of the local beaches through systematic coastal monitoring; to investigate how these particular beaches may respond to future sea level rise and changing climate; and to carefully consider the progressive implementation of longer term coastal adaptation options that provide beach access and suitable public facilities at these highly valued coastal areas.

**Table 6.1 Ocean Beach Longer Term Coastal Adaptation**

Coastal Asset	Planning Horizon (years)										
	5	10	20	30	40	50	60	70	80	90	100
Prawn Rock Channel: Ocean Beach Road and footpath along channel, including wooden bridge	Accommodate*					Protect					
Ocean Beach: Carpark and Lookout	Monitor		Managed Retreat								
Ocean Beach: SLSC and Sea Rescue Buildings (incl. toilets, change rooms etc.)	Monitor / Protect		Managed Retreat / Protect								
Ocean Beach: Coastal stairs and platforms	Accommodate			Managed Retreat							

\*Accommodate based on road closure during water level events >1m AHD (road height). Change to Protect occurs when Highest Astronomic Tide (0.7m AHD) + SLR = 1m AHD (SLR in 40 years = 0.3m as per [2]).



**Table 6.2 Peaceful Bay Longer Term Coastal Adaptation**

Coastal Asset	Planning Horizon (years)										
	5	10	20	30	40	50	60	70	80	90	100
Peaceful Bay: Finger Jetty	Accommodate										
Foul Bay: Old Peaceful Bay Road	Monitoring/ Planning		Protect or Managed Retreat								
Peaceful Bay: Coastal stairs and platforms	Accommodate			Managed Retreat							

### 6.3. ROLES AND RESPONSIBILITIES

The responsibility for the implementation of the Management and Adaptation Plan is with the Shire. Notwithstanding this, the Department of Transport (DoT) and the Department of Planning, Lands and Heritage (DPLH) also take an active role in management and planning of the State’s coast.

The Shire would implement most the works outlined in the program. However, additional expertise for investigations, survey and monitoring is also available from the Department of Transport.

### 6.4. FUNDING

The works outlined in the coastal program are subject to the Shire’s planning and works department annual budgets. There are a number of funding avenues open to help with coastal management and adaptation works. These should be explored to assist with funding for the works program outlined above.

The majority of coastal management and adaptation works in other shires throughout Western Australia are funded through the Department of Transport Coastal Adaptation and Protection Scheme (CAPS) grants. This funding scheme is available for investigations, monitoring, maintenance and capital works on coastal protection and adaptation structures and strategies. Funding should therefore be sought for all works within the program other than for those specifically related to boat ramps. More detail on the CAPS grant scheme is provided on the DoT website at:

<http://www.transport.wa.gov.au/imagery/coastal-adaptation-and-protection-cap-grants.asp>

The other funding avenue specifically open to works associated with boat ramps is the Department of Transport Recreational Boating Facilities Scheme (RBFS) grants. This grant scheme is aimed at improving boating facilities within Western Australia and should be considered for the boat ramp and jetty inspections and any upgrades identified as a result. Again, more detail is available on the DoT website at:





<https://www.transport.wa.gov.au/inline/recreational-boating-facilities-scheme-rbfs-grants.asp>

Coastwest is a State Government initiative aimed at providing opportunities for Western Australians to learn about, conserve and protect our coast. The Department of Planning, Lands and Heritage administers the Coastwest program on behalf of the Western Australian Planning Commission.

The objectives of Coastwest grants are to:

- Contribute to the implementation of local and regional coastal plans and strategies, especially those devised in accordance with SPP2.6
- Assist in the identification, protection and maintenance of environmental values, aesthetic qualities, biodiversity and water quality in the coastal zone
- Foster sustainable recreational and tourist use of the coast by assisting in the maintenance of the recreational amenity and provision of public access to the coast
- Build capacity in Western Australian communities to increase their involvement in coastal zone management activities, through joint coastal research activities, education and training.

Coastwest grants support land managers and community organisations to undertake rehabilitation, restoration and preventative projects that implement adopted local or regional coastal plans to manage and enhance the coast. Coastwest may fund a variety of activities including on-ground actions, site or local area planning, identification and monitoring, and capacity building.

For more detail refer to the WAPC website at:

<https://www.planning.wa.gov.au/coastwest.aspx>

## **6.5. APPROVALS**

Whilst the majority of the works outlined in the program are for monitoring and investigation and would not require any approvals, it will be appropriate to consider the approvals process should any capital or maintenance works be required in the future.

If maintenance or capital works require the clearing of vegetation clearing permits should be sought from Department of Water and Environmental Regulation (DWER). In addition, land tenure should also be investigated prior to the commencement of any works and approval sought from relevant authorities (including DPLH). Consideration will need to be given to Indigenous and European heritage issues and native title.



## 6.6. REVIEW AND UPDATE

In order to allow for the continued and effective management of the coastal zone it is proposed that the program outlined in Section 6.1 is updated on an annual basis. This would be undertaken following the completion of the works program for that year. This would allow for the integration of any works resulting from the monitoring and investigation exercises in the future program.

In addition, it is proposed that the CHRMAP is re-evaluated following the 2027/2028 program of works (in Year 10). This would allow the inclusion of the investigations proposed over the next 10 years allowing for a more detailed assessment and re-evaluation of the coastal risks and hazards. It would also allow a re-evaluation of local, state and federal policies and the most effective adaptation and management options for the coastal assets.

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## 7. Conclusions

The CHRMAP identifies adaptation responses to erosion and inundation of coastal assets at Ocean Beach and Peaceful Bay. This follows a systematic assessment of coastal hazards, risk, and adaptation planning options.

Planning allowances for exposure to coastal processes have been mapped at Ocean Beach and Peaceful Bay for 10, 50 and 100 years planning periods. These are not predictions of future shoreline position, but rather allow the adaptation of coastal assets to be prioritised based on a relative level exposure to coastal processes, or proximity to the coast. These maps should be considered and integrated with other Shire planning policies to ensure development is suitably located and well planned within the coastal area.

Community consultation highlighted the high social value placed on coastal assets throughout the Shire and the importance of maintaining these assets through sensitive adaptation strategies.

The risks to the Shire's coastal assets at Ocean Beach and Peaceful Bay has been assessed for defined coastal nodes based on exposure to coastal processes and estimates of the value of mostly public assets.

Adaptation planning has been undertaken for the high-risk assets at Ocean Beach and Peaceful Bay. This has focused on recommendations for the most suitable adaptation strategy for each high-risk asset based on the adaptation hierarchy outlined in SPP2.6 (avoid, managed retreat, accommodate, protect). The preferred adaptation options have also been assessed based on a multi criteria analysis and an assessment of the cost benefit ratio.

*Managed retreat* (i.e. the relocation of infrastructure that is threatened by coastal erosion) is feasible at a number of sites. In particular at Foul Bay, where the assets at threat initially are a leasehold property and the RSL Memorial that can feasibly be relocated.

*Managed retreat* is also feasible for the two SLSC buildings at Ocean Beach, however *Protection* (initially maintenance of the timber retaining wall) will be required to retain the present level of beach access and the future provision of landscaped areas and public amenities. In the longer term, coastal monitoring should inform decisions on the location and type of coastal protection required at Ocean Beach that balances beach amenity, access to the beach, public open space and amenities.

Beach access stairs and timber lookouts will require inspections and adaptation to *Accommodate* future coastal change. This may require adaptation of existing structures to better accommodate dune erosion and variable beach levels.

The long term potential for coastal erosion to threaten Old Peaceful Bay Road at Foul Bay requires a better understanding of the cause of the erosion. Coastal adaptation requires consideration of coastal hazards (erosion and inundation), emergency access and wider social and environmental values.

The CHRMAP provides a detailed 10-year implementation plan for the maintenance of existing assets and the provision of future assets as identified in the Shire's foreshore 10-year concept plan.



In the longer term, coastal adaptation will require the Shire and local community to better understand the unique behaviour of the local beaches through systematic coastal monitoring; to investigate how these particular beaches may respond to future sea level rise and changing climate. In addition, this will require careful consideration of longer-term coastal adaptation options that continue to provide beach access and suitable public facilities at these highly valued coastal areas.

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## 8. References

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## Attachment A Coastal Hazard Mapping

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## Attachment B Risk Analysis Table

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## **Attachment C Adaptation Option Assessment**

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## Attachment D Community Consultation Feedback

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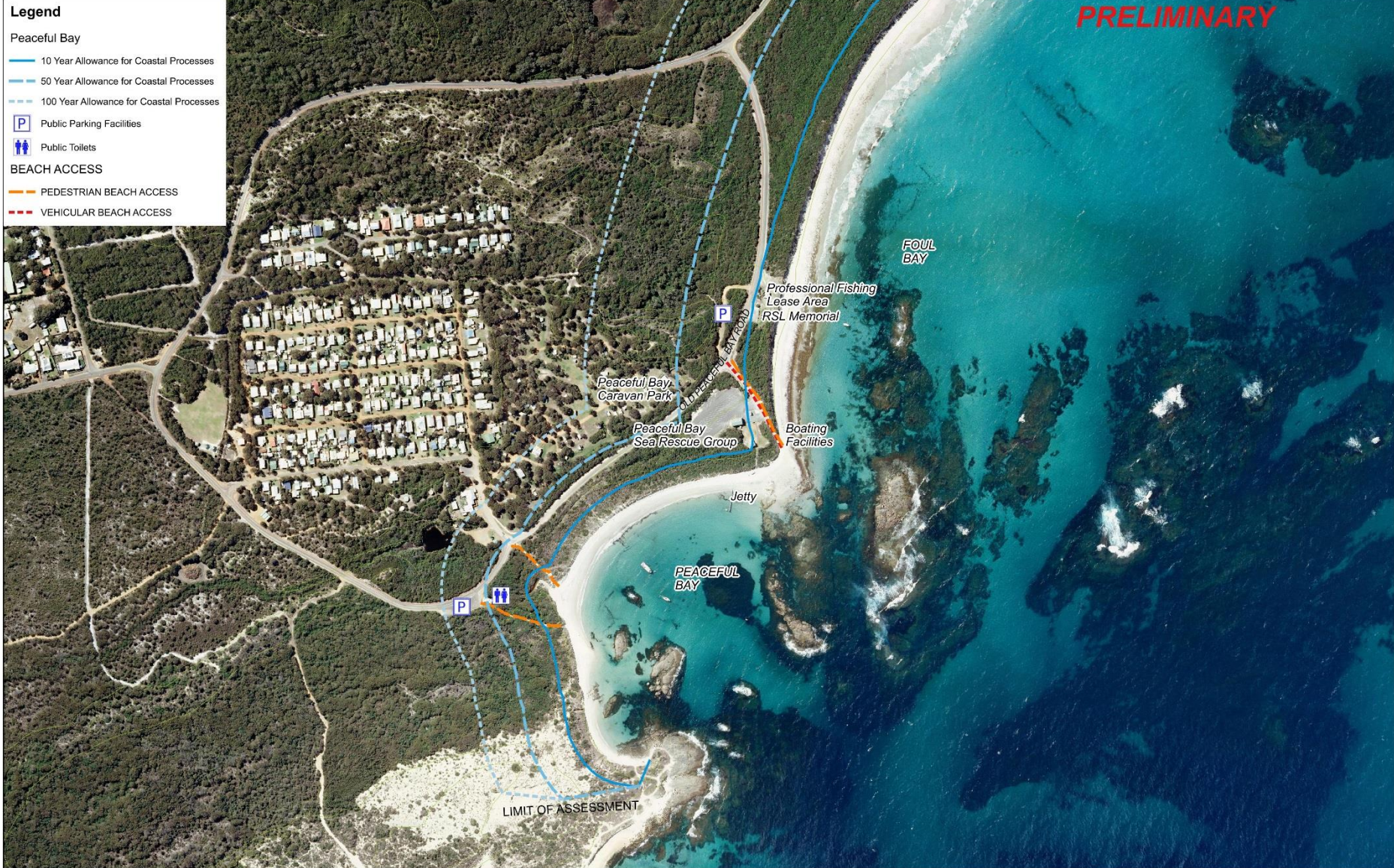
**Legend**

Peaceful Bay

- 10 Year Allowance for Coastal Processes
- - - 50 Year Allowance for Coastal Processes
- - - - - 100 Year Allowance for Coastal Processes
- P Public Parking Facilities
- ♂ ♀ Public Toilets

**BEACH ACCESS**

- PEDESTRIAN BEACH ACCESS
- - - VEHICULAR BEACH ACCESS



				<p><b>NOTES:</b></p> <ol style="list-style-type: none"> <li>1. AERIAL IMAGE JANUARY 2016</li> <li>2. CONTOURS FROM LANDSCAPE</li> <li>3. COASTAL EROSION ALLOWANCES HAVE BEEN DETERMINED USING METHODS OUTLINED IN SCHEDULE 4 OF DPPL</li> <li>4. ALLOWANCES ARE BASED ON AVAILABLE DATA AT THE TIME OF STUDY</li> <li>5. ALLOWANCES ARE NOT A PREDICTION OF THE SHORELINE POSITION AT THE END OF THE RESPECTIVE PERIODS</li> <li>6. THESE PLANS DO NOT HAVE THE PRECISION REQUIRED TO DEFINE THE EROSION RISK TO INDIVIDUAL PROPERTIES</li> <li>7. ALLOWANCES FOR COASTAL PROCESSES HAVE BEEN ROUNDED TO THE NEAREST 5 METERS AND HAVE BEEN OFFSET FROM THE HORIZONTAL VECTOR DATUM GRID</li> <li>8. THE RED IS DEFINED AS THE 5 SH AND CONTOUR WHICH IS NORMALLY THE VEGETATION LINE</li> <li>9. COASTAL HAZARDS IN THE VICINITY OF LIMESTONE CLIFFS REQUIRE FURTHER ASSESSMENT BY A GEOTECHNICAL ENGINEER. UNDERLYING ROCK HAS THE POTENTIAL TO SIGNIFICANTLY AFFECT THE EXTENT OF COASTAL HAZARD.</li> </ol>		<p>SCALE 1:5,000</p> <p>50 0 50 100 150 200</p> <p>DATUM</p> <p>VERTICAL AUSTRALIAN HEIGHT DATUM (AHD)</p> <p>HORIZONTAL MAP GRID OF AUSTRALIA, BASED ON GDA94</p>		<p><b>ACTION</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>ENGINEER</td><td>SB</td><td>SIGNATURE</td><td>DATE</td></tr> <tr><td>DRAWN</td><td>OS</td><td></td><td>22/12/16</td></tr> <tr><td>ENGINEERING CHECK</td><td></td><td></td><td>22/12/16</td></tr> <tr><td>DRAFTING CHECK</td><td></td><td></td><td></td></tr> <tr><td>APPROVED PROJECT MANAGER</td><td></td><td></td><td></td></tr> </table>		ENGINEER	SB	SIGNATURE	DATE	DRAWN	OS		22/12/16	ENGINEERING CHECK			22/12/16	DRAFTING CHECK				APPROVED PROJECT MANAGER						<p>SHIRE OF DENMARK COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN PEACEFUL BAY ALLOWANCE FOR COASTAL PROCESSES</p>	
ENGINEER	SB	SIGNATURE	DATE																														
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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>REVISED FOLLOWING CLIENT REVIEW</td> <td>OS</td> <td>SB</td> <td></td> </tr> <tr> <td>PRELIMINARY</td> <td>OS</td> <td>SB</td> <td></td> </tr> <tr> <td>AMENDMENT</td> <td>DRN</td> <td>SEBON APPROVAL</td> <td></td> </tr> </table>				REVISED FOLLOWING CLIENT REVIEW	OS	SB		PRELIMINARY	OS	SB		AMENDMENT	DRN	SEBON APPROVAL		<p>PROJECT NO: A3</p> <p>PROJECT NAME: Seashore/2 Seashore Projects/02/20 Denmark CRRM/10, CRRM/11 Hazard Assessment</p> <p>DATE: 22/12/16</p> <p>SCALE: SE050</p>				<p>DRAWING NUMBER <b>SE050-01-01</b> REV <b>B</b></p>													
REVISED FOLLOWING CLIENT REVIEW	OS	SB																															
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**PRELIMINARY**

**Legend**

**Ocean Beach**

- 10 Year Allowance for Coastal Processes
- 50 Year Allowance for Coastal Processes
- 100 Year Allowance for Coastal Processes

**Public Parking Facilities**

**Public Toilets**

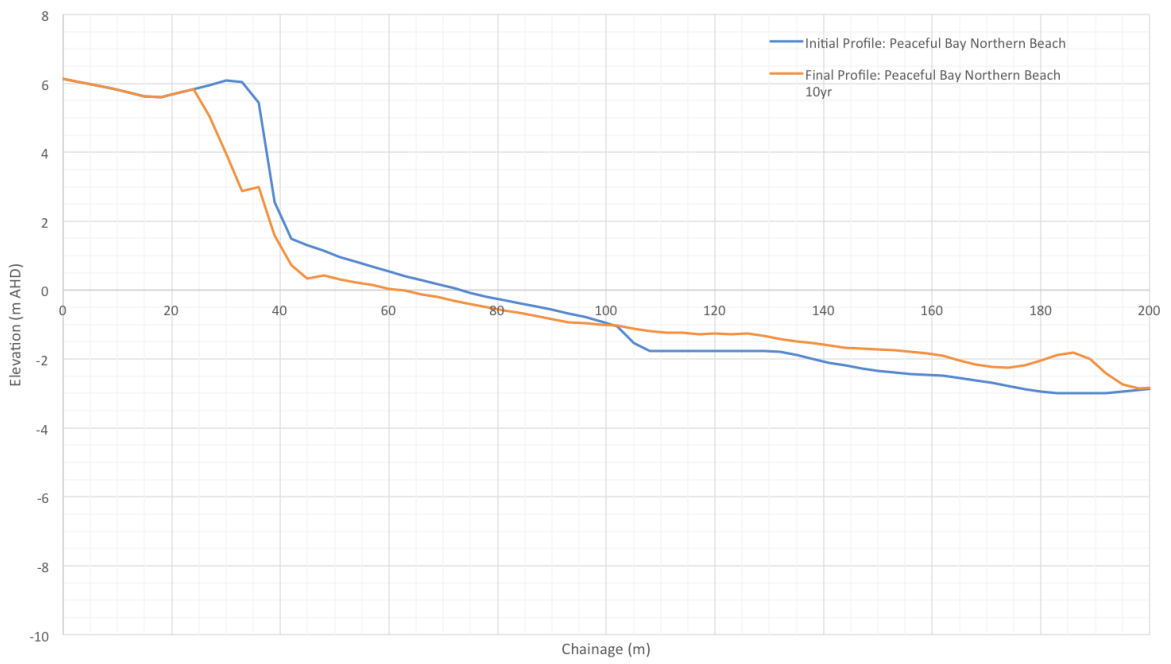
**BEACH ACCESS**

- PEDESTRIAN BEACH ACCESS
- VEHICULAR BEACH ACCESS

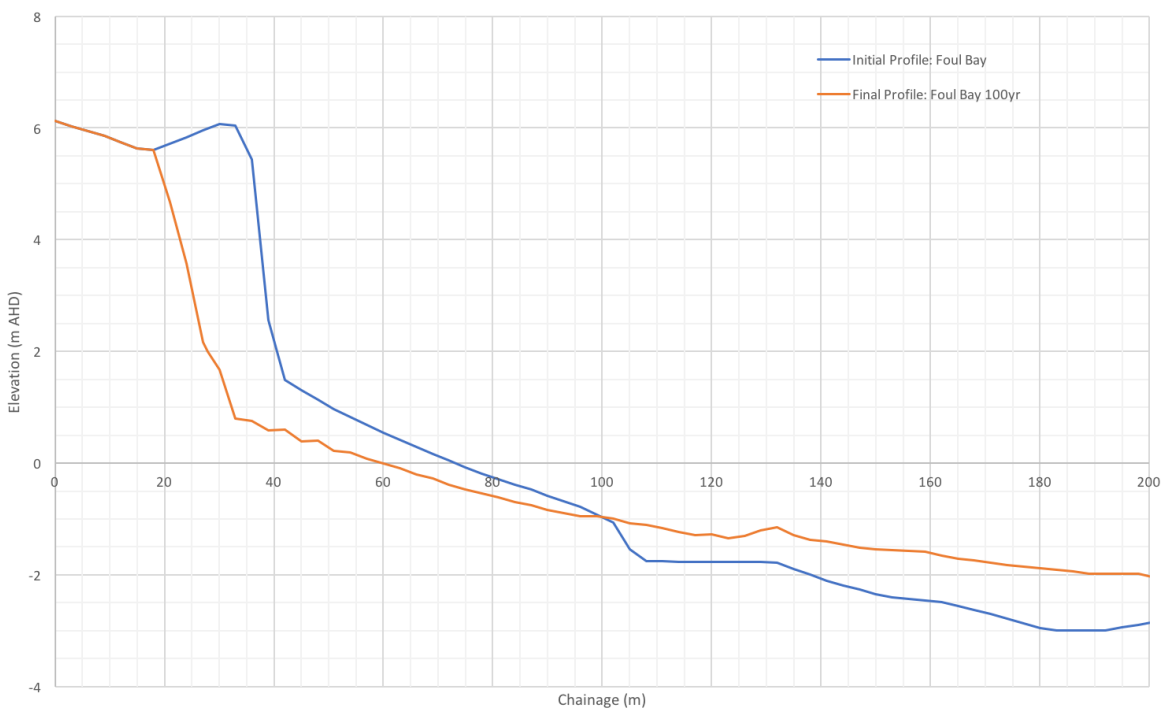


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				2. CONTOURS FROM LANDSCAPE		DATUM		SB		22/12/16			
				3. COASTAL EROSION ALLOWANCES HAVE BEEN DETERMINED USING METHODS OUTLINED IN SCHEDULE 1 OF SPEC.		VERTICAL AUSTRALIAN HEIGHT DATUM (AHD)		DRAWN		OS			
				4. ALLOWANCES ARE BASED ON AVAILABLE DATA AT THE TIME OF STUDY.		HORIZONTAL MAP GRID OF AUSTRALIA, BASED ON GDA94		ENGINEER'S CHECK					
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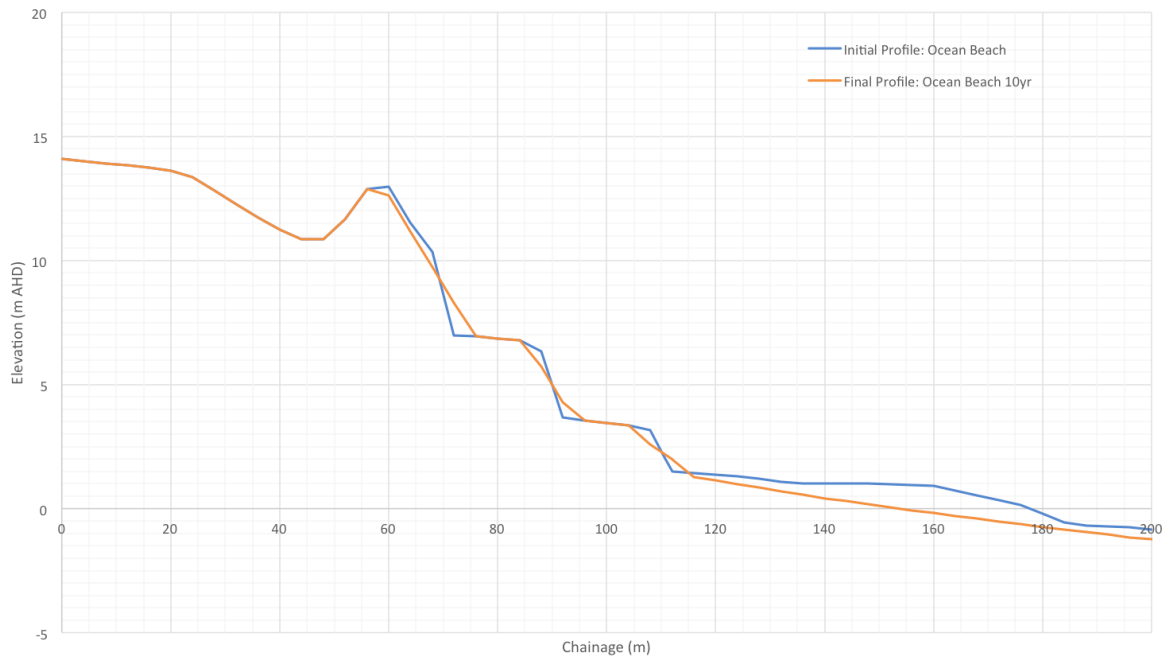
Peaceful Bay Northern Beach SBEACH 10yr Output



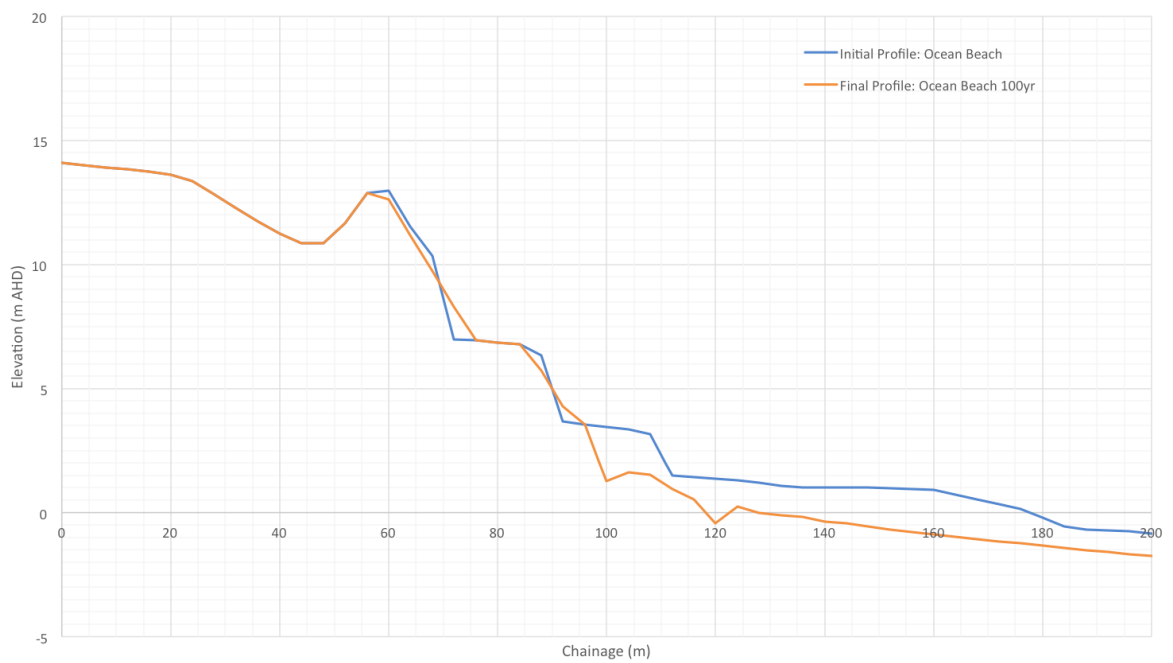
Foul Bay SBEACH 100yr Output



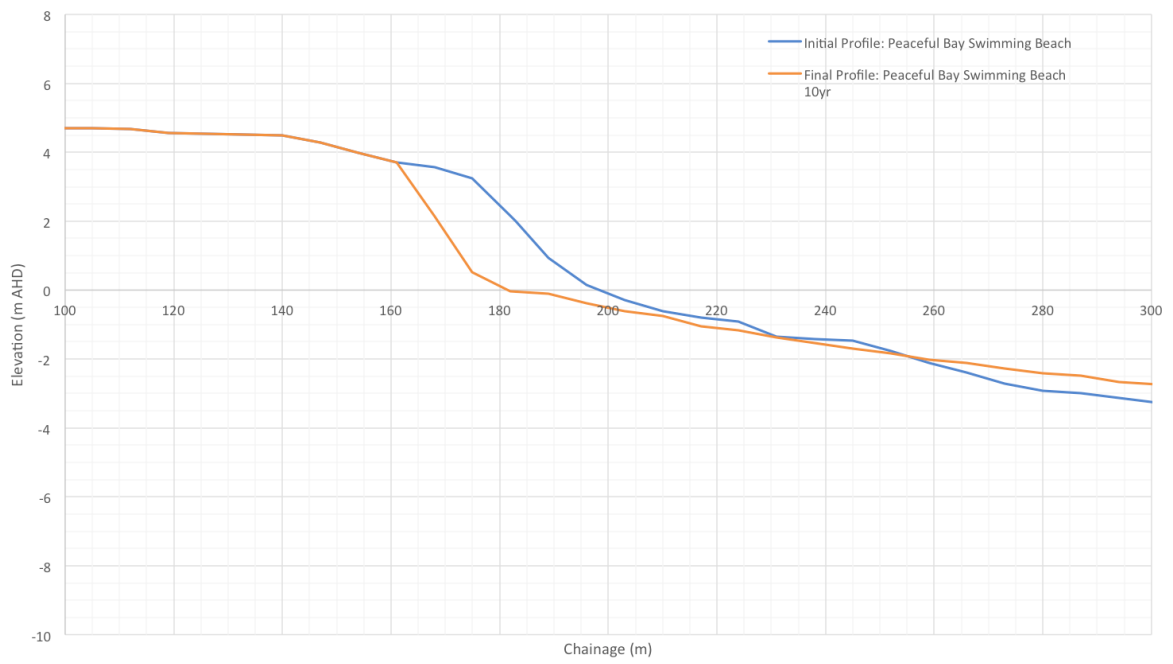
Ocean Beach SBEACH 10yr Output



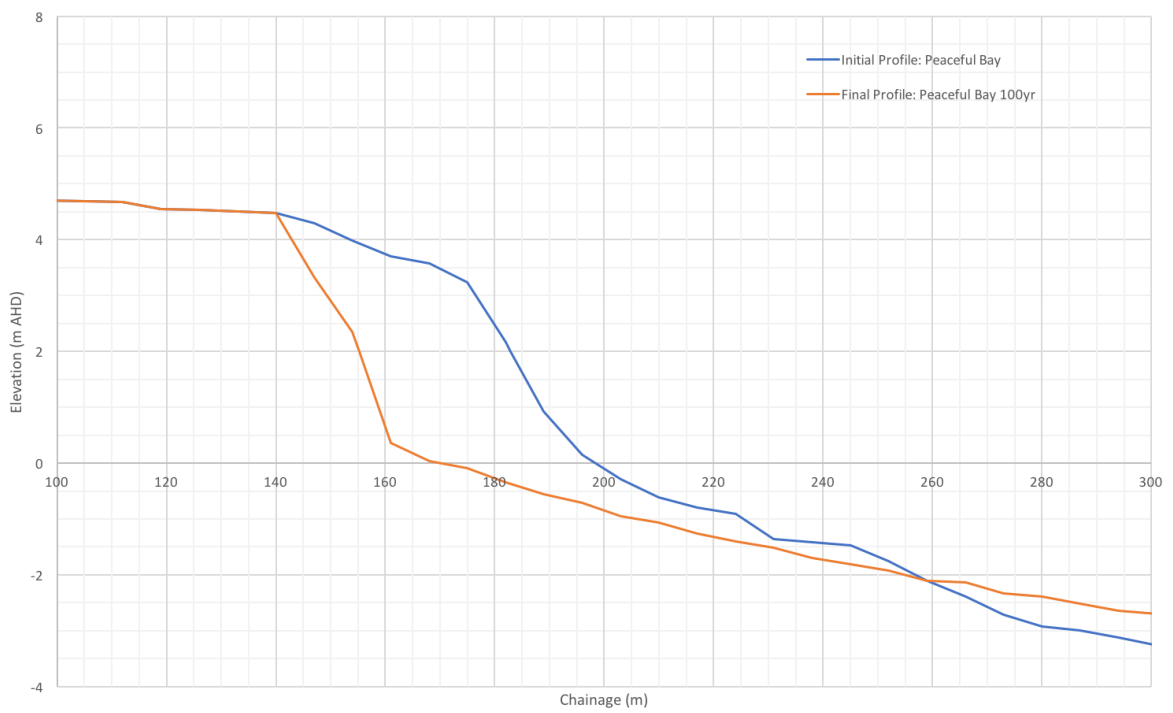
Ocean Beach SBEACH 100yr Output



Peaceful Bay (Swimming Beach) SBEACH 10yr Output



Peaceful Bay SBEACH 100yr Output



10yr	Coastal node	Peaceful Bay (Boat Launching Beach)	Foul Bay (In front of Memorial and Fishermans Lease)	Ocean Beach (In front of Surf Club)
	Coastal Type	Sandy Coast	Sandy Coast	Sandy Coast
Storm erosion	S1	24	18	8
Long-term Trend	S2	0	14	5
Erosion due to SLR	S3	4	4	4
Factor of Safety	FoS	2	2	2
Inundation	S4	5m AHD contour		
Subtotal (m)		30	38	19
10yr Coastal Processes Allowance Including Rounding (m)		30	40	20

50yr	Coastal node	Peaceful Bay	Foul Bay	Ocean Beach
	Coastal Type	Sandy Coast	Sandy Coast	Sandy Coast
Storm erosion	S1	46	24	16
Long-term Trend	S2	0	70	25
Erosion due to SLR	S3	35	35	35
Factor of Safety	FoS	10	10	10
Inundation	S4	5m AHD contour		
Subtotal (m)		91	139	86
20yr Coastal Processes Allowance Including Rounding (m)		90	140	85

100yr	Coastal node	Peaceful Bay	Foul Bay	Ocean Beach
	Coastal Type	Sandy Coast	Sandy Coast	Sandy Coast
Storm erosion	S1	46	24	16
Long-term Trend	S2	0	140	50
Erosion due to SLR	S3	90	90	90
Factor of Safety	FoS	20	20	20
Inundation	S4	5m AHD contour		
Subtotal (m)		156	274	176
100yr Coastal Processes Allowance Including Rounding (m)		155	275	175

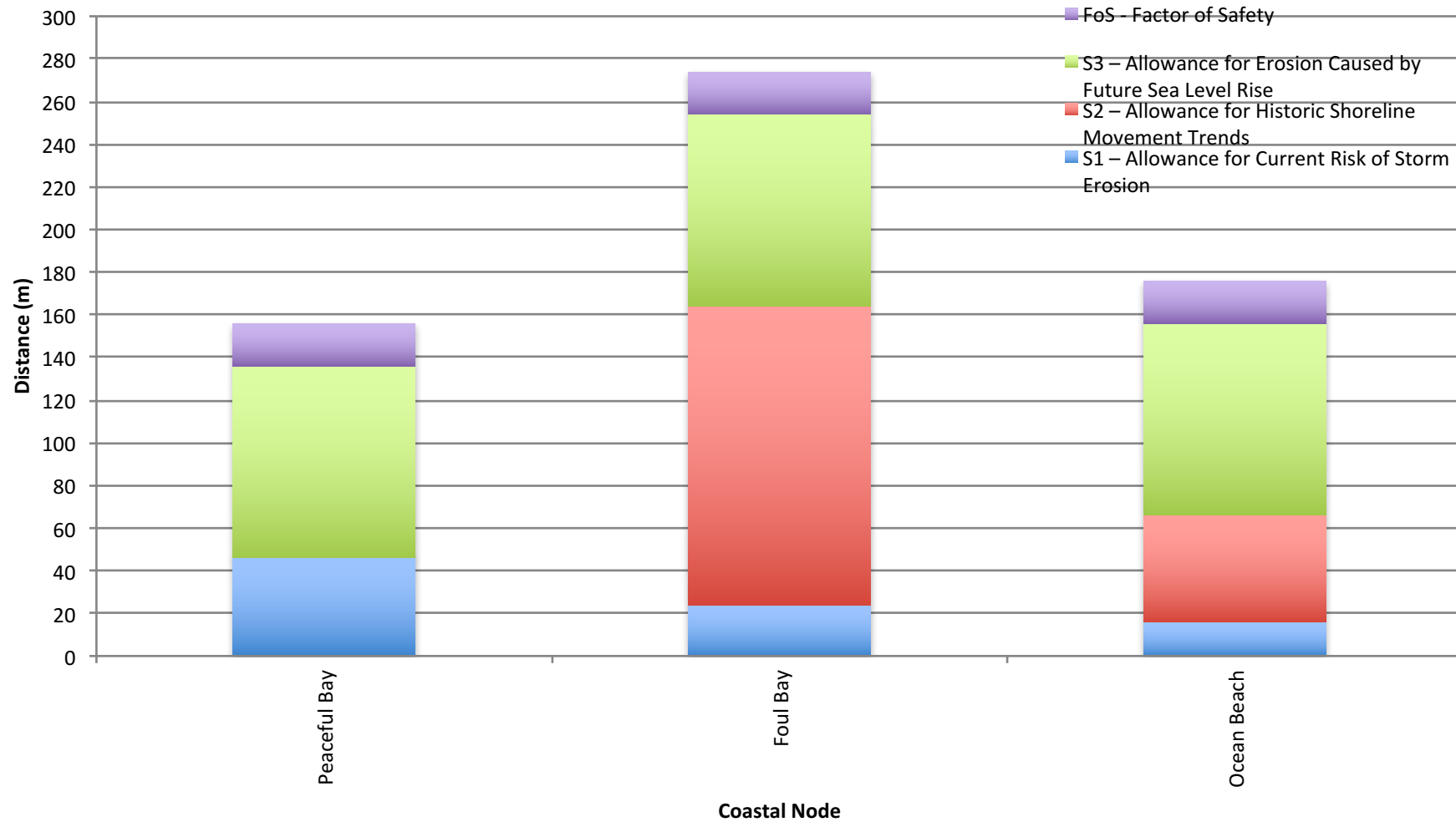
Notes	Coastal node	Peaceful Bay (Boat Launching Beach)	Foul Bay (In front of Memorial and Fishermans Lease)	Ocean Beach (In front of Surf Club)
	Coastal Type	Sandy Coast	Sandy Coast	Sandy Coast
Storm erosion	S1	Sand coast erosion based on recession of 1.5m AHD contour during a single run of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore	Sand coast erosion based on recession of 1.5m AHD contour during a single run of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore	Sand coast erosion based on recession of 1.5m AHD contour during a single run of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore
Long-term Trend	S2	2002 to 2016 aerial imagery shows accretion of 0.4m/year, so trend assumed to be 0m/year	2002 to 2016 aerial imagery shows erosion of 1.4m/year	2002 to 2016 aerial imagery shows erosion of 0.5m/year
Erosion due to SLR	S3	Assumed default value as per SPP2.6 (100 x SLR (0.04))	Assumed default value as per SPP2.6 (100 x SLR (0.04))	Assumed default value as per SPP2.6 (100 x SLR (0.04))
Factor of Safety	FoS	0.2m/year	0.2m/year	0.2m/year
Inundation	S4	5m AHD contour		

Notes	Coastal node	Peaceful Bay (Boat Launching Beach)	Foul Bay (In front of Memorial and Fishermans Lease)	Ocean Beach (In front of Surf Club)
	Coastal Type	Sandy Coast	Sandy Coast	Sandy Coast
Storm erosion	S1	Sand coast erosion based on recession of 1.5m AHD contour during 3 successive runs of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore	Sand coast erosion based on recession of 1.5m AHD contour during 3 successive runs of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore	Sand coast erosion based on recession of 1.5m AHD contour during 3 successive runs of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore
Long-term Trend	S2	2002 to 2016 aerial imagery shows accretion of 0.4m/year, so trend assumed to be 0m/year	2002 to 2016 aerial imagery shows erosion of 1.4m/year	2002 to 2016 aerial imagery shows erosion of 0.5m/year
Erosion due to SLR	S3	Assumed default value as per SPP2.6 (100 x SLR (0.35))	Assumed default value as per SPP2.6 (100 x SLR (0.35))	Assumed default value as per SPP2.6 (100 x SLR (0.35))
Factor of Safety	FoS	0.2m/year	0.2m/year	0.2m/year
Inundation	S4	5m AHD contour		

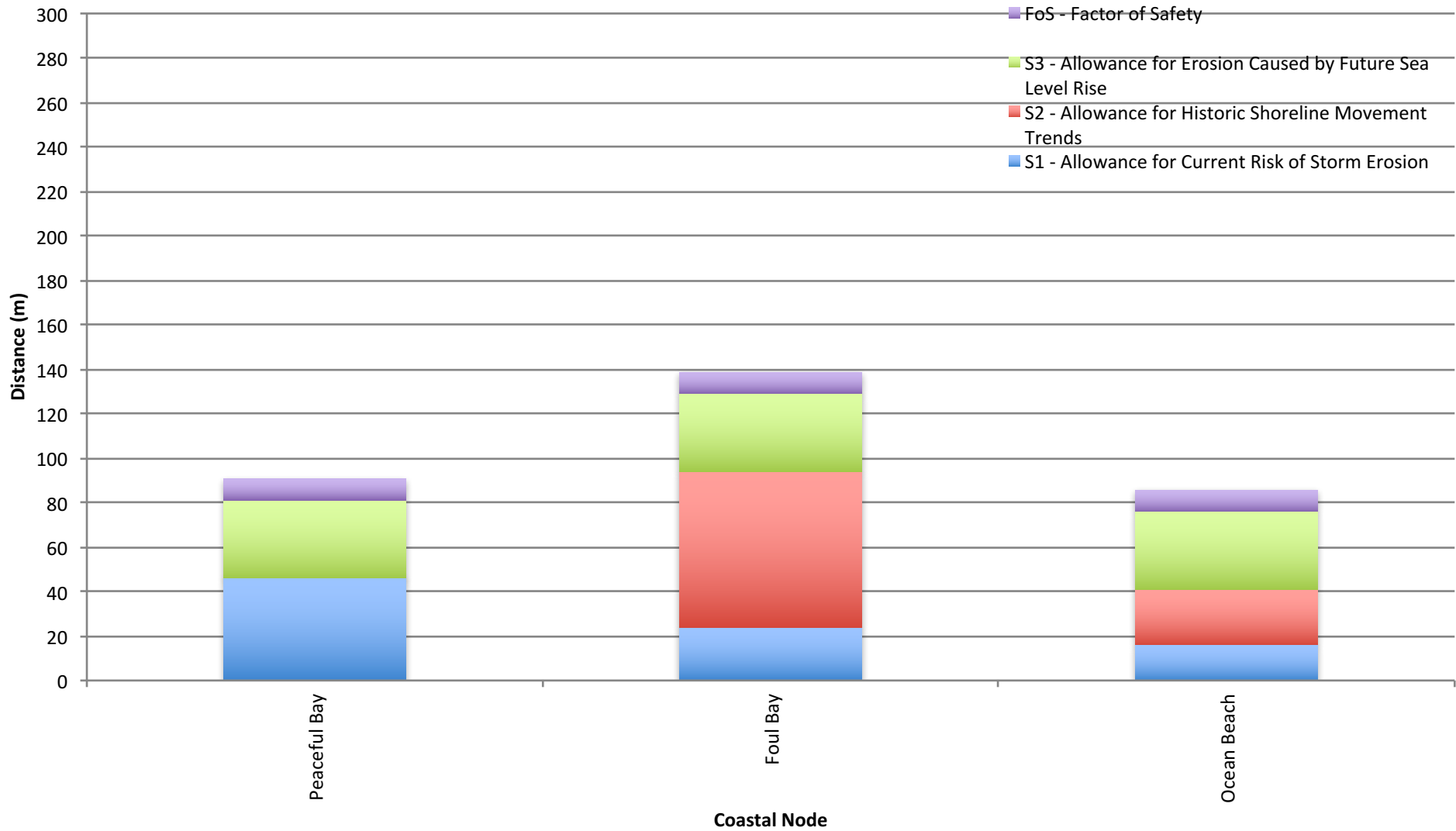
Notes	Coastal node	Peaceful Bay (Boat Launching Beach)	Foul Bay (In front of Memorial and Fishermans Lease)	Ocean Beach (In front of Surf Club)
	Coastal Type	Sandy Coast	Sandy Coast	Sandy Coast
Storm erosion	S1	Sand coast erosion based on recession of 1.5m AHD contour during 3 successive runs of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore	Sand coast erosion based on recession of 1.5m AHD contour during 3 successive runs of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore	Sand coast erosion based on recession of 1.5m AHD contour during 3 successive runs of the July 2007 storm with water levels modified to account for wave attenuation in the nearshore
Long-term Trend	S2	2002 to 2016 aerial imagery shows accretion of 0.4m/year, so trend assumed to be 0m/year	2002 to 2016 aerial imagery shows erosion of 1.4m/year	2002 to 2016 aerial imagery shows erosion of 0.5m/year
Erosion due to SLR	S3	Assumed default value as per SPP2.6 (100 x SLR (0.9))	Assumed default value as per SPP2.6 (100 x SLR (0.9))	Assumed default value as per SPP2.6 (100 x SLR (0.9))
Factor of Safety	FoS	0.2m/year	0.2m/year	0.2m/year
Inundation	S4	5m AHD contour		



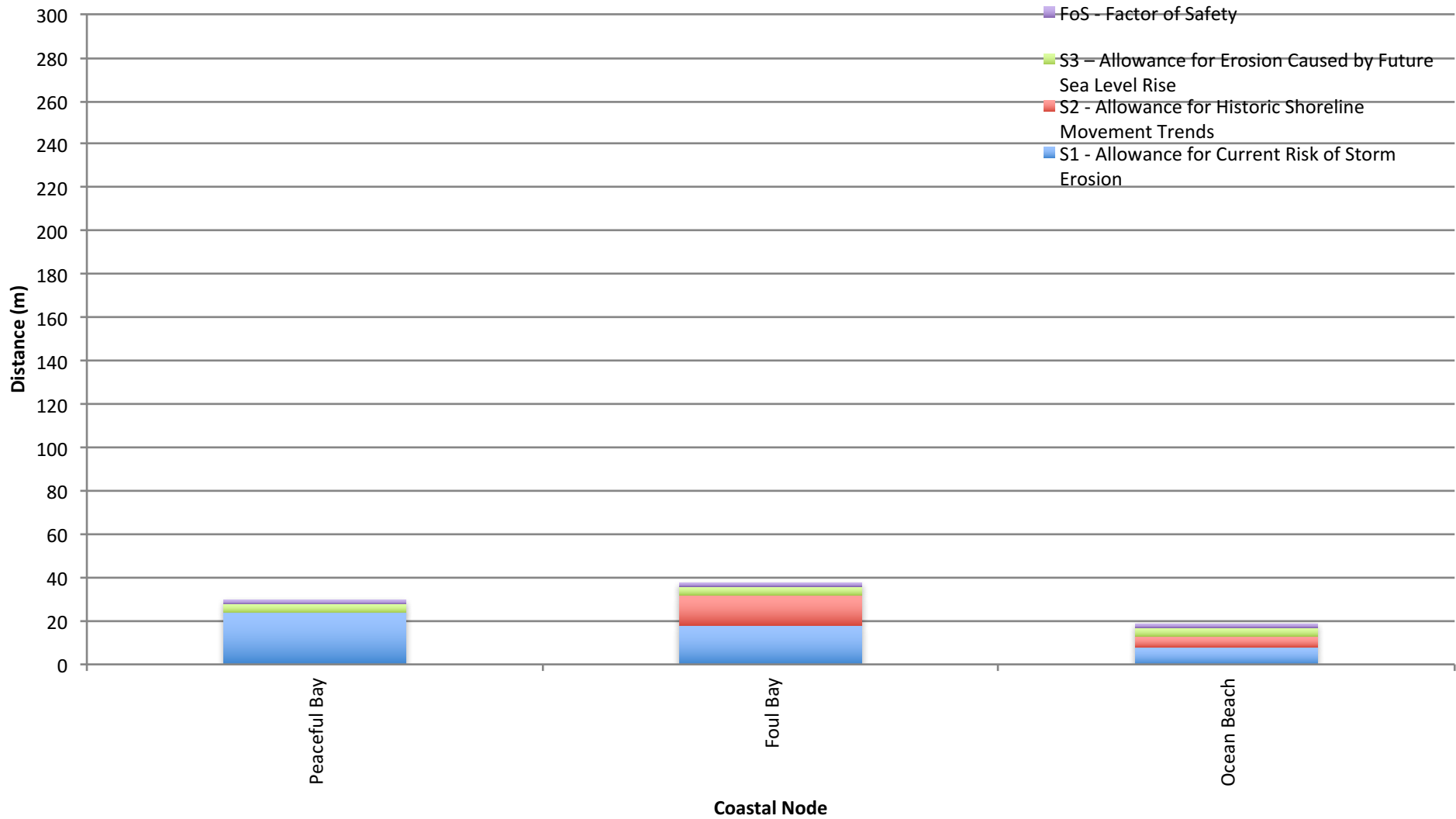
# 100 Year Coastal Processes Allowance from HSD



# 50 Year Coastal Processes Allowance from HSD



# 10 Year Coastal Processes Allowance from HSD



OCEAN BEACH RISK ASSESSMENT - EXISTING ASSETS

Ocean Beach - Asset Cost

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Shelters	Subtotal
OB_1	Tidal reaches of inland waters	Prawn Rock Channel	300	Seaward end of Prawn Rock Channel, including Prawn Rock Channel footbridge, gravel car park, 300m section of Ocean Beach Road and Prawn Rock Channel gazebo and seats.	\$ 80,000	\$ 28,000		\$ 292,300					\$ 10,000	\$ 410,300
OB_2	Weakly lithified sedimentary rock coast	Ocean Beach Lookout	350	Bitumen car park with access road, path leading to Ocean Beach Lookout, Ocean Beach lookout platform and 320m section of Ocean Beach Road.	\$ 27,000	\$ 66,500		\$ 216,200		\$ 2,250				\$ 311,950
OB_3	Sandy coast	Ocean Beach	300	Ocean Beach SLSC and Boat Shed, toilet block, Denmark Boating and Angling Club and sealed car park, bitumen car park (SLSC), stairs to beach (rail and no rail), ramp to beach (pedestrian), viewing platform fronting lower SLSC, viewing platform at railed stairs, Ocean Beach Road, vehicle access to beach, path to railed stairs, surf club shower and grassed area, and Denmark Boating and Angling Club grassed area and gazebo.	\$ 63,100	\$ 172,324	\$ 1,474,691	\$ 140,300		\$ 65,000			\$ 10,000	\$ 1,935,215
OB_4	Discontinuous rocky shoreline	Lion's Lookout	100	Lion's lookout with gravel car park and Ocean Beach Road.	\$ 81,000	\$ 38,000		\$ 211,000						\$ 330,000
			1050											\$ 2,987,465

■ High Asset Cost (>\$500,000)  
■ Moderate Asset Cost  
■ Low Asset Cost (<\$100,000)

Ocean Beach - Asset Exposure to Coastal Processes

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Shelters
OB_1	Tidal reaches of inland waters	Prawn Rock Channel	300	Seaward end of Prawn Rock Channel, including Prawn Rock Channel footbridge, gravel car park, 300m section of Ocean Beach Road and Prawn Rock Channel gazebo and seats.	H	H		H					H
OB_2	Weakly lithified sedimentary rock coast	Ocean Beach Lookout	350	Bitumen car park with access road, path leading to Ocean Beach Lookout, Ocean Beach lookout platform and 320m section of Ocean Beach Road.	H	H		M		H			
OB_3	Sandy coast	Ocean Beach	300	Ocean Beach SLSC and Boat Shed, toilet block, Denmark Boating and Angling Club and sealed car park, bitumen car park (SLSC), stairs to beach (rail and no rail), ramp to beach (pedestrian), viewing platform fronting lower SLSC, viewing platform at railed stairs, Ocean Beach Road, vehicle access to beach, path to railed stairs, surf club shower and grassed area, and Denmark Boating and Angling Club grassed area and gazebo.	H	M	M	L		H			H
OB_4	Discontinuous rocky shoreline	Lion's Lookout	100	Lion's lookout with gravel car park and Ocean Beach Road.	L	L		L					

■ High Coastal Exposure (within 10 year area)  
■ Moderate Coastal Exposure (10-50 year area)  
■ Low Coastal Exposure (50-100 year area)

Ocean Beach - Asset Risk

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Shelters
OB_1	Tidal reaches of inland waters	Prawn Rock Channel	300	Seaward end of Prawn Rock Channel, including Prawn Rock Channel footbridge, gravel car park, 300m section of Ocean Beach Road and Prawn Rock Channel gazebo and seats.	M	M		H					M
OB_2	Weakly lithified sedimentary rock coast	Ocean Beach Lookout	350	Bitumen car park with access road, path leading to Ocean Beach Lookout, Ocean Beach lookout platform and 320m section of Ocean Beach Road.	M	M		M		M			
OB_3	Sandy coast	Ocean Beach	300	Ocean Beach SLSC and Boat Shed, toilet block, Denmark Boating and Angling Club and sealed car park, bitumen car park (SLSC), stairs to beach (rail and no rail), ramp to beach (pedestrian), viewing platform fronting lower SLSC, viewing platform at railed stairs, Ocean Beach Road, vehicle access to beach, path to railed stairs, surf club shower and grassed area, and Denmark Boating and Angling Club grassed area and gazebo.	M	M	H	L		M			M
OB_4	Discontinuous rocky shoreline	Lion's Lookout	100	Lion's lookout with gravel car park and Ocean Beach Road.	L	L		L					

■ High Asset Risk  
■ Moderate Asset Risk  
■ Low Asset Risk

Coastal Risk Evaluation Matrix

		Exposure to Coastal Processes (Likelihood)		
		High (within 10yr area)	Moderate (10-20 year area)	Low (20-100yr area)
Asset Cost (Consequence)	High	Very High	High	Mod
	Moderate	High	Mod	Low
	Low	Mod	Low	Low

Notes:

- Asset costs are based on values provided by the Shire and/or based on assume rates and quantities for typical assets.
- Asset cost represents present day replacement costs with no allowance for depreciation or maintenance.
- Asset exposure to coastal processes has been assessed based on Hazard assessment maps.
- Valuation have been undertaken for coastal planning purposes. They may not be sufficient for other purposes.

OCEAN BEACH RISK ASSESSMENT - 10yr CONCEPT DESIGNS

Ocean Beach - Asset Cost

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Playgrounds and Shelters	Subtotal
OB_1	Tidal reaches of inland waters	Prawn Rock Channel	300	Seaward end of Prawn Rock Channel, including Prawn Rock Channel footbridge, gravel car park, 300m section of Ocean Beach Road and Prawn Rock Channel gazebo and seats.	\$ 86,000	\$ 28,000		\$ 292,300					\$ 10,000	\$ 410,300
OB_2	Weakly lithified sedimentary rock coast	Ocean Beach Lookout	350	Bitumen car park with access road, path leading to Ocean Beach Lookout, Ocean Beach lookout platform and 320m section of Ocean Beach Road.	\$ 427,000	\$ 86,500		\$ 216,200		\$ 2,250				\$ 711,950
OB_3	Sandy coast	Ocean Beach	300	Ocean Beach SLSC (top and lower), toilet block, Denmark Boating and Angling Club and sealed car park, bitumen car park (SLSC), universal access to SLSC building, stairs to beach (rail and no rail), ramp to beach (pedestrian), viewing platform fronting lower SLSC, viewing platform at railed stairs, Ocean Beach Road, vehicle access to beach, path to railed stairs, surf club shower and grassed area, and Denmark Boating and Angling Club grassed area and gazebo.	\$ 62,000	\$ 172,324	\$ 4,726,891	\$ 140,300			\$ 47,500		\$ 10,000	\$ 5,168,615
OB_4	Discontinuous rocky shoreline	Lion's Lookout	100	Lion's lookout with gravel car park and Ocean Beach Road.	\$ 81,000	\$ 38,000		\$ 211,000						\$ 330,000
			1050											\$ 6,620,865

High Asset Cost (>\$500,000)  
 Moderate Asset Cost  
 Low Asset Cost (<\$100,000)

Ocean Beach - Asset Exposure to Coastal Processes

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Shelters	
OB_1	Tidal reaches of inland waters	Prawn Rock Channel	300	Seaward end of Prawn Rock Channel, including Prawn Rock Channel footbridge, gravel car park, 300m section of Ocean Beach Road and Prawn Rock Channel gazebo and seats.	H	H		H					H	
OB_2	Weakly lithified sedimentary rock coast	Ocean Beach Lookout	350	Bitumen car park with access road, path leading to Ocean Beach Lookout, Ocean Beach lookout platform and 320m section of Ocean Beach Road.	H	H		M		H				
OB_3	Sandy coast	Ocean Beach	300	Ocean Beach SLSC (top and lower), toilet block, Denmark Boating and Angling Club and sealed car park, bitumen car park (SLSC), universal access to SLSC building, stairs to beach (rail and no rail), ramp to beach (pedestrian), viewing platform fronting lower SLSC, viewing platform at railed stairs, Ocean Beach Road, vehicle access to beach, path to railed stairs, surf club shower and grassed area, and Denmark Boating and Angling Club grassed area and gazebo.	H	M	M	L			H			H
OB_4	Discontinuous rocky shoreline	Lion's Lookout	100	Lion's lookout with gravel car park and Ocean Beach Road.	L	L		L						

High Coastal Exposure (within 10 year area)  
 Moderate Coastal Exposure (10-50 year area)  
 Low Coastal Exposure (50-100 year area)

Ocean Beach - Asset Risk

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Shelters	
OB_1	Tidal reaches of inland waters	Prawn Rock Channel	300	Seaward end of Prawn Rock Channel, including Prawn Rock Channel footbridge, gravel car park, 300m section of Ocean Beach Road and Prawn Rock Channel gazebo and seats.	M	M		H					M	
OB_2	Weakly lithified sedimentary rock coast	Ocean Beach Lookout	350	Bitumen car park with access road, path leading to Ocean Beach Lookout, Ocean Beach lookout platform and 320m section of Ocean Beach Road.	H	M		M		M				
OB_3	Sandy coast	Ocean Beach	300	Ocean Beach SLSC (top and lower), toilet block, Denmark Boating and Angling Club and sealed car park, bitumen car park (SLSC), universal access to SLSC building, stairs to beach (rail and no rail), ramp to beach (pedestrian), viewing platform fronting lower SLSC, viewing platform at railed stairs, Ocean Beach Road, vehicle access to beach, path to railed stairs, surf club shower and grassed area, and Denmark Boating and Angling Club grassed area and gazebo.	M	M	H	L			M			M
OB_4	Discontinuous rocky shoreline	Lion's Lookout	100	Lion's lookout with gravel car park and Ocean Beach Road.	L	L		L						

High Asset Risk  
 Moderate Asset Risk  
 Low Asset Risk

Coastal Risk Evaluation Matrix

		Exposure to Coastal Processes (Likelihood)		
		High (within 10yr area)	Moderate (10-20 year area)	Low (20-100yr area)
Asset Cost (Consequence)	High	Very High	High	Mod
	Moderate	High	Mod	Low
	Low	Mod	Low	Low

Notes:

- Asset costs are based on values provided by the Shire and/or based on assume rates and quantities for typical assets.
- Asset cost represents present day replacement costs with no allowance for depreciation or maintenance.
- Asset exposure to coastal processes has been assessed based on Hazard assessment maps.
- Valuation have been undertaken for coastal planning purposes. They may not be sufficient for other purposes.

PEACEFUL BAY RISK ASSESSMENT - EXISTING ASSETS

Peaceful Bay - Asset Cost

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Average Sandy Beach Width (m)	Nominal Sandy Beach Area (m <sup>2</sup> )	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Playgrounds and Shelters	Subtotal
PB_1	Sandy Coast	Peaceful Bay	550	20	11000	Stairs with attached ramp and boardwalk (from Sea Rescue building), bitumen car park (Sea Rescue), western beach access point with bitumen car park, toilet, boardwalk path and stairs, Peaceful Bay Sea Rescue Group (boat shed and building), Old Peaceful Bay Road, caravan park with grassed area (BBQ and gazebo) and gravel/sand path from caravan park, and finger jetty.	\$ 97,620	\$ 189,701	\$ 289,854	\$ 306,350		\$ 19,250	\$ 438,862	\$ 1,185,188	\$ 12,600	\$ 2,539,425
PB_2	Sandy Coast	Foul Bay	1500	30	45000	Lookout landward of Old Peaceful Bay Road with gravel car park, Old Peaceful Bay Road, section of Bibbulmun track, vehicle beach access track, RSL memorial and Fisherman's lease area.	\$ 27,000	\$ 7,600		\$ 724,100	\$ 10,000	\$ 5,000		\$ 12,000	\$ 30,000	\$ 815,700
			2050		56000											\$ 3,355,125

■ High Asset Cost (>\$500,000)  
■ Moderate Asset Cost  
■ Low Asset Cost (<\$100,000)

Peaceful Bay - Asset Exposure to Coastal Processes

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Average Sandy Beach Width (m)	Nominal Sandy Beach Area (m <sup>2</sup> )	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Playgrounds and Shelters
PB_1	Sandy Coast	Peaceful Bay	550	20	11000	Stairs with attached ramp and boardwalk (from Sea Rescue building), bitumen car park (Sea Rescue), western beach access point with bitumen car park, toilet, boardwalk path and stairs, Peaceful Bay Sea Rescue Group (boat shed and building), Old Peaceful Bay Road, caravan park with grassed area (BBQ and gazebo) and gravel/sand path from caravan park, and finger jetty.	H	M	M	M		H	H	L	L
PB_2	Sandy Coast	Foul Bay	1500	30	45000	Lookout landward of Old Peaceful Bay Road with gravel car park, Old Peaceful Bay Road, section of Bibbulmun track, vehicle beach access track, RSL memorial and Fisherman's lease area.	M	M		M	L	H		H	H

■ High Coastal Exposure (within 10 year area)  
■ Moderate Coastal Exposure (10-50 year area)  
■ Low Coastal Exposure (50-100 year area)

Peaceful Bay - Asset Risk

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Average Sandy Beach Width (m)	Nominal Sandy Beach Area (m <sup>2</sup> )	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Playgrounds and Shelters
PB_1	Sandy Coast	Peaceful Bay	550	20	11000	Stairs with attached ramp and boardwalk (from Sea Rescue building), bitumen car park (Sea Rescue), western beach access point with bitumen car park, toilet, boardwalk path and stairs, Peaceful Bay Sea Rescue Group (boat shed and building), Old Peaceful Bay Road, caravan park with grassed area (BBQ and gazebo) and gravel/sand path from caravan park, and finger jetty.	M	M	M	M		M	H	M	L
PB_2	Sandy Coast	Foul Bay	1500	30	45000	Lookout landward of Old Peaceful Bay Road with gravel car park, Old Peaceful Bay Road, section of Bibbulmun track, vehicle beach access track, RSL memorial and Fisherman's lease area.	L	L		H	L	M		M	M

■ High Asset Risk  
■ Moderate Asset Risk  
■ Low Asset Risk

Coastal Risk Evaluation Matrix

		Exposure to Coastal Processes (Likelihood)		
		High (within 10yr area)	Moderate (10-20 year area)	Low (20-100yr area)
Asset Cost (Consequence)	High	Very High	High	Mod
	Moderate	High	Mod	Low
	Low	Mod	Low	Low

Notes:

- Asset costs are based on values provided by the Shire and/or based on assume rates and quantities for typical assets.
- Asset cost represents present day replacement costs with no allowance for depreciation or maintenance.
- Asset exposure to coastal processes has been assessed based on Hazard assessment maps.
- Valuation have been undertaken for coastal planning purposes. They may not be sufficient for other purposes.

PEACEFUL BAY RISK ASSESSMENT - 10yr CONCEPT

Peaceful Bay - Asset Cost

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Average Sandy Beach Width (m)	Nominal Sandy Beach Area (m <sup>2</sup> )	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Playgrounds and Shelters	Subtotal
PB_1	Sandy Coast	Peaceful Bay	550	20	11000	Stairs with attached ramp and boardwalk (from Sea Rescue building), bitumen car park (Sea Rescue), western beach access point with bitumen car park, toilet, boardwalk path and stairs, Peaceful Bay Sea Rescue Group (boat shed and building), Old Peaceful Bay Road, caravan park with grassed area (BBQ and gazebo) and gravel/sand path from caravan park, and finger jetty.	\$ 166,440	\$ 189,701	\$ 289,854	\$ 306,350		\$ 28,500	\$ 438,862	\$ 1,185,188	\$ 12,600	\$ 2,617,495
PB_2	Sandy Coast	Foul Bay	1500	30	45000	Lookout landward of Old Peaceful Bay Road with gravel car park, Old Peaceful Bay Road, section of Bibbulmun track, vehicle beach access track, RSL memorial and Fisherman's lease area.	\$ 27,000	\$ 7,600		\$ 724,100	\$ 10,000	\$ 5,000		\$ 12,000	\$ -	\$ 785,700
			2050		56000											\$ 3,403,195

■ High Asset Cost (>\$500,000)  
■ Moderate Asset Cost  
■ Low Asset Cost (<\$100,000)

Peaceful Bay - Asset Exposure to Coastal Processes

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Average Sandy Beach Width (m)	Nominal Sandy Beach Area (m <sup>2</sup> )	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Playgrounds and Shelters
PB_1	Sandy Coast	Peaceful Bay	550	20	11000	Stairs with attached ramp and boardwalk (from Sea Rescue building), bitumen car park (Sea Rescue), western beach access point with bitumen car park, toilet, boardwalk path and stairs, Peaceful Bay Sea Rescue Group (boat shed and building), Old Peaceful Bay Road, caravan park with grassed area (BBQ and gazebo) and gravel/sand path from caravan park, and finger jetty.	H	M	M	M		H	H	L	L
PB_2	Sandy Coast	Foul Bay	1500	30	45000	Lookout landward of Old Peaceful Bay Road with gravel car park, Old Peaceful Bay Road, section of Bibbulmun track, vehicle beach access track, RSL memorial and Fisherman's lease area.	M	M		M	L	H		H	H

■ High Coastal Exposure (within 10 year area)  
■ Moderate Coastal Exposure (10-50 year area)  
■ Low Coastal Exposure (50-100 year area)

Peaceful Bay - Asset Risk

ID	Coastal Type	Coastal Node	Length of Coastal Node (m)	Average Sandy Beach Width (m)	Nominal Sandy Beach Area (m <sup>2</sup> )	Description	1. Coastal Stairs and Platforms	2. Carparks	3. Buildings (large structures, toilets, changerooms etc)	4. Roads & Adjacent Paths	5. Coastal Walkways	6. Coastal Access Paths	7. Public Marine Structures (Boat Ramps / Jetties)	8. Leasehold or Residential Property	9. Landscaping and Playgrounds and Shelters
PB_1	Sandy Coast	Peaceful Bay	550	20	11000	Stairs with attached ramp and boardwalk (from Sea Rescue building), bitumen car park (Sea Rescue), western beach access point with bitumen car park, toilet, boardwalk path and stairs, Peaceful Bay Sea Rescue Group (boat shed and building), Old Peaceful Bay Road, caravan park with grassed area (BBQ and gazebo) and gravel/sand path from caravan park, and finger jetty.	H	M	M	M		M	H	M	L
PB_2	Sandy Coast	Foul Bay	1500	30	45000	Lookout landward of Old Peaceful Bay Road with gravel car park, Old Peaceful Bay Road, section of Bibbulmun track, vehicle beach access track, RSL memorial and Fisherman's lease area.	L	L		H	L	M		M	

■ High Asset Risk  
■ Moderate Asset Risk  
■ Low Asset Risk

Coastal Risk Evaluation Matrix

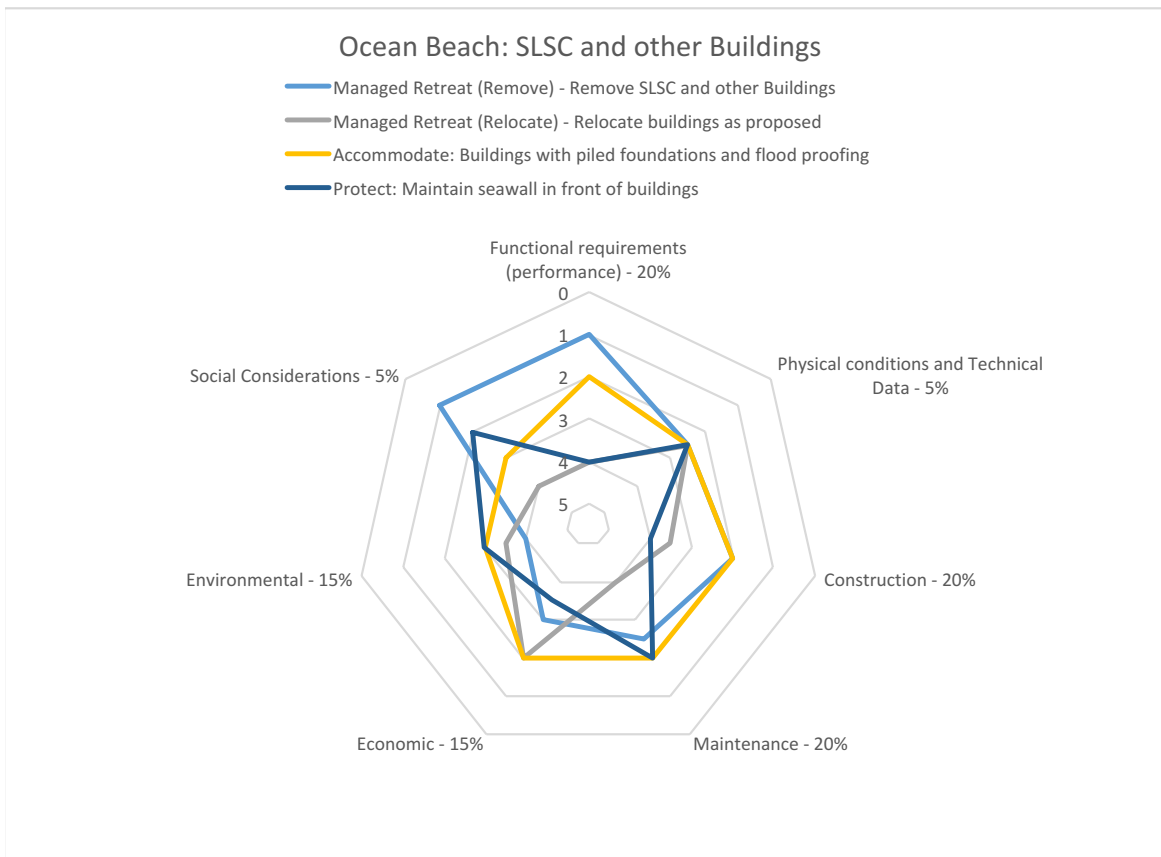
		Exposure to Coastal Processes (Likelihood)		
		High (within 10yr area)	Moderate (10-20 year area)	Low (20-100yr area)
Asset Cost (Consequence)	High	Very High	High	Mod
	Moderate	High	Mod	Low
	Low	Mod	Low	Low

Notes:

- Asset costs are based on values provided by the Shire and/or based on assume rates and quantities for typical assets.
- Asset cost represents present day replacement costs with no allowance for depreciation or maintenance.
- Asset exposure to coastal processes has been assessed based on Hazard assessment maps.
- Valuation have been undertaken for coastal planning purposes. They may not be sufficient for other purposes.
- 10yr Concept Designs provided by Shire of Denmark

MCA Criteria	Managed Retreat (Remove)	Managed Retreat (Relocate)	Accommodate	Protect
	Managed Retreat (Remove) - Remove SLSC and other Buildings	Managed Retreat (Relocate) - Relocate buildings as proposed	Accommodate: Buildings with piled foundations and flood proofing	Protect: Maintain seawall in front of buildings
Functional requirements (performance) - 20%	1.0	4.0	2.0	4.0
Physical conditions and Technical Data - 5%	2.5	2.5	2.5	2.5
Construction - 20%	2.0	3.5	2.0	4.0
Maintenance - 20%	2.5	4.0	2.0	2.0
Economic - 15%	3.0	2.0	2.0	3.5
Environmental - 15%	4.0	3.5	3.0	3.0
Social Considerations - 5%	1.0	4.0	3.0	2.0
	11.625	17.25	11.125	16

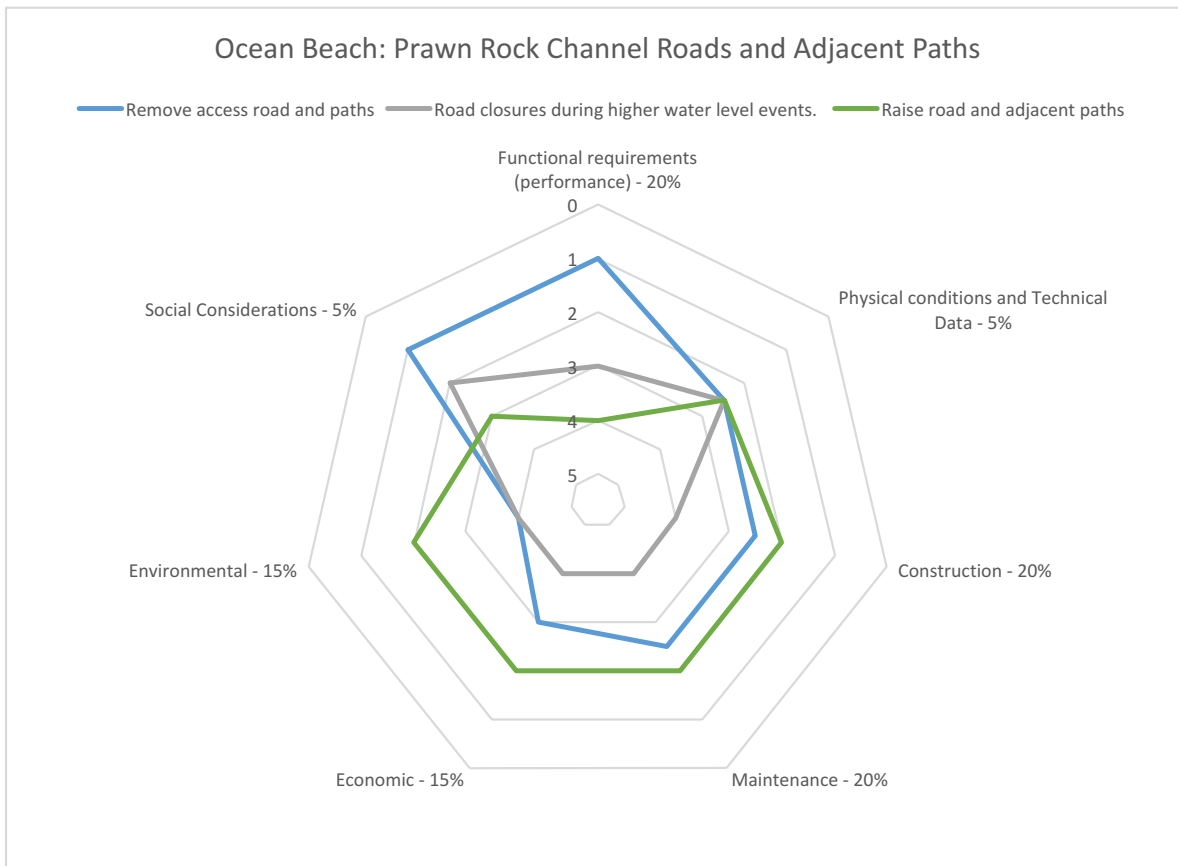
Note: 5 = excellent; 4 = good; 3 = satisfactory; 2 = below average; 1 = poor.  
 A value of 2.5 is used where the condition is not applicable, i.e. constructability for "Do Nothing" is not applicable





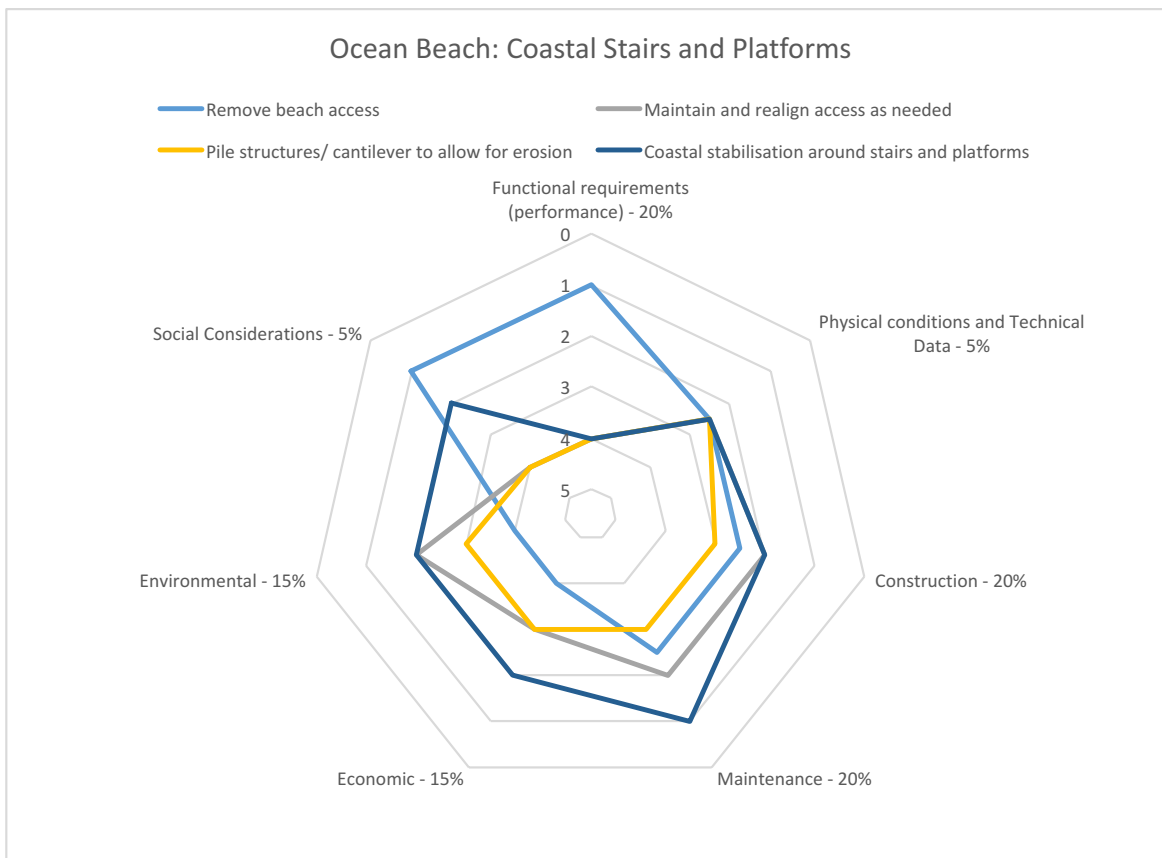
	Managed Retreat (Remove)	Accommodate	Protect
	Remove access road and paths	Road closures during higher water level events.	Raise road and adjacent paths
Functional requirements (performance) - 20%	1.0	3.0	4.0
Physical conditions and Technical Data - 5%	2.5	2.5	2.5
Construction - 20%	2.5	4.0	2.0
Maintenance - 20%	2.5	4.0	2.0
Economic - 15%	3.0	4.0	2.0
Environmental - 15%	4.0	4.0	2.0
Social Considerations - 5%	1.0	2.0	3.0
	12.125	18.125	12.375

Note: 5 = excellent; 4 = good; 3 = satisfactory; 2 = below average; 1 = poor.  
 A value of 2.5 is used where the condition is not applicable, i.e. constructability for "Do Nothing" is not applicable



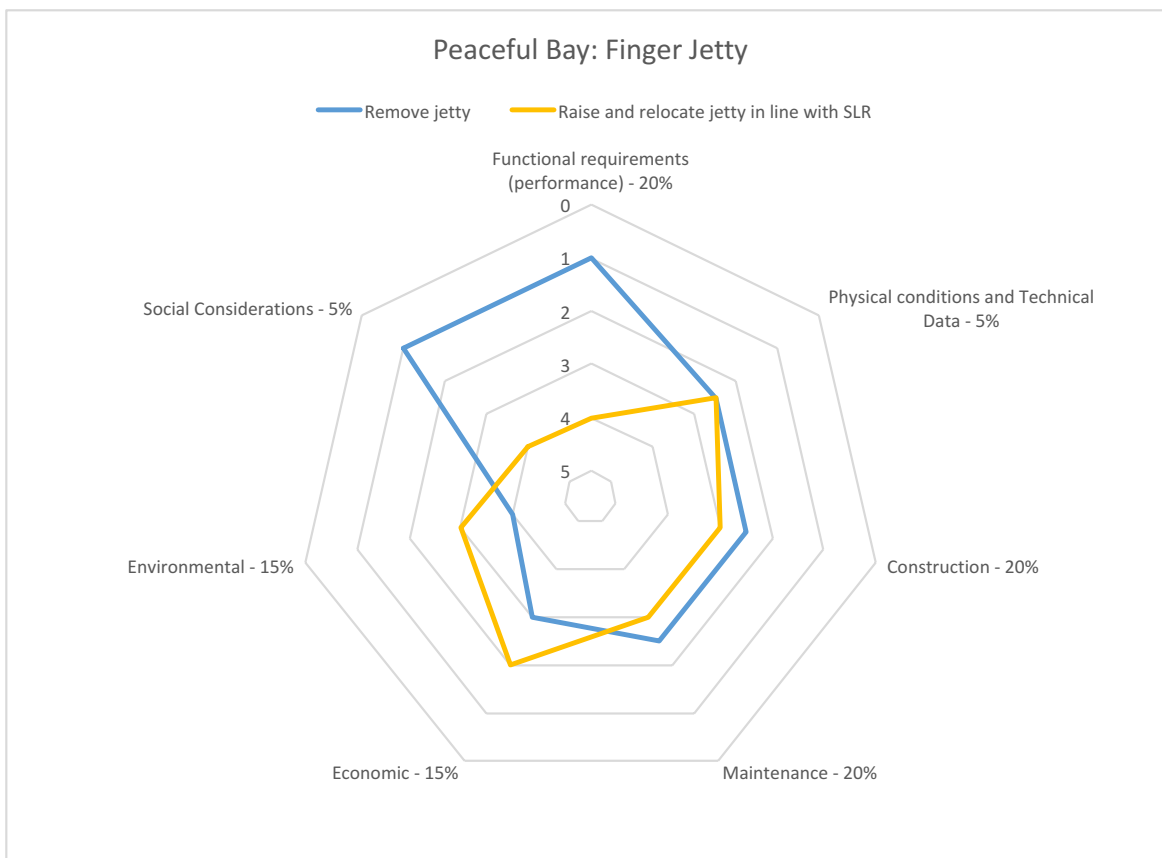
	Managed Retreat (Remove)	Managed Retreat (Relocate)	Accommodate	Protect
	Remove beach access	Maintain and realign access as needed	Pile structures/ cantilever to allow for erosion	Coastal stabilisation around stairs and platforms
Functional requirements (performance) - 20%	1.0	4.0	4.0	4.0
Physical conditions and Technical Data - 5%	2.5	2.5	2.5	2.5
Construction - 20%	2.5	2.0	3.0	2.0
Maintenance - 20%	2.5	2.0	3.0	1.0
Economic - 15%	4.0	3.0	3.0	2.0
Environmental - 15%	4.0	2.0	3.0	2.0
Social Considerations - 5%	1.0	4.0	4.0	2.0
	12.875	13.375	16.125	11.125

Note: 5 = excellent; 4 = good; 3 = satisfactory; 2 = below average; 1 = poor.  
A value of 2.5 is used where the condition is not applicable, i.e. constructability for "Do Nothing" is not applicable



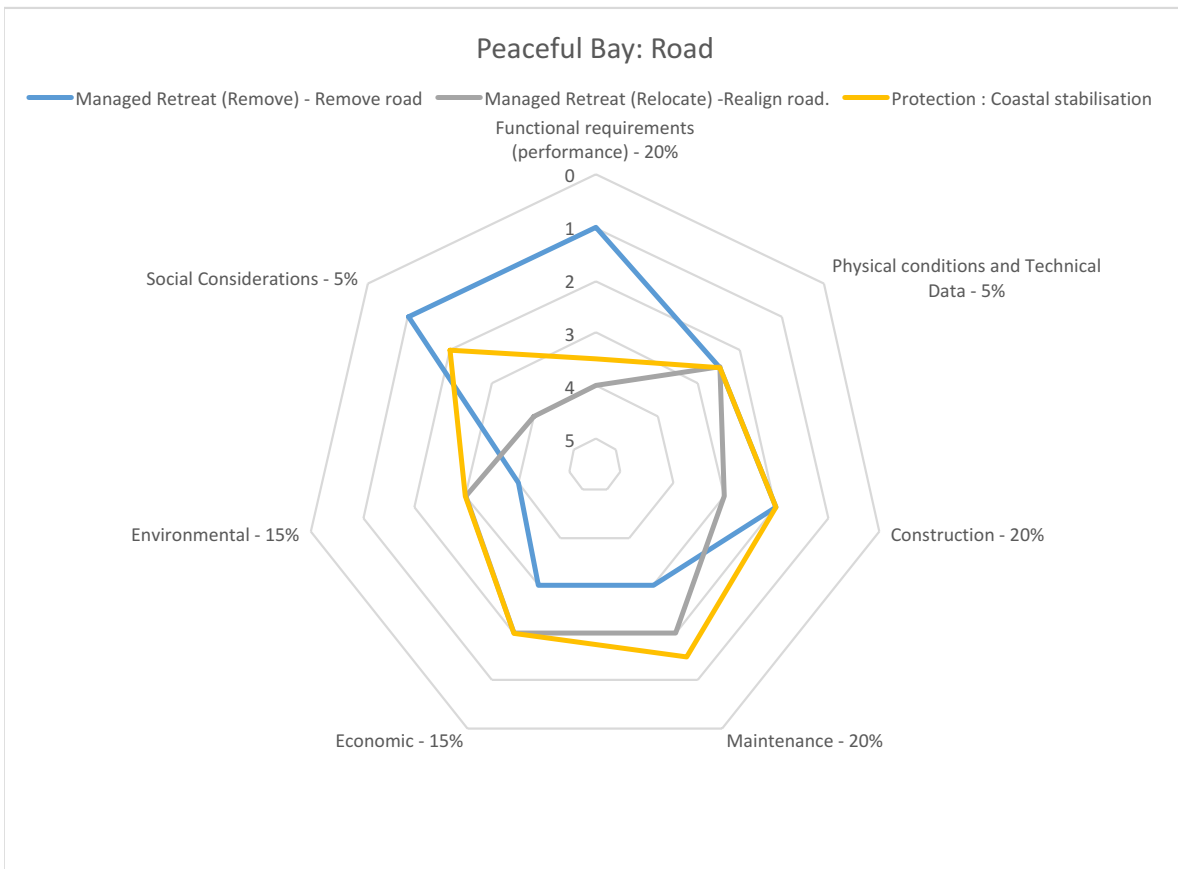
	Managed Retreat (Remove)	Accommodate
	Remove jetty	Raise and relocate jetty in line with SLR
Functional requirements (performance) - 20%	1.0	4.0
Physical conditions and Technical Data - 5%	2.5	2.5
Construction - 20%	2.5	3.0
Maintenance - 20%	2.5	3.0
Economic - 15%	3.0	2.0
Environmental - 15%	4.0	3.0
Social Considerations - 5%	1.0	4.0
	12.125	15.375

Note: 5 = excellent; 4 = good; 3 = satisfactory; 2 = below average; 1 = poor.  
 A value of 2.5 is used where the condition is not applicable, i.e. constructability for "Do Nothing" is not applicable



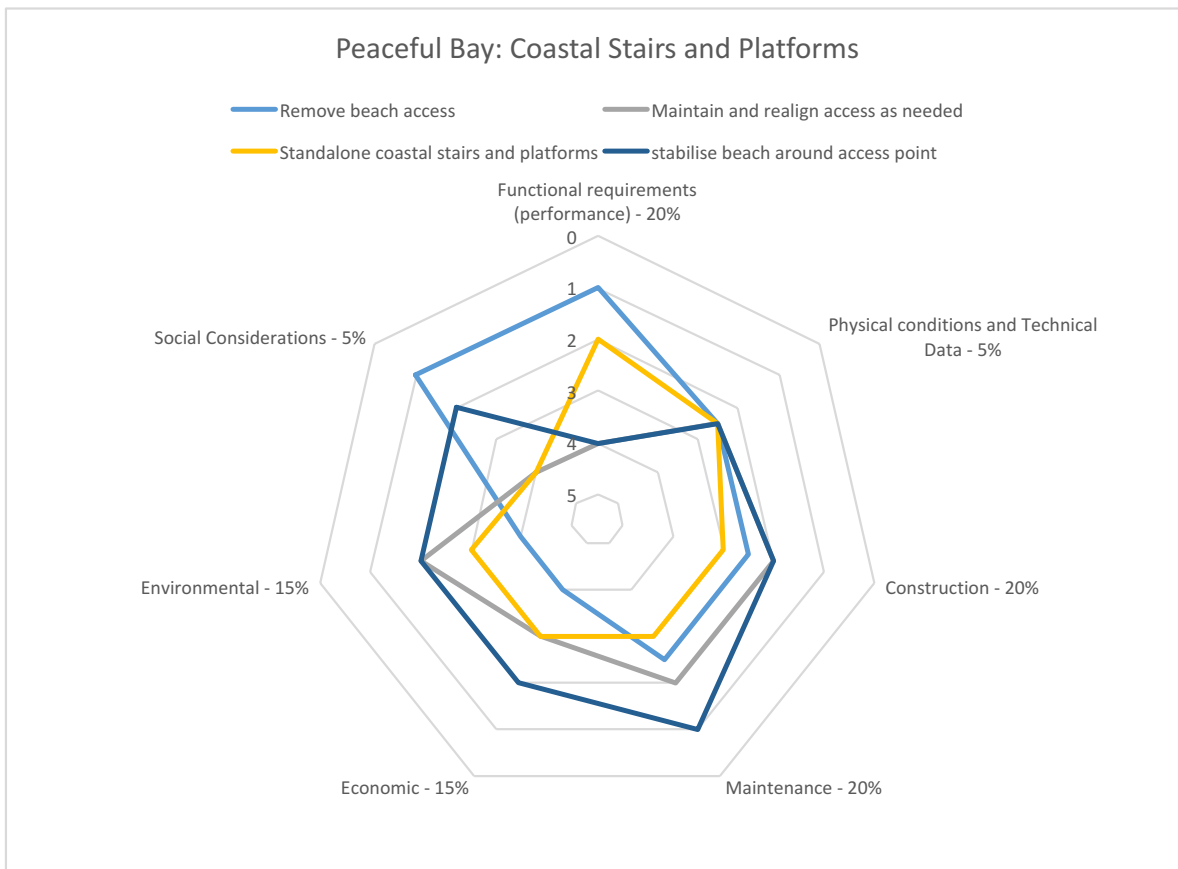
	Managed Retreat (Remove)	Managed Retreat (Relocate)	Protect
	Managed Retreat (Remove) - Remove road	Managed Retreat (Relocate) -Realign road.	Protection : Coastal stabilisation
Functional requirements (performance) - 20%	1.0	4.0	3.5
Physical conditions and Technical Data - 5%	2.5	2.5	2.5
Construction - 20%	2.0	3.0	2.0
Maintenance - 20%	3.0	2.0	1.5
Economic - 15%	3.0	2.0	2.0
Environmental - 15%	4.0	3.0	3.0
Social Considerations - 5%	1.0	4.0	2.0
	12.125	14.375	11.875

Note: 5 = excellent; 4 = good; 3 = satisfactory; 2 = below average; 1 = poor.  
 A value of 2.5 is used where the condition is not applicable, i.e. constructability for "Do Nothing" is not applicable



	Avoid	Managed Retreat	Accommodate	Protect
	Remove beach access	Maintain and realign access as needed	Standalone coastal stairs and platforms	stabilise beach around access point
Functional requirements (performance) - 20%	1.0	4.0	2.0	4.0
Physical conditions and Technical Data - 5%	2.5	2.5	2.5	2.5
Construction - 20%	2.5	2.0	3.0	2.0
Maintenance - 20%	2.5	2.0	3.0	1.0
Economic - 15%	4.0	3.0	3.0	2.0
Environmental - 15%	4.0	2.0	3.0	2.0
Social Considerations - 5%	1.0	4.0	4.0	2.0
	12.875	13.375	14.125	11.125

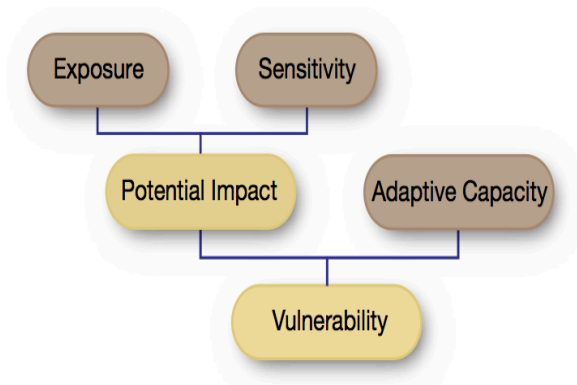
Note: 5 = excellent; 4 = good; 3 = satisfactory; 2 = below average; 1 = poor.  
 A value of 2.5 is used where the condition is not applicable, i.e. constructability for "Do Nothing" is not applicable



ID	Coastal Type	Coastal Node	Asset Type	Description	Exposure	Sensitivity		Potential Impact	Adaptive Capacity				Asset Risk	Risk Management and Adaptation Options
						Coastal Erosion	Coastal Inundation		Avoid	Managed Retreat	Accommodate	Protect		
OB_1	Tidal reaches of inland waters	Prawn Rock Channel	Roads and Adjacent Paths	Coastal road and footpath along channel, including wooden bridge	High	X	XX	1) Bank instability associated with bank erosion due to increase in MSL and variable climatic conditions 2) Exposure of seaward edge of road and adjacent paths to slope instability 3) Road inundated during higher tides due to increase in MSL			✓	✓	High	Accommodate: Road closures during higher water level events. Protect: raise road and path to above flood waters and provide erosion protection
OB_3	Sandy coast	Ocean Beach	Buildings	SLSC and Sea Rescue Buildings, and toilet block	Medium	XX	X	1) Slope instability associated with toe erosion of dune due to increase in MSL and variable climatic conditions 2) Exposure of seaward edge of buildings to slope instability 3) Exposure of foundation of timber retaining wall and reduced support for structure 4) Increased frequency and depth of inundation of buildings due to increased MSL		✓	✓	✓	High	Managed Retreat: rolling retreat of platform, Sea Rescue Building and toilet block as needed (relocate to proposed location) Accommodate: ensure buildings have piled foundations sufficiently deep to accommodate the risk of erosion and design buildings to be flood proof or ensure minimal damage to buildings during flooding. Protect: Maintain existing timber retaining wall in front of the buildings to protect from erosion and inundation.
OB_4	Sandy coast	Ocean Beach	Coastal Stairs and Platforms	Wooden stairs, ramps and viewing platforms	High	X	X	1) Increased erosion adjacent to lower stair 2) Exposure of footings for timber supports of stairs and platforms and reduced support for structure		✓	✓	✓	Medium	Managed Retreat: Progressively move stairs and platforms in line with erosion. Accommodate: Relocate stairs and platforms to be founded on rock and behind naturally occurring rock. Protect: install coastal stabilisation to protect coastal stairs and platforms.

Notes:

- Asset exposure based on Risk Analysis (Phase 2). High exposure means assets within 10yr coastal processes zone.
- X means coastal asset is sensitive to coastal erosion or inundation
- XX means visual inspection indicated high sensitivity to coastal erosion or inundation.
- Adaptive capacity identifies most feasible options. Other options may be considered.
- Asset risk based on Risk Evaluation (Phase 3) and is based on asset cost (consequence) and asset exposure (likelihood).
- There is not sufficient beach survey and design information to quantitatively assess the sensitivity of individual assets to coastal erosion or inundation. For example, the sensitivity of beach access stairs to erosion requires regular beach survey and design details including the depth of vertical supports.
- The vulnerability of individual assets, as defined, cannot presently be assessed with confidence due to limited information on their sensitivity to erosion/inundation. This could however be assessed at a project scale where beach survey and design information is collected or collated.



Vulnerability Assessment Flowchart (CHMAP Guidelines)

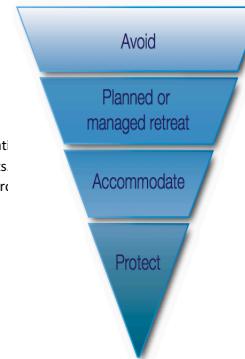


Risk Management and Adaptation Hierarchy (CHMAP Guidelines)

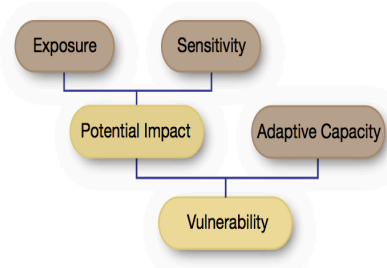
ID	Coastal Type	Coastal Node	Asset Type	Description	Exposure	Sensitivity		Potential Impact	Adaptive Capacity				Asset Risk	Risk Management and Adaptation Options
						Coastal Erosion	Coastal Inundation		Avoid	Managed Retreat	Accommodate	Protect		
PB_1	Sandy Coast	Peaceful Bay	Public Marine Structures	Finger jetty	High	✗		1) Jetty inundated during higher tides due to increase in MSL 2) Jetty damage due to increased exposure to waves 3) Exposure of jetty piles and reduced support for structure 4) Damage to jetty 5) Reduction in frequency of safe launching conditions			✓		High	Accommodate: Inform public of when to expect jetty to be inundated (higher tides). Inspect and maintain jetty to required standards. Design jetty deck level to accommodate future sea level rise at time of replacement or major maintenance. Jetty to be pulled back in line with coastal erosion during future maintenance operations
PB_2	Sandy Coast	Foul Bay	Roads and Adjacent Paths	Coastal road with section leading to Sea Rescue Group car park	Medium	✗	✗	1) Slope instability associated with toe erosion of dune due to increase in MSL and variable climatic conditions 2) Exposure of seaward edge of road and adjacent paths to slope instability 3) Road inundated during higher tides due to increase in MSL		✓		✓	High	Managed Retreat: realign road as required Protect: install seawall or similar coastal protection to protect road
PB_3	Sandy Coast	Peaceful Bay	Coastal Stairs and Platforms	Wooden stairs and ramp	High	✗	✗	1) Increased erosion adjacent to lower stair 2) Exposure of footings for timber supports of stairs and platforms and reduced support for structure 3) Slope instability associated with toe erosion of dune due to increase in MSL and variable climatic conditions		✓	✓	✓	Medium	Managed Retreat: Progressively move stairs and platforms in line with erosion. Accommodate: Design access infrastructure to be piled self supporting structures. Protect: install coastal stabilisation to protect coastal stairs and platforms.

Notes:

1. Asset exposure based on Risk Analysis (Phase 2). High exposure means assets within 10yr coastal processes zone.
  2. ✗ means coastal asset in sensitive to coastal erosion or inundation
  3. ✗✗ means visual inspection indicated high sensitivity to coastal erosion or inundation.
  4. Adaptive capacity identifies most feasible options. Other options may be considered.
  5. Asset risk based on Risk Evaluation (Phase 3) and is based on asset cost (consequence) and asset exposure (likelihood).
  6. There is not sufficient beach survey and design information to quantitatively assess the sensitivity of individual assets to coastal erosion or inundat
  7. The vulnerability of individual assets, as defined, cannot presently be assessed with confidence due to limited information on their sensitivity to er
- This could however be assessed at a project scale where beach survey and design information is collected or collated.



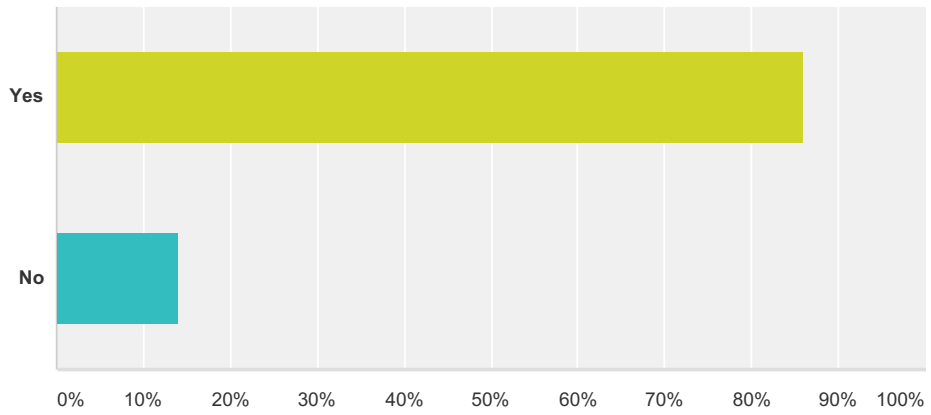
Risk Management and Adaptation Hierarchy (CHRMAP Guidelines)



Vulnerability Assessment Flowchart (CHRMAP Guidelines)

### Q1 Do you live in the Shire of Denmark?

Answered: 64 Skipped: 0

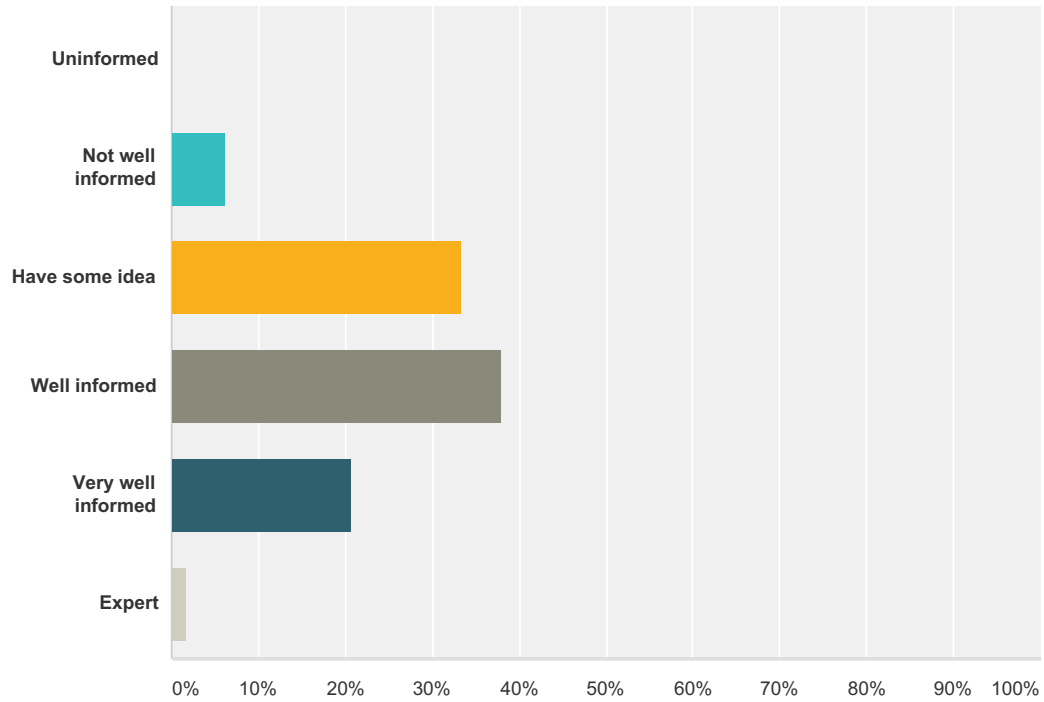


Answer Choices	Responses	
Yes	85.94%	55
No	14.06%	9
<b>Total</b>		<b>64</b>



## Q2 How well informed do you consider yourself to be on coastal impacts (erosion, storm surges) that may happen due to rising sea levels?

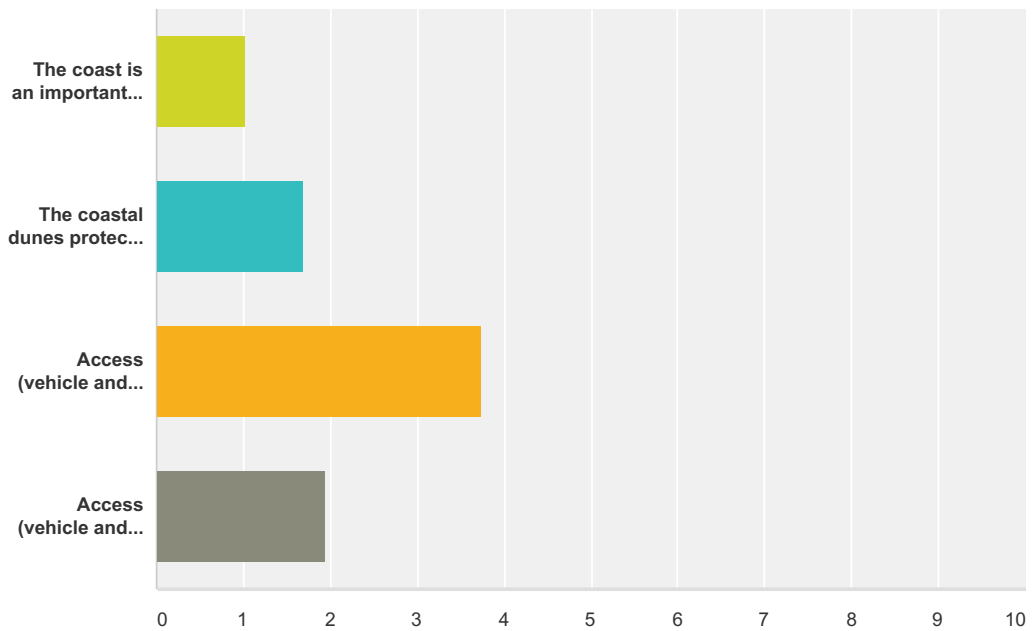
Answered: 63 Skipped: 1



Answer Choices	Responses
Uninformed	0.00% 0
Not well informed	6.35% 4
Have some idea	33.33% 21
Well informed	38.10% 24
Very well informed	20.63% 13
Expert	1.59% 1
<b>Total</b>	<b>63</b>

### Q3 How much do you agree with the following statements?

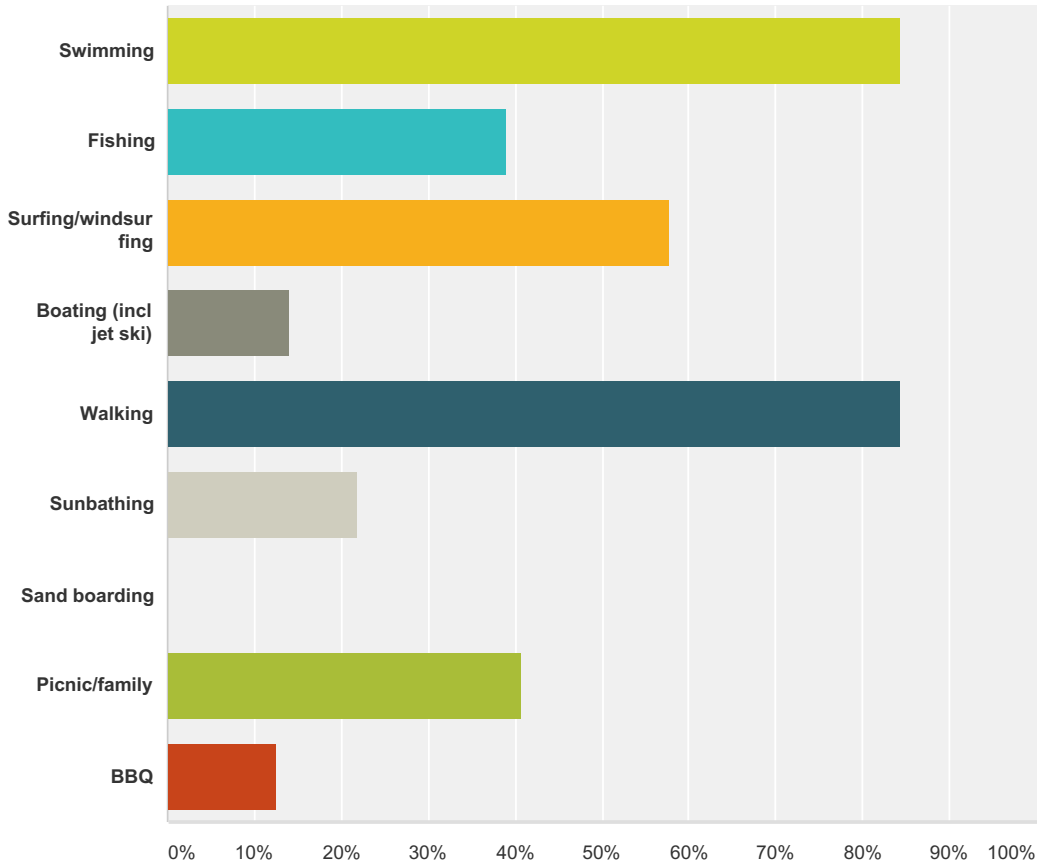
Answered: 63 Skipped: 1



	Strongly agree	Agree	No clear opinion	Disagree	Strongly disagree	Total	Weighted Average
The coast is an important part of the Shire of Denmark's lifestyle	96.83% 61	3.17% 2	0.00% 0	0.00% 0	0.00% 0	63	1.03
The coastal dunes protect public and private property	46.03% 29	42.86% 27	6.35% 4	4.76% 3	0.00% 0	63	1.70
Access (vehicle and pedestrian) should be provided to all parts of the coast	13.11% 8	6.56% 4	4.92% 3	44.26% 27	31.15% 19	61	3.74
Access (vehicle and pedestrian) should only be provided to specific areas of the coast	40.32% 25	43.55% 27	4.84% 3	3.23% 2	8.06% 5	62	1.95

### Q4 What are your main activities at the Ocean Beach beach and foreshore? (Please tick all relevant)

Answered: 64 Skipped: 0



Answer Choices	Responses
Swimming	84.38% 54
Fishing	39.06% 25
Surfing/windsurfing	57.81% 37
Boating (incl jet ski)	14.06% 9
Walking	84.38% 54
Sunbathing	21.88% 14
Sand boarding	0.00% 0
Picnic/family	40.63% 26
BBQ	12.50% 8
<b>Total Respondents: 64</b>	

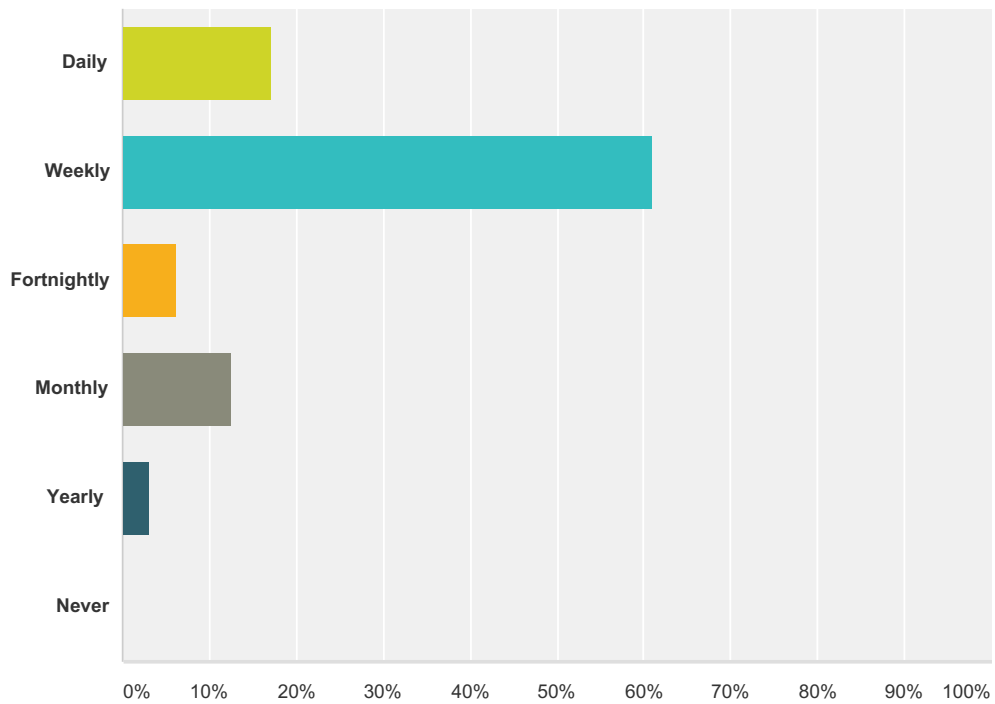
#	Other (please specify)	Date
1	bird watching	6/22/2017 3:04 PM

## Ocean Beach Coastal Hazard Risk Management and Adaptation Plan and Concept Plan

2	kayaking	5/26/2017 3:26 PM
3	Beach patrol for Denmark SLSC & coaching	5/25/2017 8:49 AM
4	Surf Club	5/22/2017 2:42 PM
5	Sea Rescue	5/19/2017 4:10 PM
6	seasonal prawning	5/19/2017 11:25 AM
7	Surf club	5/18/2017 8:25 PM
8	photography	5/18/2017 3:55 PM
9	horse-riding when access across the inlet	5/17/2017 6:11 PM
10	SLSC	5/17/2017 4:14 PM
11	Bird watching	5/17/2017 12:09 PM
12	Walking dog (when the channel is open)	5/17/2017 11:17 AM
13	Running and Playing	5/17/2017 10:48 AM
14	Surf Club ... patrol, training, IRB, surf ski, boards	5/17/2017 8:35 AM
15	surf lifesaving	5/16/2017 1:59 PM
16	Birdwatching and photography	5/16/2017 9:37 AM
17	Dog exercise	5/16/2017 9:25 AM

### Q5 How often to you visit the beach and foreshore at Ocean Beach?

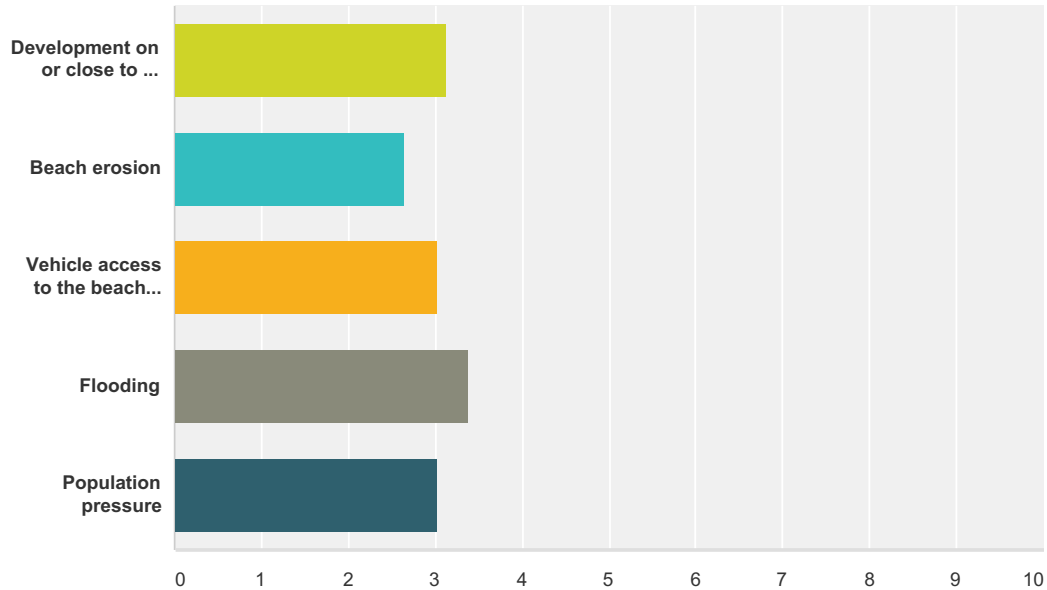
Answered: 64 Skipped: 0



Answer Choices	Responses	Count
Daily	17.19%	11
Weekly	60.94%	39
Fortnightly	6.25%	4
Monthly	12.50%	8
Yearly	3.13%	2
Never	0.00%	0
<b>Total</b>		<b>64</b>

**Q6 Which of these threats/activities currently impact your use of the coastal areas of Ocean Beach? (Please rank the threats from 1 to 5 with 1 being a great threat and 5 being no threat)**

Answered: 64 Skipped: 0



	1	2	3	4	5	Total	Weighted Average
Development on or close to the beach	26.56% 17	7.81% 5	20.31% 13	17.19% 11	28.13% 18	64	3.13
Beach erosion	25.00% 16	20.31% 13	29.69% 19	14.06% 9	10.94% 7	64	2.66
Vehicle access to the beach (4WD's)	24.59% 15	18.03% 11	16.39% 10	13.11% 8	27.87% 17	61	3.02
Flooding	6.45% 4	22.58% 14	22.58% 14	22.58% 14	25.81% 16	62	3.39
Population pressure	18.33% 11	13.33% 8	36.67% 22	10.00% 6	21.67% 13	60	3.03

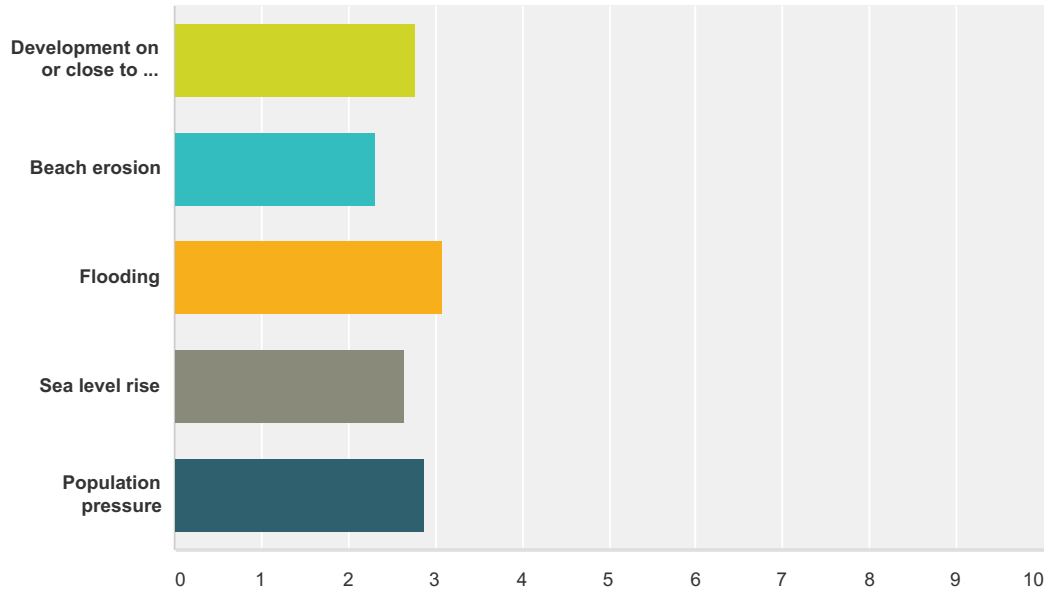
#	Other (please specify)	Date
1	Dogs at Prawn Rock Channel. Jet skis - bar area	6/22/2017 3:10 PM
2	dogs at Prawn Rock Channel exercise area	6/22/2017 3:04 PM
3	burning coastal vegetation	6/22/2017 2:32 PM
4	Note - not concerned with current level of 4WD access for boat launching	6/5/2017 11:59 AM
5	unregulated dog access	6/1/2017 11:27 PM
6	Boat launching & kite surfing	5/25/2017 8:49 AM
7	Ocean Beach is a shared use zone. Individuals who are not community minded and want Ocean Beach for their own use and want to ban others activities have been and could be again a threat. Ocean Beach must remain a shared use area.	5/19/2017 4:10 PM

## Ocean Beach Coastal Hazard Risk Management and Adaptation Plan and Concept Plan

8	Degradation of the inlet (which has a follow on effect to the beach and coastline) from farming and fishing.	5/17/2017 4:14 PM
9	Dogs in habitat areas	5/17/2017 12:09 PM
10	Strangely worded question. I mean that 4WD access has no threat to my activities to clarify	5/17/2017 10:48 AM
11	Boats, Jet Skis, Fishing, Vehicles & Dogs on the beach	5/17/2017 8:35 AM
12	Flooding is only significant to the extent that it prevents access to the dog exercise areas	5/16/2017 9:25 AM

**Q7 Which activities do you think are likely to impact the coastal areas of Ocean Beach in the future? (Please rank the threats 1 to 5 with 1 being a great threat and 5 being no threat)**

Answered: 63 Skipped: 1



	1	2	3	4	5	Total	Weighted Average
Development on or close to the beach	31.75% 20	14.29% 9	20.63% 13	11.11% 7	22.22% 14	63	2.78
Beach erosion	38.10% 24	22.22% 14	17.46% 11	14.29% 9	7.94% 5	63	2.32
Flooding	13.56% 8	18.64% 11	32.20% 19	16.95% 10	18.64% 11	59	3.08
Sea level rise	21.67% 13	28.33% 17	25.00% 15	13.33% 8	11.67% 7	60	2.65
Population pressure	23.73% 14	20.34% 12	20.34% 12	15.25% 9	20.34% 12	59	2.88

#	Other (please specify)	Date
1	dune erosion	6/22/2017 3:10 PM
2	dune erosion	6/22/2017 3:04 PM
3	prescribed or unsuppressed fire if left in a stron and healthy condition and unburnt. Coastal vegetation will sustain the coastal dunes and avoid wind and human damage	6/22/2017 2:32 PM
4	By flooding I presume this means storm surge? If not both questions relating to flooding can score 1.	6/5/2017 11:59 AM
5	Boat launching & kite surfing	5/25/2017 8:49 AM
6	Development of acces to alternate local beaches should continue	5/19/2017 4:10 PM
7	I can't really answer the above, don't have the info	5/19/2017 9:39 AM

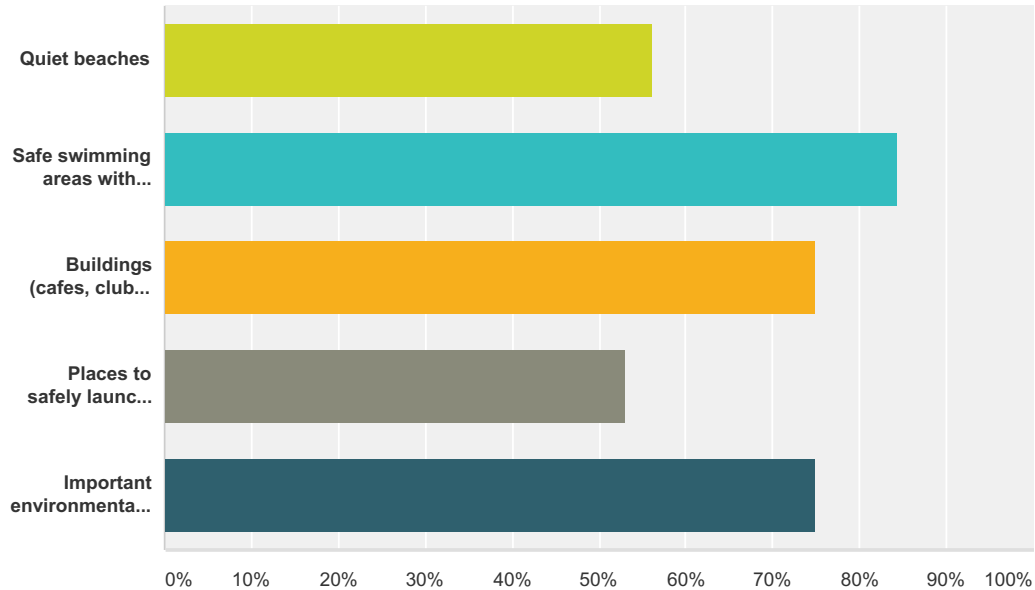


## Ocean Beach Coastal Hazard Risk Management and Adaptation Plan and Concept Plan

8	Weed / pest species negatively impacting the dune system and ecosystem.	5/17/2017 6:11 PM
9	sandboarding, fishing/boating	5/17/2017 8:35 AM

**Q8 Which of these uses or assets do you think should be safeguarded so they continue to be available at Ocean Beach beach and foreshore? (Please tick all relevant)**

Answered: 64 Skipped: 0



Answer Choices	Responses
Quiet beaches	56.25% 36
Safe swimming areas with seasonal patrols and swimming lessons	84.38% 54
Buildings (cafes, clubs, SLSC), ablution blocks, parking and playgrounds	75.00% 48
Places to safely launch recreational boats	53.13% 34
Important environmental sites and plant and animal communities	75.00% 48
<b>Total Respondents: 64</b>	

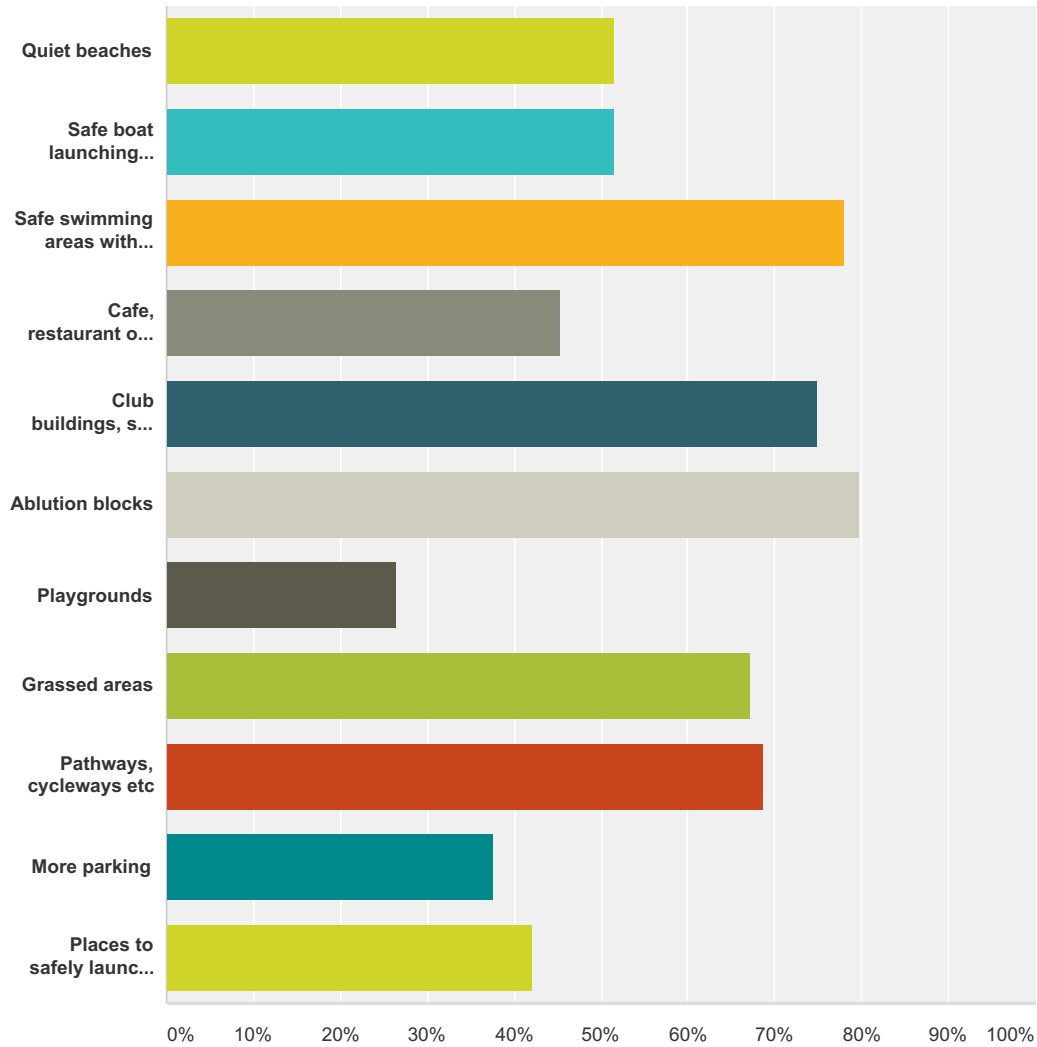
#	Other (please specify)	Date
1	Not playground. Shorebird protection at Prawn Rock Channel.	6/22/2017 3:10 PM
2	shore birds/migratory and resident	6/22/2017 3:04 PM
3	current surf club facilities very important	6/22/2017 2:59 PM
4	protecting adjacent flora	6/22/2017 2:32 PM
5	minimal traditional infrastructure - minimal traditional SLSC, functional ablution, grassed area for passive recreation	6/1/2017 11:27 PM
6	pedestrian access to areas	5/26/2017 3:26 PM
7	Boats launch facility elsewhere too unsafe here	5/25/2017 8:49 AM
8	A cafe or restaurant development on or overlooking Ocean Beach would spoil the area. The two clubs are enough and neither should encroach further into the vista.	5/19/2017 4:10 PM
9	should have vehicle access to beach out of tourist season	5/19/2017 11:25 AM

## Ocean Beach Coastal Hazard Risk Management and Adaptation Plan and Concept Plan

10	if alternate boat launch areas can be provided elsewhere then boat access could be stopped or becomes less important	5/18/2017 3:55 PM
11	Safe launching for Sea Rescue, Relocate old SLSC building, NOT swimming lessons, Not playgrounds, lawn & BBQ	5/17/2017 8:35 AM
12	Recreational boat launches at limited hours (early morning)	5/16/2017 9:39 AM

**Q9 What facilities, uses or assets would you like to see at the beach and foreshore at Ocean Beach over the next 10 years?  
(Please tick all relevant)**

Answered: 64 Skipped: 0



Answer Choices	Responses
Quiet beaches	51.56% 33
Safe boat launching facilities and/or upgrades to existing facilities	51.56% 33
Safe swimming areas with seasonal patrols and swimming lessons	78.13% 50
Cafe, restaurant or kiosk	45.31% 29
Club buildings, surf lifesaving clubs	75.00% 48
Ablution blocks	79.69% 51
Playgrounds	26.56% 17

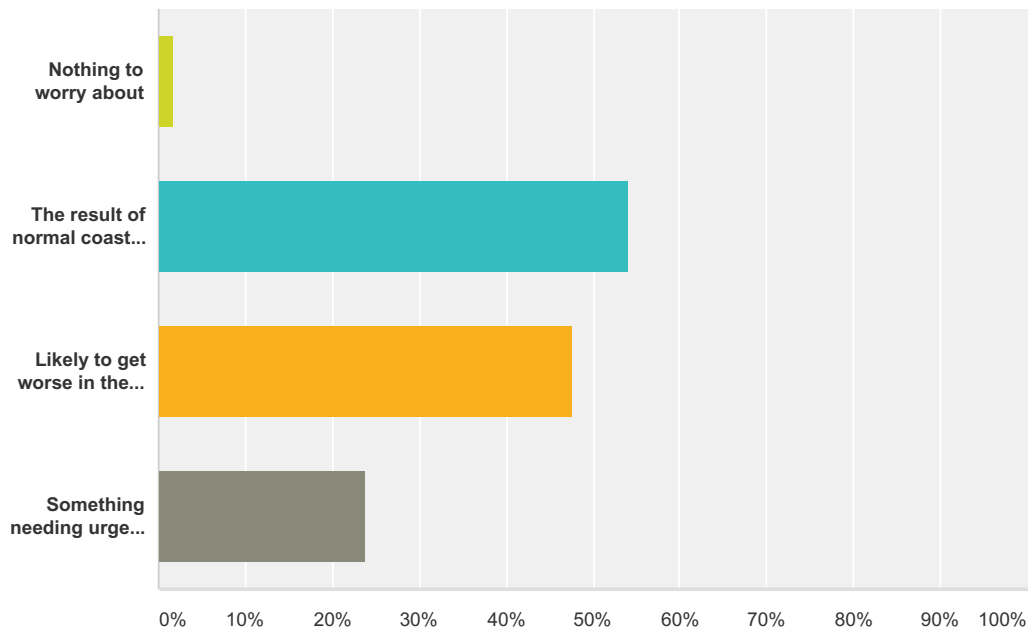
## Ocean Beach Coastal Hazard Risk Management and Adaptation Plan and Concept Plan

Grassed areas	<b>67.19%</b>	43
Pathways, cycleways etc	<b>68.75%</b>	44
More parking	<b>37.50%</b>	24
Places to safely launch recreational boats	<b>42.19%</b>	27
<b>Total Respondents: 64</b>		

#	Other (please specify)	Date
1	BBQ at Ocean Beach. Minimal infrastructure but protection/fence for coastal dunes	6/22/2017 3:10 PM
2	BBQ	6/22/2017 3:04 PM
3	shade shelter in grassed area	6/22/2017 2:59 PM
4	BBQ	6/22/2017 2:36 PM
5	protecting adjacent vegetation	6/22/2017 2:32 PM
6	Possibly Cafe franchise within Surf Club	6/8/2017 10:30 AM
7	see above Q8	6/1/2017 11:27 PM
8	Boat launch facilities elsewhere too dangerous here	5/25/2017 8:49 AM
9	Maintain over beach launch as there is no local alternative, make track to beach safer with a footpath alongside. Better no-parking signs in lower turn around area.	5/19/2017 4:10 PM
10	if alternate boat launch areas can be provided elsewhere then boat access could be stopped or becomes less important	5/18/2017 3:55 PM
11	Protection of native vegetation along the coast.	5/17/2017 6:11 PM
12	Not swimming lessons, Launching for sea rescue, BBQ, kiosk (seasonal)	5/17/2017 8:35 AM
13	A proper boat launching facility - somewhere close to Ocean Beach if not in the current place. This is one of the biggest failures in this shire, the provision of safe boat launching facilities.	5/17/2017 6:41 AM
14	BBQs	5/16/2017 8:17 PM
15	Barbeques at Ocean Beach	5/16/2017 9:24 AM

### Q10 Do you think erosion of the coast at Ocean Beach is (Please tick all relevant)

Answered: 63 Skipped: 1

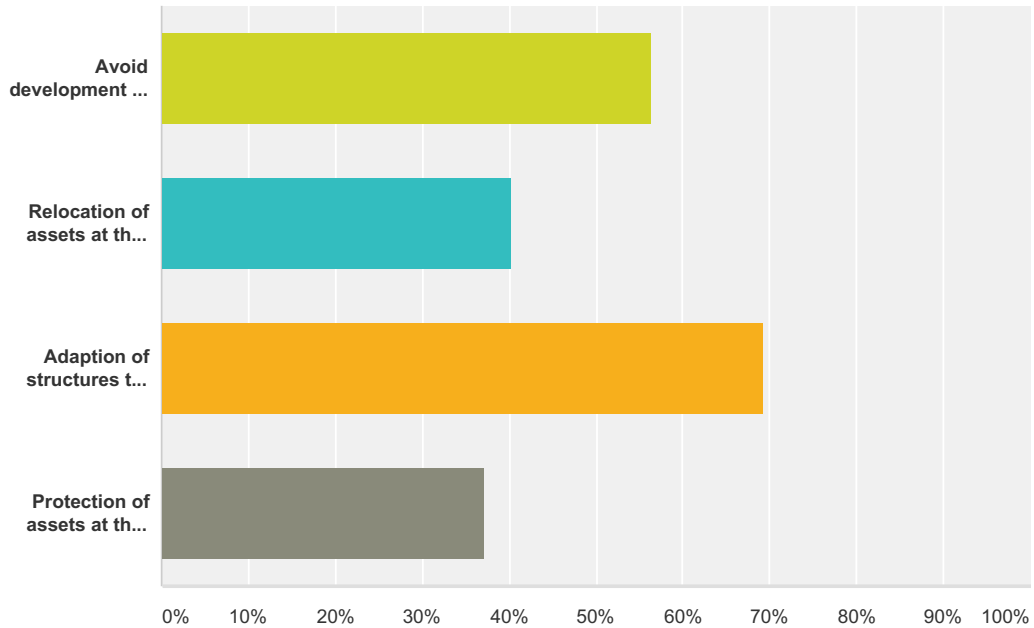


Answer Choices	Responses
Nothing to worry about	1.59% 1
The result of normal coastal processes	53.97% 34
Likely to get worse in the future	47.62% 30
Something needing urgent attention by the Shire	23.81% 15
<b>Total Respondents: 63</b>	

#	Other (please specify)	Date
1	Dune systems close to SLSC need protection	6/22/2017 3:10 PM
2	dune erosion due to people	6/22/2017 3:04 PM
3	Ocean Beach seems fairly stable	6/22/2017 2:59 PM
4	if existing vegetation is protected and left unburnt	6/22/2017 2:32 PM
5	situating SLSC and other infrastructure a sensible distance from intertidal zone is mandatory. intervention e.g hard armouring is PROVEN ineffective with unintended consequences	6/1/2017 11:27 PM
6	However, sea level rise and declining rainfall is likely to have significant impacts on erosion and depositional processes	5/27/2017 6:27 PM
7	Don't really know	5/19/2017 9:39 AM
8	There is not that much erosion.	5/17/2017 4:14 PM
9	Relocate old SLSC building, more grass area	5/17/2017 8:35 AM
10	build up of sand causing expansion of shallows appears to be effecting the hydrology of the beach	5/17/2017 8:03 AM
11	Seems to be due to the deliberate opening of the inlet. Perhaps if the inlet was allowed to operate naturally or the inlet was opened in line with the channel on the east side then there would be better data on coastal erosion in front of the beach/surf club.	5/17/2017 6:41 AM

### Q11 What options would you like the Shire to consider to adapt to coastal erosion over the next 50 years? (Please tick all relevant)

Answered: 62 Skipped: 2



Answer Choices	Responses	
Avoid development in coastal areas of potential future coastal erosion	56.45%	35
Relocation of assets at the coast exposed to erosion (ie planned or managed retreat)	40.32%	25
Adaption of structures to accommodate erosion (eg beach access stairs)	69.35%	43
Protection of assets at the coast exposed to erosion	37.10%	23
<b>Total Respondents: 62</b>		

## Q12 Is there anything else you would like to add about the value of the beach and foreshore at Ocean Beach?

Answered: 30 Skipped: 34

#	Responses	Date
1	Keep it as natural as possible. No more "Hazard signs" - there are already too many. Prawn Rock Channel - informative signs about the shorebirds and the threats posed by dogs. No future development/buildings along foreshore area. I do not want to see any development between Ocean Beach and Lights Beach - particularly roads. Recycling bins during peak season (minimum). Shade shelters - during summer months.	6/22/2017 3:10 PM
2	Protection of shorebirds both migratory and resident from threats such as people, dogs, horses, vehicles. Birds breed and feed in the Prawn Rock Channel dog exercise area!	6/22/2017 3:04 PM
3	No jetties or boat launching slipways! Could change beach dynamics with serious consequences!!	6/22/2017 2:59 PM
4	Ocean Beach and adjacent coast is in very good condition, if existing vegetation and man made structures are maintained and improved the long term future of Ocean Beach should be able to cope with increased population. However, if fire whether deliberate or poor capacity to suppress is allowed to damage the coast then erosion will have a severe impact. I believe it is most important that the natural character currently existing with beaches and coastal reserves under the control of the Shire of Denmark be valued and maintained, in time this undeveloped or unmanaged landscapes will become valuable tourist and local assets. Interestingly this careful and respectful form of land care is very different to that now used by DPaW whereby spectacular natural icons are being developed radically to attract tourists and gain money with entry fees while the balance of National Parks and reserves within DPaW's control are set ablaze and species become extinct, if Denmark's natural environment is treated with respect it will become a valuable asset to our community. Good luck with your valuable work.	6/22/2017 2:32 PM
5	It would be lovely to have a restaurant near the beach that remains open all year.	6/8/2017 10:33 AM
6	Given projected population increases human pressures will only increase on this relatively small area (the study area). Additionally there are limited alternatives for people wanting to enjoy the coast. William Bay is obviously an alternative but the activities that occur in the two areas have different levels of involvement -eg Ocean beach is very important for surfing, William Bay less so. Protecting the coastline and managing competing uses will not be easy. Dynamic and adaptive planning is required. With regard to question 8, it is unclear what it is meant by "quiet beaches". ie - no noisy activities like jet ski's of areas of beach not heavily used? If "maintaining environmental sites" means all the existing dunes etc this will not be practical nor achievable given this steady increase in demand for access to the area.	6/5/2017 11:59 AM
7	Ocean Beach must be acknowledged as a local , regional and perhaps international asset - but it should be remembered that the drawback for the myriad of locals and outside visitors is the laid back, traditional Australian beach experience with only enough development to ensure safety and cleanliness	6/1/2017 11:27 PM
8	I really believe a quick rescue response of a jet ski at the all times either by the surf club or sea rescue for the increase in rescues for the future. Many unrecorded rescues by surfers occur and will increase.	5/28/2017 3:21 PM
9	Natural and undeveloped coast lines and beaches are a significant part of the appeal of the south coast, low impact (ie pedestrian) access should be maintained in all areas, motorised access should likely be restricted in various areas	5/26/2017 3:26 PM
10	BBQ and picnic facilities Protect dunes by fencing off	5/25/2017 8:49 AM
11	Better facilities for Denmark Surf Life Saving Club. They do a wonderful job with limited facilities.	5/20/2017 10:55 AM
12	The growth of the sand dune to the east of the opening due to marron grass (and those against an eastern opening) could have further impact on erosion at the beach by taking sand out of the system.	5/19/2017 4:10 PM
13	prime area should have development to suit all beach users and vehicle access to alban end of beach out of tourist season like it use to be when channel is closed.beach access could be easily made by track down beach from prawn rock channel lookout to beach (limestone base easy make track) to be open at given times. No need then to go past surf club area and opens mostly unused area of beach to people for activities prawning/fishing specially at night	5/19/2017 11:25 AM
14	Just keep it simple- no boat launch, no JetSki use, no cafe needed as there are plenty in Denmark.	5/19/2017 9:39 AM
15	It is a significant tourist destination and needs management	5/18/2017 8:25 PM
16	It is one of Denmark's greatest assets as it exists today and steps need to be taken to preserve it with very minimal further development	5/18/2017 6:33 PM

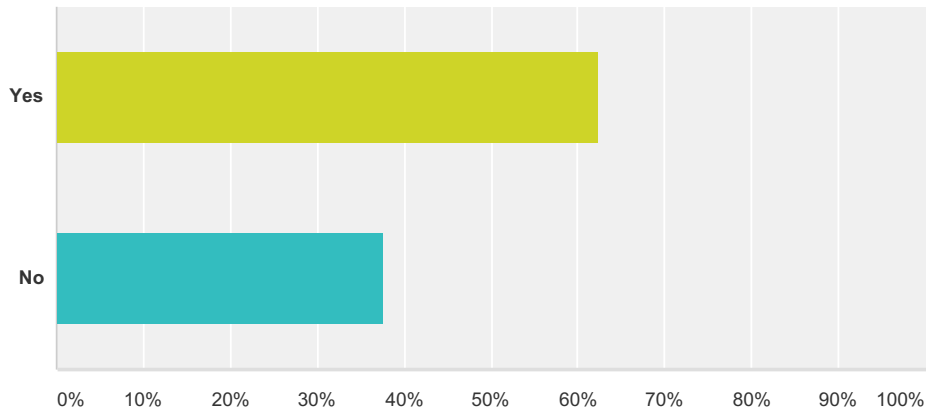


## Ocean Beach Coastal Hazard Risk Management and Adaptation Plan and Concept Plan

17	I would love to see more awareness of litter and how it affects the ecosystem and particularly animal life. I regularly pick up rubbish at OB - a lot of it is made up of deteriorating fishing nets, plastic drink bottle lids, bait bags and cigarette butts when the fishermen are on the rocks. I also think visitors love the beach in its undeveloped state. I personally would hate to see it developed too much more than it is - sensitive low impact development is critical to maintain the character of the main Denmark beach and the town in general.	5/18/2017 6:22 PM
18	Enhancement of the Surf Life Saving Facilities for club and community use and potential future commercial opportunities (café), also surrounding precinct (pathways, parking, access, landscape, lighting and public amenities)	5/17/2017 7:53 PM
19	At some times of the year mainly winter there is considerable erosion that only impacts beach access and summer seabreeze s/e winds returns sand to the beach. Money would be better spent on the Wilson Inlet health	5/17/2017 7:08 PM
20	Every once in a while the beach does wash away, but this is part of a seasonal natural process. Severe storms usually emphasise this, as do the tides. The beach and foreshore are well managed. Please don't do anything unnecessary.	5/17/2017 4:14 PM
21	The Ocean Beach area has a variety of habitat values and coastal vegetation/landscape types. Risk management should look at all the types separately as they have different hazards.	5/17/2017 12:09 PM
22	Don't play "god" by fighting nature. Encourage walking, cycling to get to the beach. Storms and erosion are part of nature ... have greater setbacks for buildings. Redesign access or be prepared to lose and re-make.	5/17/2017 8:35 AM
23	The Surf Club is a valuable asset as it allows the community life savers to keep our beach safe and to educate and strengthen our kids and communities.	5/16/2017 8:17 PM
24	Erosion at Ocean Beach during winter is part of the natural cycle, it is probably getting worse due to rising sea levels hence the impact on facilities currently in-situ. There is nothing that can be realistically done to protect these facilities, sea protection will only move the erosion along the coast.	5/16/2017 2:25 PM
25	One of the shire's greatest assets as far as tourism visitors like a beach that is patrolled and one of the best beaches for young surfers to learn. So keep what is there for future generations.	5/16/2017 1:59 PM
26	Tick first three boxes for question 11 Limit recreational jetski and boat use to certain hours of the day Reassess the area where many surfers park to watch the waves (Boat launch area)	5/16/2017 9:39 AM
27	Keep it in its natural state. That's why people visit Denmark for.	5/16/2017 9:37 AM
28	Dog access to the beach should be retained all year round. Limit the use of jet skis in the bay and inlet and ensure that the beach is a facility that should be available to ALL members of the community and not exclusively the domain of any specific group.	5/16/2017 9:32 AM
29	Ocean beach should also extend to past prawn channel and improve the foreshore overlooking the inlet. A coffee shop with deck overlooking the inlet could be considered. Perhaps located opposite the caravan park so that it gets good patronage and therefore viable	5/16/2017 9:29 AM
30	I think it is important to establish access to encourage use of areas but reduce risk of people forging their own access. But some areas should be restricted to 4WD only to protect coastal processes/environmental values from excessive disturbance.	5/16/2017 9:27 AM

### Q1 Do you live in the Shire of Denmark?

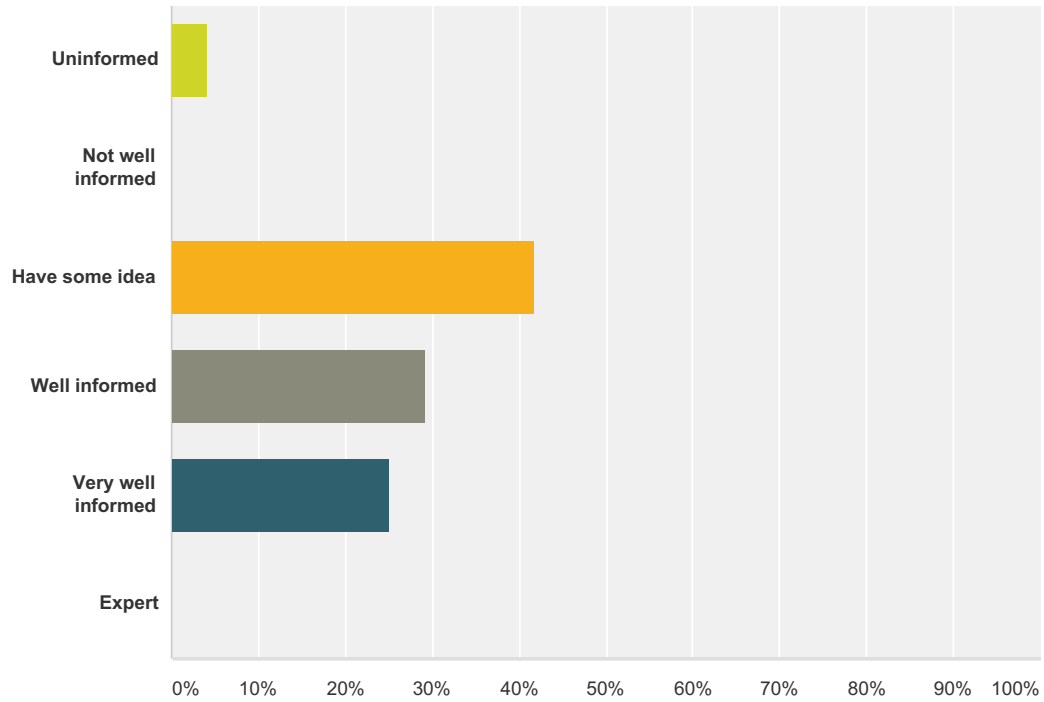
Answered: 24 Skipped: 0



Answer Choices	Responses	
Yes	62.50%	15
No	37.50%	9
<b>Total</b>		<b>24</b>

### Q2 How well informed do you consider yourself to be on coastal impacts(eg erosion, storm surges) that may happen due to rising sea levels?

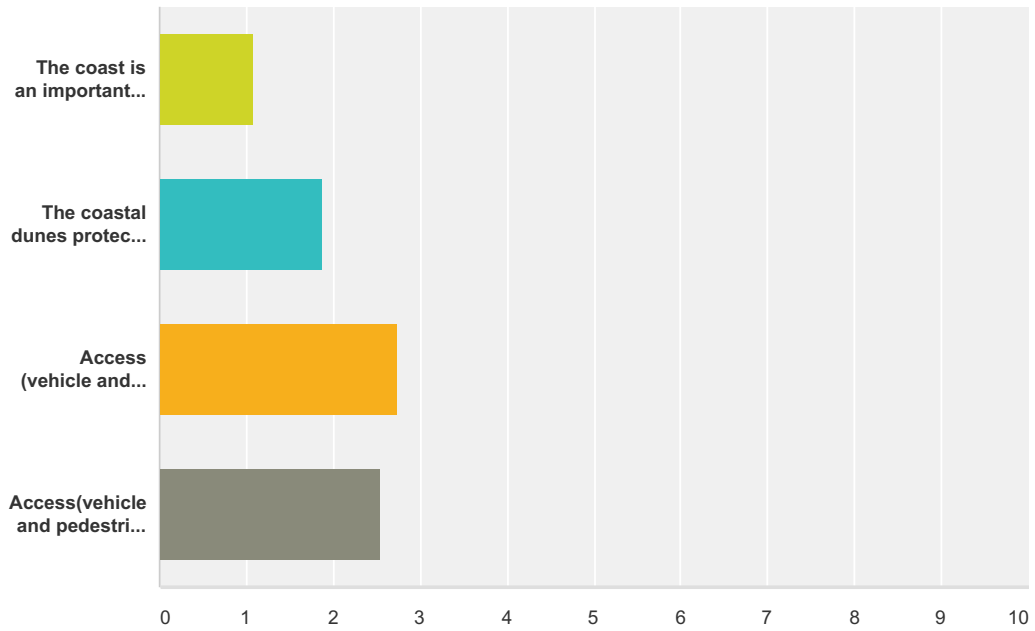
Answered: 24 Skipped: 0



Answer Choices	Responses	Count
Uninformed	4.17%	1
Not well informed	0.00%	0
Have some idea	41.67%	10
Well informed	29.17%	7
Very well informed	25.00%	6
Expert	0.00%	0
<b>Total</b>		<b>24</b>

### Q3 How much do you agree with the following statements?

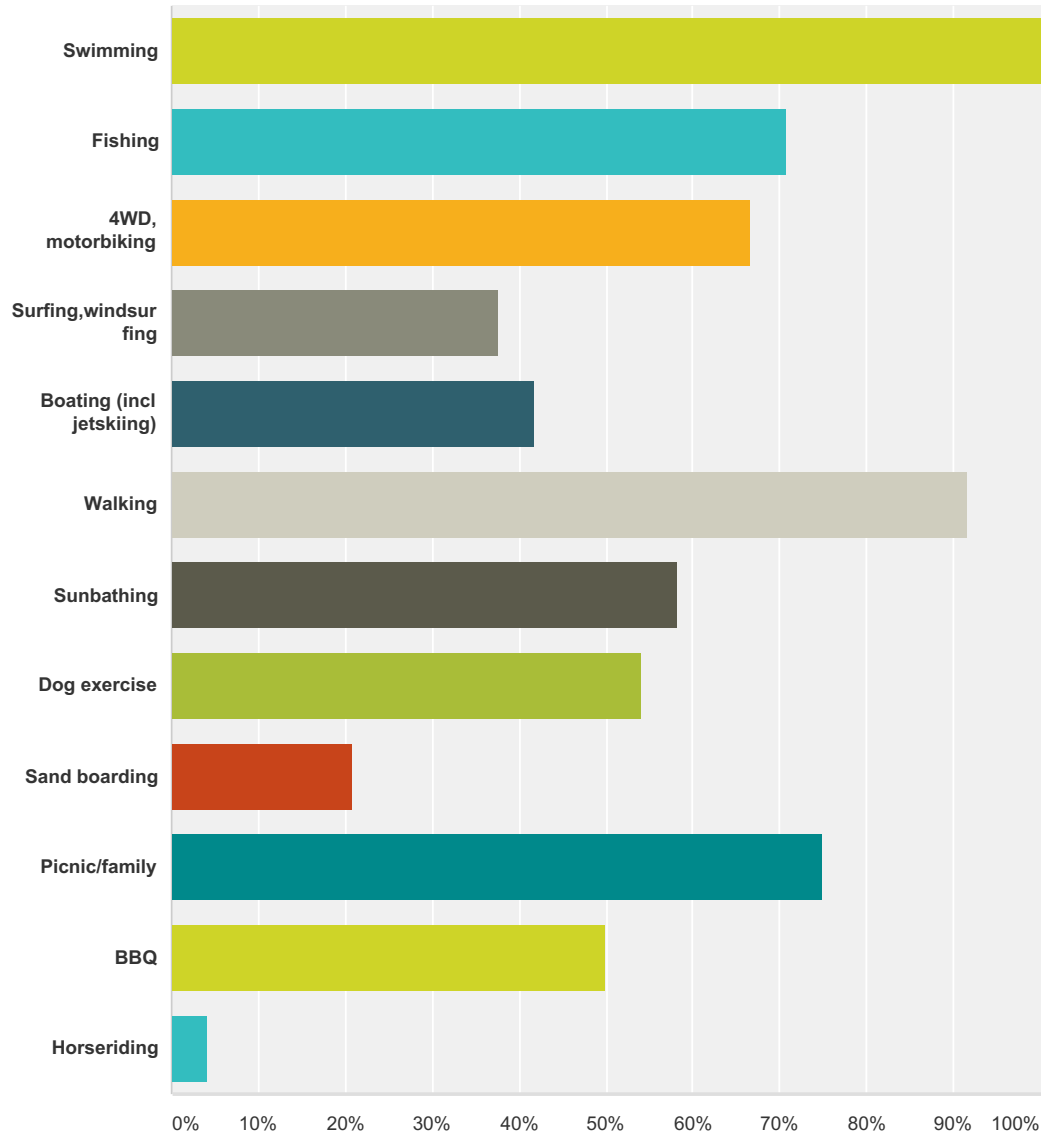
Answered: 24 Skipped: 0



	Strongly agree	Agree	No clear opinion	Disagree	Strongly disagree	Total	Weighted Average
The coast is an important part of the Shire of Denmark's lifestyle	91.67% 22	8.33% 2	0.00% 0	0.00% 0	0.00% 0	24	1.08
The coastal dunes protect private and public property	47.83% 11	34.78% 8	4.35% 1	8.70% 2	4.35% 1	23	1.87
Access (vehicle and pedestrian) should be provided to all parts of the coast	31.82% 7	18.18% 4	0.00% 0	45.45% 10	4.55% 1	22	2.73
Access(vehicle and pedestrian) should only be provided to specific areas of the coast	20.83% 5	50.00% 12	0.00% 0	12.50% 3	16.67% 4	24	2.54

### Q4 What are your main activities at the Peaceful Bay beach and foreshore? (tick all that are relevant)

Answered: 24 Skipped: 0



Answer Choices	Responses
Swimming	100.00% 24
Fishing	70.83% 17
4WD, motorbiking	66.67% 16
Surfing, windsurfing	37.50% 9
Boating (incl jetskiing)	41.67% 10
Walking	91.67% 22

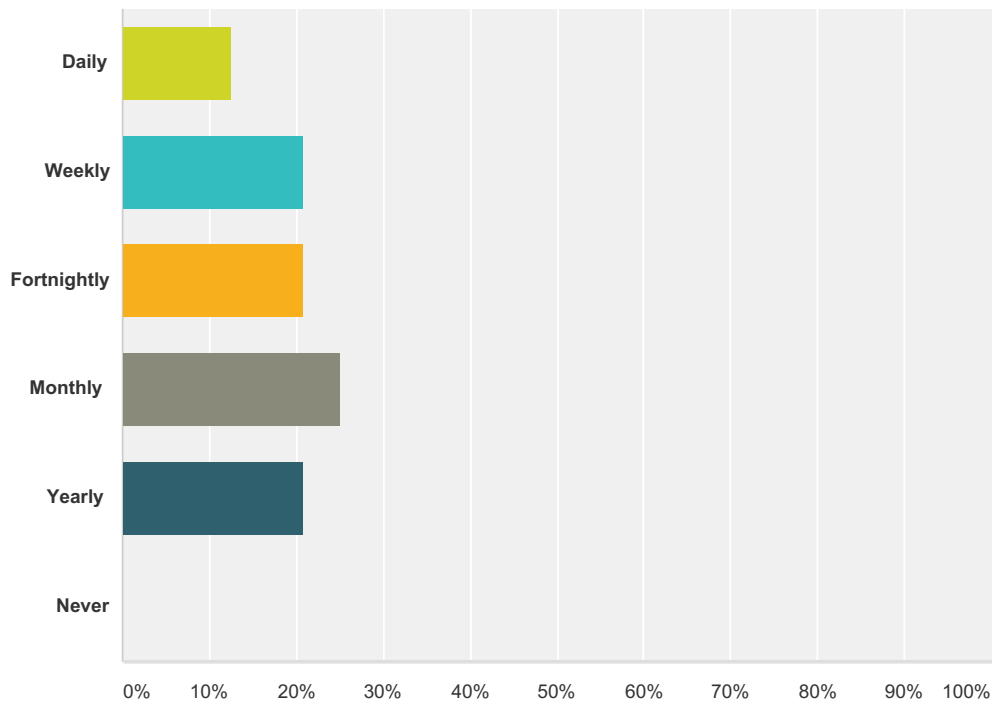
## Peaceful Bay Coastal Hazard Risk Management & Adaptation Plan and Concept Plan

Sunbathing	58.33%	14
Dog exercise	54.17%	13
Sand boarding	20.83%	5
Picnic/family	75.00%	18
BBQ	50.00%	12
Horsriding	4.17%	1
<b>Total Respondents: 24</b>		

#	Other (please specify)	Date
1	camping	6/22/2017 2:01 PM
2	camping	6/22/2017 1:59 PM
3	snorkelling and scuba diving	5/21/2017 3:25 PM
4	Peaceful Bay Memorial services	5/16/2017 11:56 AM

### Q5 How often do you visit the beach and foreshore at Peaceful Bay?

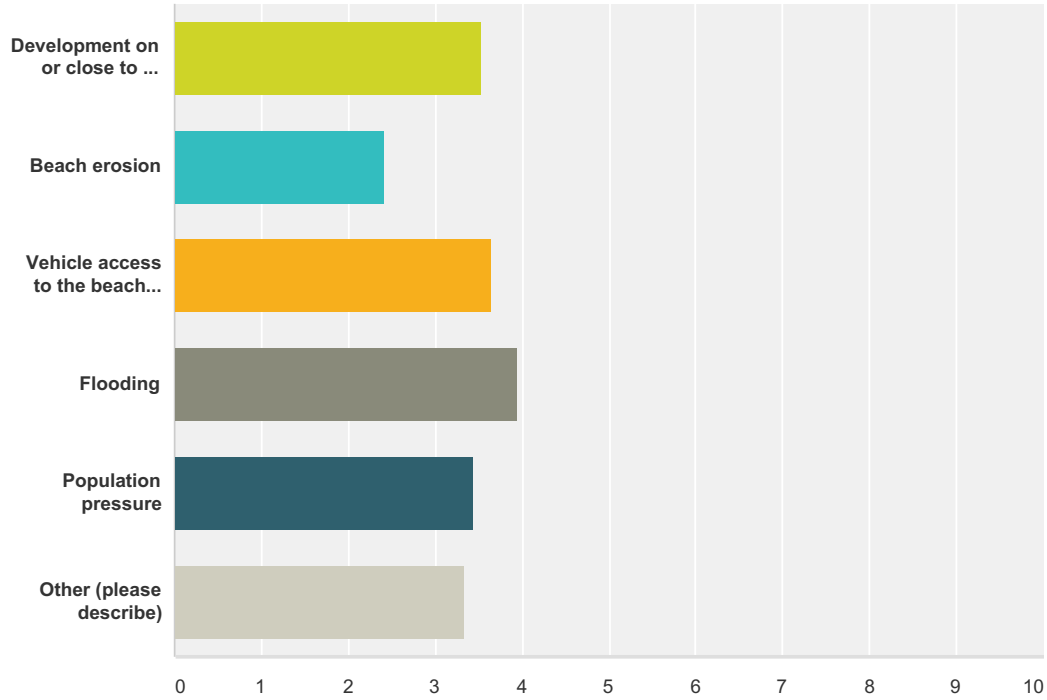
Answered: 24 Skipped: 0



Answer Choices	Responses	Count
Daily	12.50%	3
Weekly	20.83%	5
Fortnightly	20.83%	5
Monthly	25.00%	6
Yearly	20.83%	5
Never	0.00%	0
<b>Total</b>		<b>24</b>

**Q6 Which of these activities currently impact your use of the coastal areas of Peaceful Bay? (Please rank the threats from 1 to 5 with 1 being a great threat and 5 being no threat)**

Answered: 23 Skipped: 1

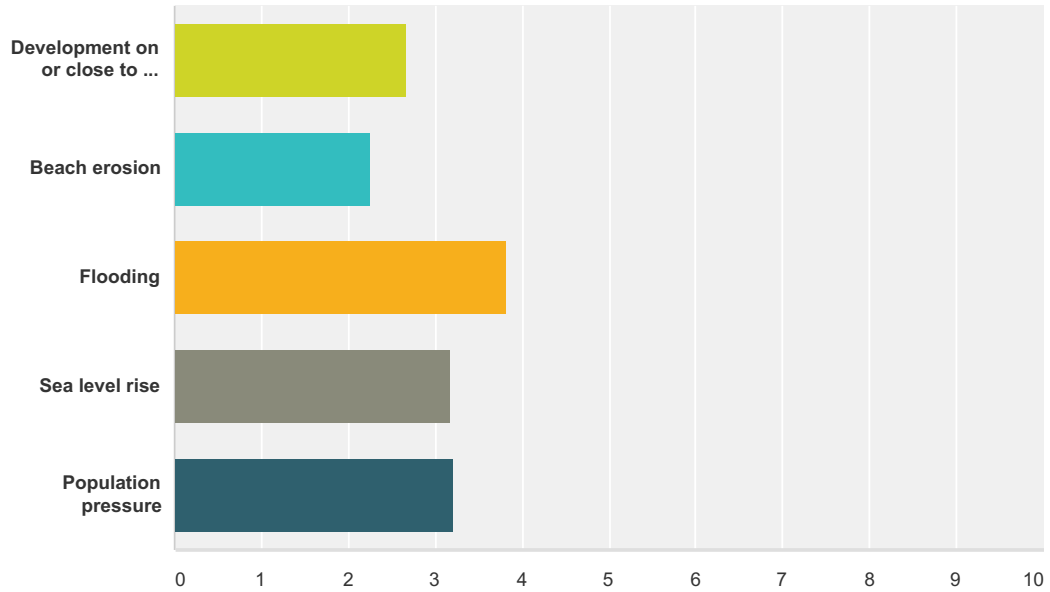


	1	2	3	4	5	Total	Weighted Average
Development on or close to the beach	13.04% 3	17.39% 4	4.35% 1	34.78% 8	30.43% 7	23	3.52
Beach erosion	39.13% 9	8.70% 2	30.43% 7	13.04% 3	8.70% 2	23	2.43
Vehicle access to the beach and dunes (4WD's, motorbikes)	13.04% 3	13.04% 3	8.70% 2	26.09% 6	39.13% 9	23	3.65
Flooding	4.76% 1	9.52% 2	19.05% 4	19.05% 4	47.62% 10	21	3.95
Population pressure	9.09% 2	18.18% 4	18.18% 4	27.27% 6	27.27% 6	22	3.45
Other (please describe)	33.33% 2	0.00% 0	16.67% 1	0.00% 0	50.00% 3	6	3.33



**Q7 Which threats/activities do you think are likely to impact the coastal areas of Peaceful Bay in the future? (Please rank the threats from 1 to 5 with 1 being a great threat and 5 being no threat)**

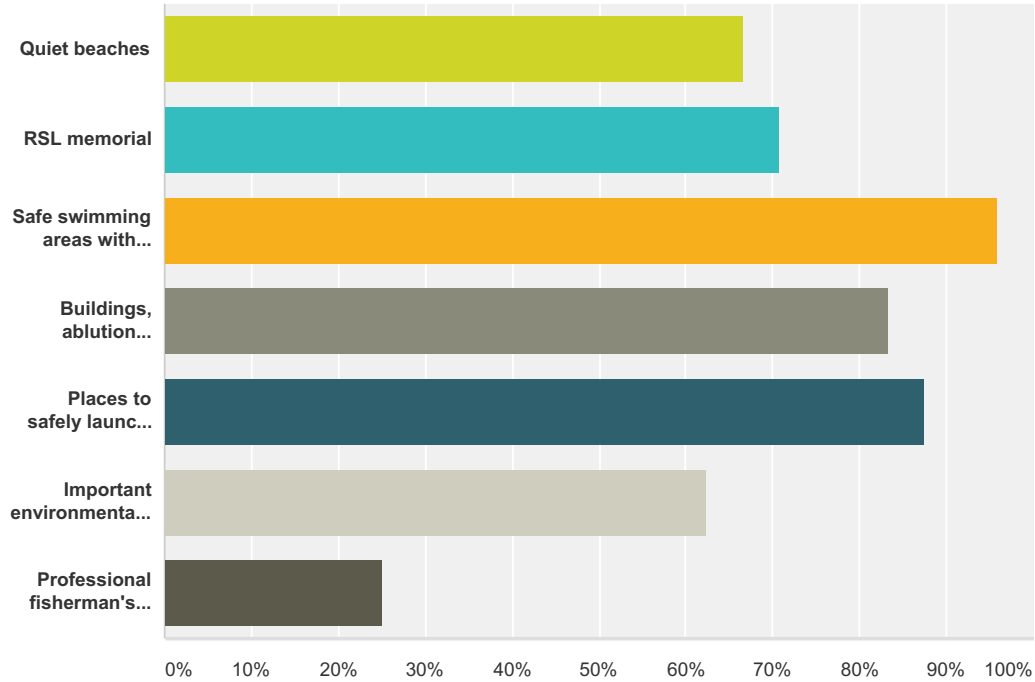
Answered: 24 Skipped: 0



	1	2	3	4	5	Total	Weighted Average
Development on or close to the beach	29.17% 7	16.67% 4	25.00% 6	16.67% 4	12.50% 3	24	2.67
Beach erosion	37.50% 9	20.83% 5	25.00% 6	12.50% 3	4.17% 1	24	2.25
Flooding	4.35% 1	8.70% 2	26.09% 6	21.74% 5	39.13% 9	23	3.83
Sea level rise	4.35% 1	21.74% 5	34.78% 8	30.43% 7	8.70% 2	23	3.17
Population pressure	13.04% 3	26.09% 6	17.39% 4	13.04% 3	30.43% 7	23	3.22

**Q8 Which of these uses or assets do you think should be safeguarded so they continue to be available at the Peaceful Bay beach and foreshore? (Please tick all relevant)**

Answered: 24 Skipped: 0



Answer Choices	Responses
Quiet beaches	66.67% 16
RSL memorial	70.83% 17
Safe swimming areas with seasonal patrols and swimming lessons	95.83% 23
Buildings, ablu... blocks, parking and playgrounds	83.33% 20
Places to safely launch recreational boats	87.50% 21
Important environmental sites and plant and animal communities	62.50% 15
Professional fisherman's shack/lease area	25.00% 6
<b>Total Respondents: 24</b>	

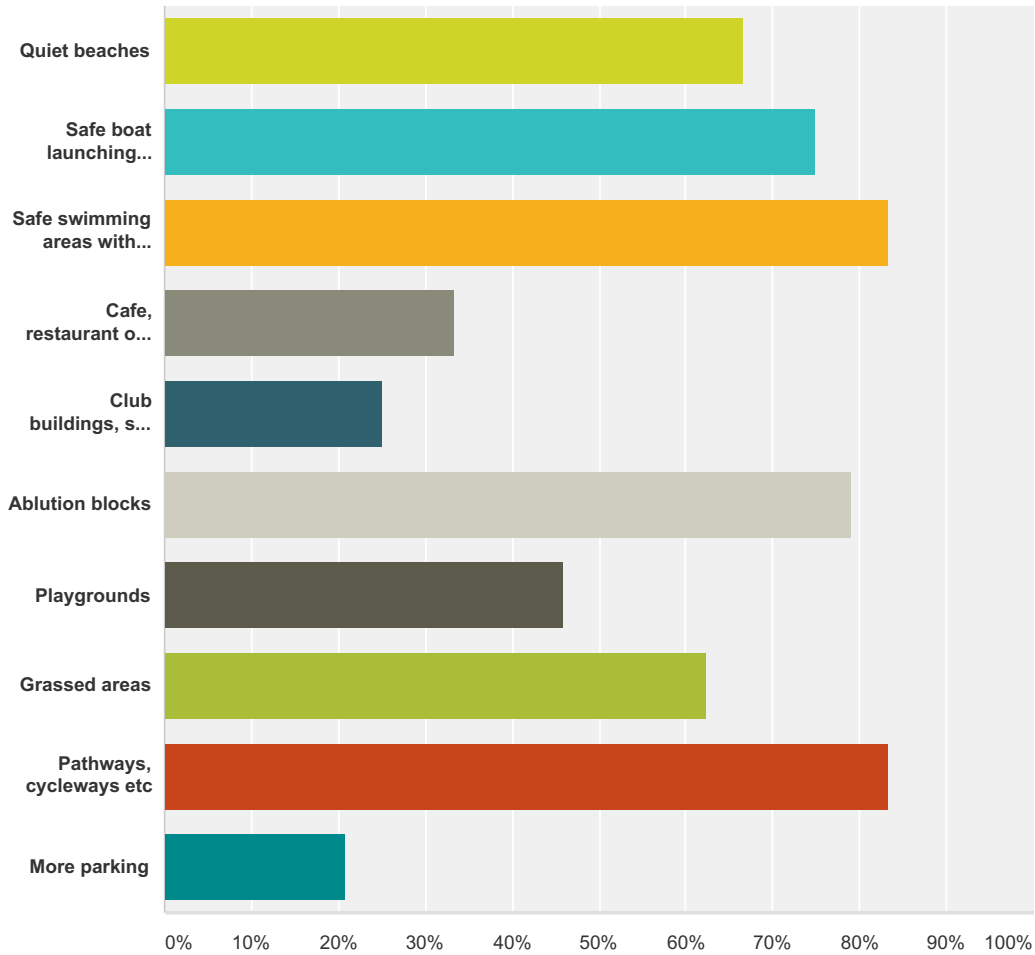
#	Other (please specify)	Date
1	Fishermans shack should be upgraded or moved to a more industrial type site	6/2/2017 4:27 PM
2	RSL memorial should be shifted to Tingledale Hall.	6/2/2017 1:24 PM
3	Maintain access to estuary along beach	5/16/2017 9:32 PM
4	Dog walking and horse riding	5/16/2017 8:51 PM

## Peaceful Bay Coastal Hazard Risk Management & Adaptation Plan and Concept Plan

5	With regard to No.3 - What seasonal patrols? With regard to Nos 2&7 if these assets erode away the road into Peaceful Bay will be at great risk..	5/16/2017 8:11 PM
6	Vehicle access to beach and inlet	5/16/2017 1:37 PM

**Q9 What facilities, uses or assets would you like to see at the Peaceful Bay beach and foreshore over the next 10 years? (Please tick all relevant)**

Answered: 24 Skipped: 0



Answer Choices	Responses
Quiet beaches	66.67% 16
Safe boat launching facilities and/or upgrades to existing facilities	75.00% 18
Safe swimming areas with seasonal patrols and swimming lessons	83.33% 20
Cafe, restaurant or kiosk	33.33% 8
Club buildings, surf lifesaving club	25.00% 6
Ablution blocks	79.17% 19
Playgrounds	45.83% 11
Grassed areas	62.50% 15
Pathways, cycleways etc	83.33% 20

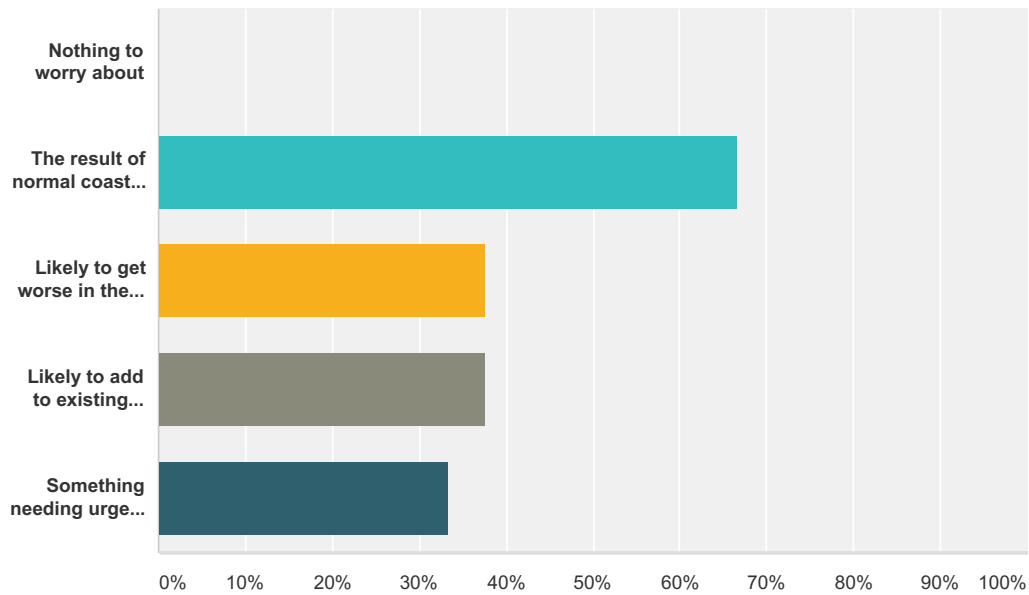
## Peaceful Bay Coastal Hazard Risk Management & Adaptation Plan and Concept Plan

More parking	20.83%	5
<b>Total Respondents: 24</b>		

#	Other (please specify)	Date
1	Protect native vegetation and avoid fire.	6/22/2017 1:51 PM
2	Large boat service jetty and marina	6/2/2017 1:24 PM
3	Not more of most, just retain what is there. Club building as planned as a combined facility, not more individual buildings.	5/16/2017 11:56 AM
4	Bbq areas	5/16/2017 9:01 AM

### Q10 Do you think erosion of the coast at Peaceful Bay is (Please tick all relevant)

Answered: 24 Skipped: 0

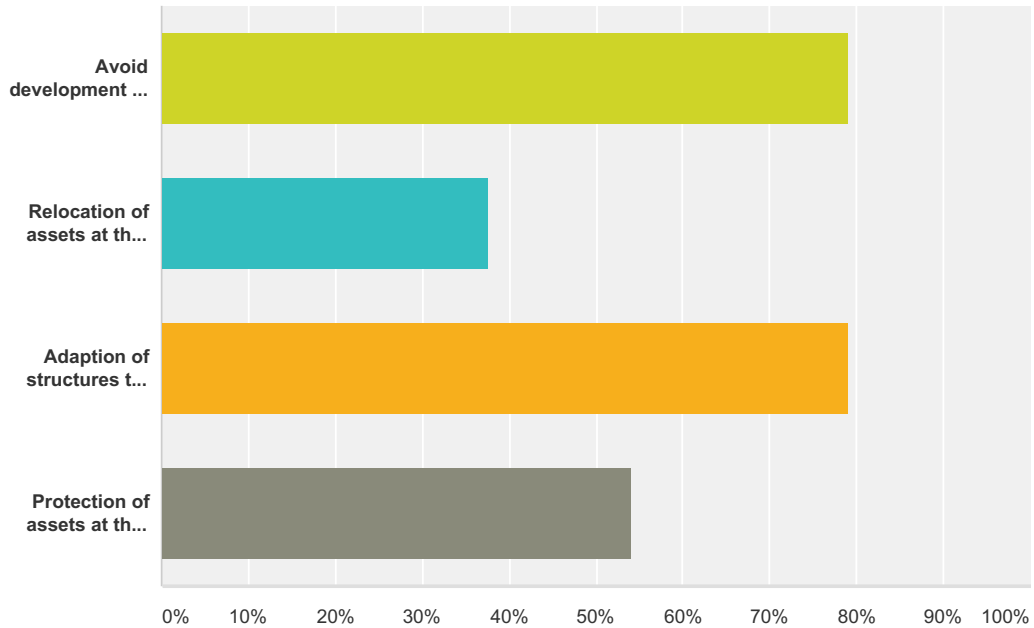


Answer Choices	Responses
Nothing to worry about	0.00% 0
The result of normal coastal processes	66.67% 16
Likely to get worse in the future	37.50% 9
Likely to add to existing damage	37.50% 9
Something needing urgent attention by the Shire	33.33% 8
<b>Total Respondents: 24</b>	

#	Other (please specify)	Date
1	Needs to be monitored	6/2/2017 4:27 PM
2	Problem could be fixed easily and inexpensively.	6/2/2017 1:24 PM
3	To protect the RSL site only	5/16/2017 1:37 PM
4	I have been a regular resident and visitor to Peaceful Bay for 60 + years. The introduction of marram grass had a huge impact on the beach and interfered with normal sand movement, particularly in Foul Bay and on the swimming beach headland. Valuable anecdotal information will come from long term residents/users and fishermen. Vehicles should not be permitted anywhere near the southern headland of the swimming beach. Barriers should be introduced to stop people taking quad bikes along the swimming beach to the headland.	5/13/2017 8:59 AM

### Q11 What options would you like the Shire to consider to adapt to coastal erosion over the next 50 years (Please tick all relevant)

Answered: 24 Skipped: 0



Answer Choices	Responses
Avoid development in areas of potential future coastal erosion	79.17% 19
Relocation of assets at the coast exposed to erosion (ie planned or managed retreat)	37.50% 9
Adaption of structures to accommodate erosion (eg beach access stairs)	79.17% 19
Protection of assets at the coast exposed to erosion	54.17% 13
<b>Total Respondents: 24</b>	

## Q12 Is there anything else you would like to add about the value of Peaceful Bay beach and foreshore?

Answered: 11 Skipped: 13

#	Responses	Date
1	Peaceful Bay is an icon of this region and of immense value to the young and old. Development must not damage this beautiful beach. The Denmark Council must avoid the policy of DPaW whereby tourist icons are developed and managed as an income asset with entry fees. It's obscene! Peaceful Bay is where I learnt to swim in the early 1960s. Tom's Rock was a goal to swim around and diver from. It's a beautiful place. The beach to the east with vehicle access and Salmon Camp could easily become the Denmark's Community's boat launching asset with careful construction in a fashion that did not alter the character of this beach in an aggressive manner. Peaceful Bay must not be impacted by this development at all I believe. Good luck with your valuable work.	6/22/2017 1:51 PM
2	Town and caravan park close to protected beaches. Need disabled acces to beach	6/2/2017 4:27 PM
3	Denmark Shire should install a marina similar to the one at Augusta. You could have cruise ships anchoring in the Lee of point Irwin. Tendering its passengers ashore to visit the Tree Walk and Tourist Spots throughout the shire. Imagine the economic value this would bring to the local economy.	6/2/2017 1:24 PM
4	reduction in vehicle access to sensitive dune areas	5/21/2017 3:25 PM
5	The finger jetty makes it safer to launch boats in the bay. However, the lack of depth in the water and shallow, flat beach makes retrieval of larger boats difficult. A better form of launching facility would assist and encourage visitors to the bay, that would only enhance the businesses in the area. Boat launching facilities, for anything larger than a dinghy, are appalling in the Shire of Denmark.	5/17/2017 6:46 AM
6	When the erosion is part of nature humans need to leave it alone. When it is the result of humans, esp during high usage times, it needs to be more strongly regulated. Ie. People showing no respect for the place they are visiting, driving way too fast on the beach and leaving rubbish. I don't think the dunes right on the beach necessarily need protection as these will erode/wash away with winter swells and high tides anyway.	5/16/2017 8:51 PM
7	The value is the beach and foreshore itself and structures and developments should be avoided anywhere near these natural assets.	5/16/2017 8:11 PM
8	As long as easy beach access remains available for vehicles and maintained boardwalks/steps, it will remain a more natural attraction which is its best asset.	5/16/2017 1:37 PM
9	While protection of assets is desirable, (Point 11) I do not believe groins are advisable. They only shift the problem to elsewhere and can even make it worse.	5/16/2017 11:56 AM
10	i feel the welfare of the beach and surrounds should be held in higher regard than the comfort or convience of humans. No further development ie clubs, cafes etc. I feel money should be spent on preserving the beauty of Peaceful and to minimise the impact of erosion.	5/16/2017 7:33 AM
11	The fisherman's huts are part of the history of Peaceful Bay and should be retained. Long drop toilets would be an advantage near the surf rescue building. Rubbish bins should be provided for people who collect marine debris, with appropriate signage. Removal of marram grass is now impossible but serves as a good warning that human interference can have massive impact.	5/13/2017 8:59 AM





# Coastal Hazards Issues Paper



## OCEAN BEACH and PEACEFUL BAY Shire of Denmark

The Shire of Denmark is undertaking a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for Ocean Beach and Peaceful Bay. The CHRMAP will influence the development of 10-year Concept Plans for the beach and foreshore at both sites. This ISSUES PAPER outlines the results of the initial coastal hazard assessment associated with beach erosion and long term coastal change.

Feedback on the planning and management of coastal assets at Peaceful Bay and Ocean Beach is being sought via a community survey.



**SYNOPSIS**

The WA State Coastal Planning Policy notes that coastal hazard risk management and adaptation planning (CHRMAP) should be undertaken in areas at risk of being affected by coastal hazards over a 100-year planning timeframe (WAPC 2013).

This is a risk based approach to coastal adaptation planning that requires local governments in Western Australia to consider the following adaptation hierarchy:

- *Avoid* new development in areas subject to impact by coastal processes.
- *Managed Retreat* - removing assets subject to intolerable risk of damage.
- *Accommodation* - adapting assets to suitably address the identified risks.
- *Coastal Protection* works to protect vital assets not suitable for other actions through construction of groynes, seawalls and other works.

The present study focuses on those portions of the Ocean Beach and Peaceful Bay coastlines with the highest value assets. This includes built assets (i.e. coastal infrastructure, buildings) and natural assets (i.e. the sandy beach, coastal dunes).

This issues paper outlines the results of the coastal hazard assessment and key management and adaptation issues that will be considered in the CHRMAP. Ultimately, as part of the CHRMAP process, 10-year Concept Plans will be developed for the Ocean Beach and Peaceful Bay beach and foreshore.

**Coastal Hazards**

A hazard assessment of the sites has been undertaken to develop allowances for potential erosion due to coastal processes. This required assessment of the current risk of storm erosion (S1), historic shoreline movement trends (S2) and future sea level rise (S3). S1 and S2 allowances have been developed from modeling and historic analysis, while the S3 allowance for sea level rise is based on values identified in the State Coastal Planning Policy (SPP2.6). The concept for the assessment of coastal processes allowances under SPP2.6, including the required factor of safety (FOS) from the horizontal setback datum (HSD), is shown in Figure 1.

Allowances for coastal process have been assessed for the 10, 50 and 100-year planning timeframes at Ocean Beach and Peaceful Bay. Maps have been developed identifying broad areas where consideration is required of the potential impact of coastal processes on existing structures, or planned future development.

This analysis will allow the management and future planning of this highly valued public coastal environment, which is a dynamic system subject to natural cycles of erosion and recovery, to be undertaken in a sustainable manner. Management options may include adaptation of structures, appropriate siting of new public amenities and improved coastal monitoring.



Figure 1: Concept for the assessment of coastal processes allowances under SPP2.6 as applied to Gracetown Beach for Augusta Margaret River CHRMAP.



## Ocean Beach

Ocean Beach is an east facing high-energy sandy beach popular for swimming, surfing and boating; and has been subject to coastal erosion in the late 1990's, 2013 and 2016. Coastal infrastructure and beach access is provided along a 400m section at the southern end of the beach, between the granite rock outcrops and the entrance to the seasonally open Wilson Inlet. This is the main recreational ocean beach for the Town of Denmark and is used for commercial and club based activities. Redevelopment of the Surf Life Saving Club is proposed at some time in the future.



Figure 2: Ocean Beach During Reconnaissance Site Inspection (June 2016)

### Allowance for Coastal Processes

To identify historic storms with high water levels or high waves, 11 years of wave records and 29 years of water level records were assessed from Albany, the closest available records. Cross-shore beach erosion modeling for a 1 in 100yr event was undertaken using the USACE's SBEACH one-line model at a typical beach profile along Ocean Beach. The initial (pre-storm) and final (post-storm) beach profiles output from the model are shown in Figure 3. The assumed allowance for Acute Storm Erosion (S1) was 16 meters.

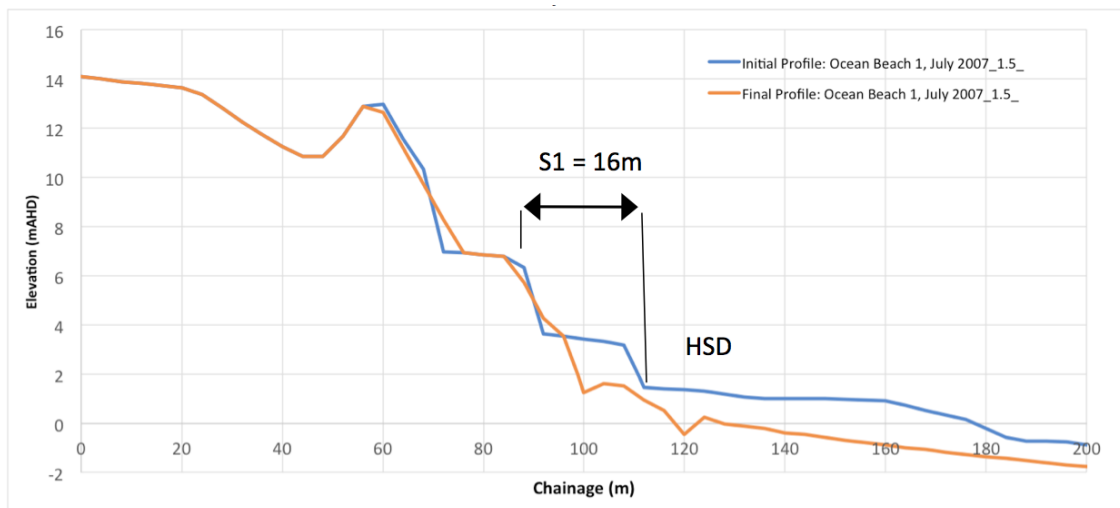


Figure 3: SBEACH erosion model for 100-year average return interval storm.

Note: HSD = Horizontal Setback Datum

The historic shoreline movement trends at Ocean Beach have been assessed based on aerial imagery provided by the Shire from 2002, 2006, 2010, 2014 & 2016 (Figure 4). The following was noted based on the assessment of 4 profiles:

- The vegetation line has eroded about 7 meters in the profile south of the Denmark Surf Life Saving Club (Denmark SLSC) club since 2002. The nature of this erosion may be episodic, and there is capacity for the dunes to recover between events, however historically this represents a net erosion trend in the order of 0.5m/year.



- Net erosion has not occurred at the Denmark SLSC due to the timber seawall.
- The beach to the north near the entrance has been relatively stable due to rock controls along the back of the beach limiting the landward extent of erosion.

The assumed allowance over a 100-year planning period for Historic Shoreline Movement Trends (S2) was 50 meters. The policy also requires an additional factor of safety of 10m for the 100-year planning period.

The allowance erosion due to future sea level rise (S3) is based on the requirements of State Planning Policy 2.6 for a sandy coast of 90 meters (100 times the adopted sea level rise value of 0.9m over a 100-year timeframe).

The allowances for Coastal Processes at Ocean Beach for the 10, 50 and 100 year planning periods (S1 + S2 + S3), including the required factor of safety, are summarised in Table 1.

Table 1 – Ocean Beach Allowances for Coastal Processes

Planning Timeframe	10 year	50 year	100 year
Coastal Processes Allowances (m)	20	85	175

Key issues for consideration in the risk management and adaptation phase of the CHRMAP for Ocean Beach include:

- The design and present condition of the timber seawall and its capacity to provide longer-term protection. This wall provides important protection to the old Denmark SLSC building.
- Ocean Beach has a number of structures located relatively high on the seaward face of steep dunes. The risk of reduced foundation capacity for these structures following an erosion event, due to slope stability issues, requires consideration.
- Beach access infrastructure is presently subject to ocean forces. Adaptation of these assets may be required in order to maintain a high level of public beach access.
- Future Denmark SLSC development requires careful consideration of coastal processes.
- The presence or otherwise of buried rock.
- The interplay between Wilson Inlet and the beach.



Figure 4: Ocean Beach during a storm in September 2016 and Peaceful Bay Beach Access Stairs

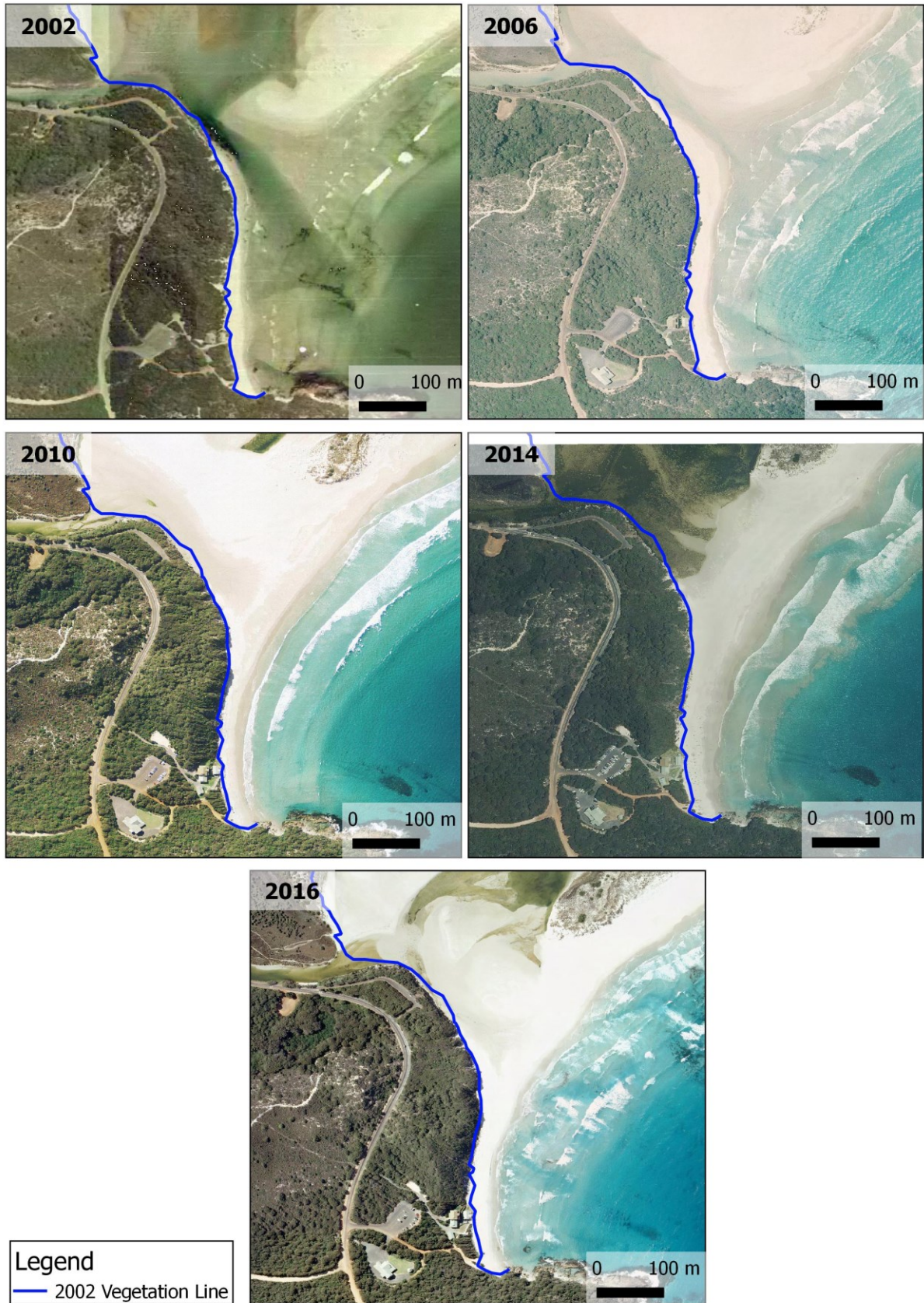


Figure 5: Historic Aerial Imagery for Ocean Beach



## Peaceful Bay

Peaceful Bay is a smaller settlement west of the Town of Denmark with a lower energy sandy beach. A small sheltered pocket beach provides a relatively calm swimming beach and beach launching for recreational vessels, while there is a longer eroding sandy beach to the north.

The coastline north of the Peaceful Bay boat launching area, in Foul Bay, has eroded approximately 15 m between 2002 and 2014, resulting in the retreat of sheds from a Fishermen's lease area. If the current rate of erosion continues, the Shire is concerned about future threats to Peaceful Bay Road, which is an access route for the townsite.



Figure 6: Sandy Beaches at Peaceful Bay (L) and Foul Bay to the North of the Boat Launching Area (R) During Reconnaissance Site Inspection (June 2016)

### Allowances for Coastal Processes

The Shire provided site photos from historic storm erosion events. Whilst scarping is apparent in the swimming beach foredunes at Peaceful Bay following storms, higher and more persistent erosion scarps are apparent along the beach to the north of the boat ramp within Foul Bay.

#### *Cross Shore Erosion Modelling*

Cross-shore beach erosion modeling was undertaken using the USACE's SBEACH 2D model and an adjusted July 2007 storm event as per Ocean Beach. At Peaceful Bay two typical beach profiles were generated, one at the main swimming beach for Peaceful Bay and one at the beach north of the boat launching area (Foul Bay). The modelled allowances for Acute Storm Erosion (S1) are larger at Peaceful Bay than Ocean Beach due to the high responsiveness of relatively sheltered beaches with lower lying dunes to rare high water level and high wave storm events.

The historic shoreline movement trends have been assessed based on aerial imagery provided by the Shire from 2002, 2006, 2014 & 2016. The following was noted based on the assessment of 5 profiles:

- The swimming beach in Peaceful Bay has been relatively stable since 2002 due to rock headlands providing a stable shoreline.
- The vegetation line has eroded between 16 and 24 meters at Foul Bay, to the north of the boat launching area, since 2002. Erosion and/or removal of a number of structures is evident in the aerial photography. Whilst erosion is expected to be associated with storms, and there is capacity for the dunes to recover between events, a net erosion trend in the order of 1.4m/yr was observed. Progressive realignment of the shoreline and net loss of sediment may be occurring and requires consideration in the risk analysis phase.

As at Ocean Beach, the allowance erosion due to future sea level rise (S3) at Peaceful Bay is based on the requirements of State Planning Policy 2.6 for a sandy coast of 90 meters (100 times the adopted sea level rise value of 0.9m over a 100-year timeframe). The policy also requires an additional safety factor of 20m for the 100-year planning period.



The allowances for Coastal Processes at Peaceful Bay for the 10, 50 and 100 year planning periods (S1 + S2 + S3), including the required factor of safety, are summarised in Table 2.

Table 2 – Peaceful Bay - Allowances for Coastal Processes

Planning Period	Peaceful Bay			Foul Bay		
	10 year	50 year	100 year	10 year	50 year	100 year
Coastal Processes Allowances (m)	30	90	155	40	140	275

Key issues at Peaceful Bay that will be considered in the CHRMAP include:

- The nature of storm events that cause erosion at Peaceful Bay, and the capacity of these beaches to recover between erosive cycles.
- Beach access infrastructure is presently subject to ocean forces, and the design and adaptation of these structures is required to maintain a high level of public beach access.
- The observed erosion trend north of the boat ramp within Foul bay is significant and requires further consideration of potential causes and adaptation.
- The potential implications in longer term planning periods for the Peaceful Bay Road, Caravan Park and coastal residents require consideration.



Figure 7: Peaceful Bay – Erosion Near Fisherman’s Lease Area (Supplied by Shire)

## Where to from here?

The coastal hazard assessment will be used for the identification and assessment of risks to coastal assets, and the consideration of sustainable adaptation options. The Shire of Denmark will be undertaking consultation with stakeholders and the wider community through the CHRMAP process. The study includes consultation through a stakeholder workshop and an online survey. Hard copies of the survey will also be available from the Shire of Denmark offices.

The results of the feedback and further analysis will feed into recommendations for the future management of the assets and coastline at Ocean Beach and Peaceful Bay. Ultimately, as part of the CHRMAP process, 10-year Concept Plans will be developed for the Ocean Beach and Peaceful Bay beach and foreshore.

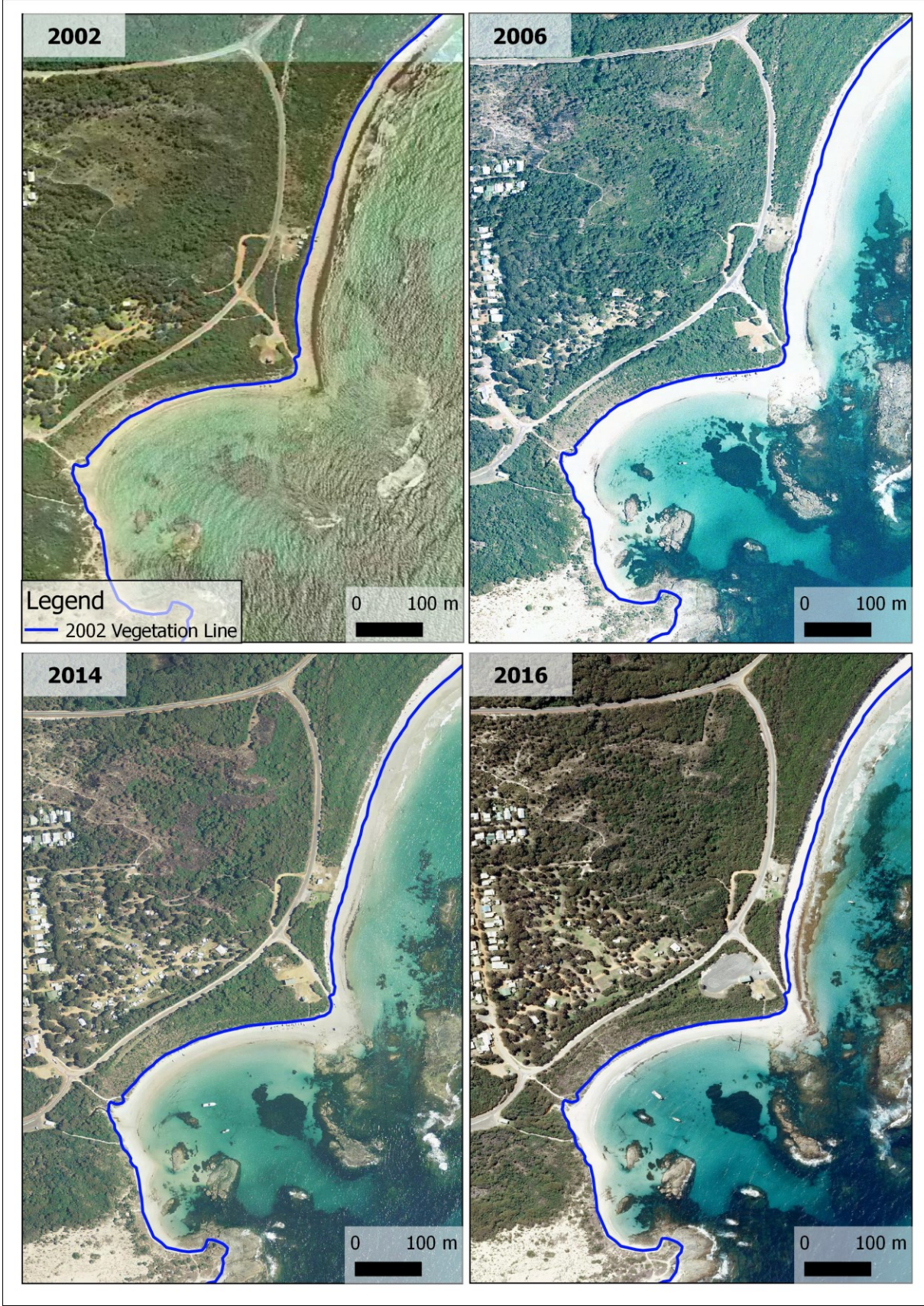


Figure 8 Peaceful Bay Aerial Imagery





# Shire of Denmark

## Minutes

### Ocean Beach and Peaceful Bay Concept Plan Working Group

Meeting held on Friday 3 March 2017 at the Denmark Surf Life Saving Club, commencing at 9.25 am.

#### 1. DECLARATION OF OPENING/ANNOUNCEMENT OF VISITORS

In the absence of Cr Allen, Cr Gearon assumed the Chair.

#### 2. RECORD OF ATTENDANCE/APOLOGIES

##### MEMBERS IN ATTENDANCE

Cr Ceinwen Gearon	Councillor (Acting Chair) ( <i>until 1.15 pm</i> )
Mrs Annette Harbron	Director of Planning & Sustainability
Ms Donna Sampey	Sustainability Officer
Mr Sam Bishopp	Department of Planning ( <i>via phone</i> )
Mr Mark Jendrzczak	Department of Planning
Mr Brett Dal Pozzo	South Coast Natural Resource Management
Mr Martin Norwood	Denmark Surf Life Saving Club
Ms Mavis Jones	Peaceful Bay Progress Association
Mr Lee Shelley	Community Member
Ms Diane Harwood	Community Member

##### APOLOGIES:

Cr Mark Allen (Chair)	Councillor
Mr Gilbert Arlandoo	Director of Infrastructure Services
Ms Deborah Millener	Department of Planning

##### VISITORS:

Mr Stuart Barr	Seashore Engineering
Mr Michael Taylforth	Land Insights
<i>Ocean Beach site visit:</i>	
Mr Murray Thornton	Denmark Surf Life Saving Club
Ms Jane Kelsbie	Denmark Surf Life Saving Club (President)
Mr Mike Neunuebel	South Coast Surfing Lessons
Mr Don Smith	Denmark Boating and Angling Club (President)
<i>Peaceful Bay site visit:</i>	
Mr Ray Walker	Peaceful Bay Returned Services League Sub-Branch
Mr Garry Bevan	Bevans (WA) Pty Ltd (Managing Director)
Ms Glenda Bevan	Bevans (WA) Pty Ltd
Ms Janine Phillips	Peaceful Bay Progress Association (proxy)

##### DECLARATION OF INTEREST:

Name	Item No	Interest	Nature
Cr Ceinwen Gearon	4	Impartiality	Member of the Denmark Surf Life Saving Club
Mr Lee Shelley	4	Impartiality	Member of the Denmark Boating and Angling Club
Ms Diane Harwood	4	Impartiality	Member of the Denmark Weed Action Group

### 3. ANNOUNCEMENT BY THE PERSON PRESIDING

All members and visitors present introduced themselves.

### 4. GENERAL BUSINESS

**4.1 Project re-cap and document review.** Mr Barr presented a summary of the Coastal Hazard Risk Management Adaptation Plan (CHRMAP) and Issues Paper.

Comments provided on the draft documents for review (at the meeting and before/after the meeting) are below:

#### Issues Paper

- Lee Shelley – 1<sup>st</sup> paragraph under heading “Ocean Beach” – add “boating” to the list of uses.
  - Include page numbers
- Mark Jendrzyczak – “Ocean Beach” “key issues for consideration” paragraph, 2<sup>nd</sup> dot point – reword to improve understanding/clarity
- Mavis Jones – make the document simpler to maximize community understanding
- Annette Harbron – “FOS” has not been defined
  - Include a schematic of S1 to S4 to aid in understanding
  - Include under “Where to from here?” the other methods of consultation ie. Other ways to access the community survey
  - Include Shire logo on front page
  - Synopsis – add “ie.” at start of brackets in 3<sup>rd</sup> paragraph.
  - Change all references of “town of Denmark” to “Town of Denmark”
  - “Ocean Beach” end paragraph, 1<sup>st</sup> dot point – change “capacity of provide” to “capacity to provide”
- Brett Dal Pozzo – make reference to the coastal systems being dynamic and system recovery (not just erosion)
- Donna Sampey – Suggest deleting the link to the survey on the cover page, since there are other ways of obtaining the survey
  - “Synopsis” section – include a dash after “Managed Retreat” and “Accommodation”
    - Add full stops after first two dot points.
    - Replace “Denmark SLSC” with “buildings”
    - Add full stop at end of last paragraph.
    - Need to make reference to the concept planning process (10 year future assets) as part of the CHRMAP
  - Ocean Beach “Allowance for Coastal Processes” section – word missing first sentence.
  - Figure 3 – “HSD” needs defining
  - Change “surf club” to Denmark Surf Life Saving Club (can abbreviate after first mention).
  - Table 1 and 2 – would it be easier to understand if the full table from the Hazard Assessment was included? Could then delete some of the text above it.
    - Table 2 – add units after “Coastal Processes Allowances”
  - Change “old surf club building” to “old Denmark SLSC building”
  - 3<sup>rd</sup> dot point – delete “particularly at Ocean Beach”
  - 6<sup>th</sup> dot point – change “Wilsons” to “Wilson”
  - Peaceful Bay section – change “boat ramp” to “boat launching area”
    - “Jetty beach” – does this refer to Peaceful Bay?
    - Change “access road” to “Peaceful Bay Road”

### Stakeholder and Community Engagement Strategy

- Annette Harbron – make reference to inclusion of other relevant documents eg. State Planning Policy 2.6, Coast Adapt, on Shire website during community consultation periods.
- Donna Sampey – Section 2.4 – word “be” missing in 2<sup>nd</sup> sentence
  - Section 2.5 – add 2 x Councillors to the list of Working Group members (refer to Working Group Terms of Reference).
  - Table 2 - Add “Seashore Engineering and Land Insights” to personnel in 1<sup>st</sup> row.
    - Spelling error – “Action” column, last row under “Priority 1”
    - Pg 11 – “Working Group meeting” wasn’t included under the list of meetings on pg 4
    - “Review of submissions” – change “2018” to “2017”
    - Another Working Group meeting will be required to review submissions and finalise draft CHRMAP.

### Community Survey

- There was consensus to break the survey up into two – one for Peaceful Bay and one for Ocean Beach. Ensure then that the answer options are relevant to each site eg. 4WD, motor biking, dog exercise and horse riding does not occur at Ocean Beach.
- Lee Shelley – questions relating to “threats/activities” may be better only referred to as “activities”.
  - Q7a and b – need to have reference to safe boat launch facilities &/or upgrade to existing facilities
- Ceinwen Gearon – Include in the introduction a short explanation of what the survey is trying to achieve ie. What is most valued about the sites, concept planning etc.
- Brett Dal Pozzo – include a question relating to usage and behaviours at each site.
- Annette Harbron – Include RSL memorial (Peaceful Bay) into list of current assets that need to be safeguarded
  - Further explanation of options in Q9 may be needed
- Donna Sampey – ensure numbering correct when referring to ranking answers ie. May list order from 1 to 6, but there are only 5 options.
  - Footnote – letter missing from the end of “Plan”
  - “Flooding” may need more explanation as a threat – does this mean flooding of the beach, foreshore area or other? Hasn’t been an issue currently, except associated with rising Wilson Inlet water levels at Prawn Rock Channel (Ocean Beach) ie. Not coastal related (yet).
  - Change “Quiet beaches to fish and walk” to just “quiet beaches”
  - Peaceful Bay assets – there are currently no seasonal patrols, playgrounds or SLSC
  - Erosion of the coast at Peaceful Bay – answer relating to damage from 4WDs etc does not strictly fit with the question, because there could also be a perception that the erosion is caused by these factors (not added to by them).
  - Q9 – delete full stops at end of row 2 and 3.
  - Options for hand-delivering surveys – change “Shire office” to “Shire Administration office”
  - When splitting survey into two, please reference at the end that the other site’s survey is also available and where it can be obtained.
- Sam Bishopp – Addition of questions which have appeared in other CHRMAP projects:
  - Do you live in the Shire of Denmark?
    - Yes

- *No*

How well informed do you consider yourself to be on coastal impacts (e.g. erosion, storm surges) that may happen due to rising sea levels?

- *Uninformed*
- *Not well informed*
- *Have some idea*
- *Well informed*
- *Very well informed*
- *Expert*

If you would like to receive updates about this project, please fill out your details below:

- *Name*
- *Address*
- *Address 2*
- *City/Town*
- *State/Province*
- *Post code*
- *Email address*
- Suggested amendments to current questions:
  - Qu 6a & b – Add the following option: “Important environmental sites and plant and animal communities”.
  - Qu 9 – amend ‘Relocation’ option to: “RELOCATION of assets at the coast exposed to erosion (i.e planned or managed retreat)”
  - Q7 – delete extra question mark at end of question
  - Q9 – delete extra word (“to”) in question

**ACTIONS:**

- Shire staff (Annette Harbron and Donna Sampey) to liaise with Michael Taylforth and Stuart Barr about best ways to accommodate concept planning in the CHRMAP process and include in Stakeholder and Community Engagement Strategy.
- Brett Dal Pozzo to provide a copy of the Mutton Bird Reserve community survey to Donna Sampey, for forwarding to the consultants.

**4.2 Site visit – Ocean Beach.**

- Murray Thornton – The original (lower) SLSC building was built in 1958 without any coastal protection. At that time, the Wilson Inlet sandbar was opened on the east, which would dump sand on the beach.
  - In the early 1960s, a minor wall was built in front of the lower SLSC building, mainly for aesthetic reasons.
  - In 1998, a major event occurred (not a storm). The Wilson Inlet sandbar was opened on the west. A large rainfall event occurred, which meant the discharge from the inlet flowed in front of the SLSC and out through the rip at the rocky headland (southern end of Ocean Beach). The wall failed due to loss of sand and the beach disappeared.
  - A new wall was then built to the underlying limestone bedrock, which lies ~ 5 m below the sand surface. The bedrock slopes up towards the inlet and inland. Sand was backfilled behind the new wall. The timber sleepers will stay in place even if sand is washed from behind the wall. The timber pylons were driven into the sand until rock was hit. The bottom sleeper was laid in 1999, at the lowest water level possible.

- The end of the wall closest to the Inlet receives more energy. Sand is washed from this end and the sand behind the wall drops. Wind blows into this corner from the east.
- The SLSC seek to protect the bottom building. As protection, Murray suggests laying sheet pile behind the wall, which is then capped by concrete and buried. The sheet pile can be driven into the underlying limestone, which will stop the leakage of sand from behind the wall. More sheet pile could be used further up slope (between the bottom and top buildings) to protect the top building.
- The top building is situated on a mobile foredune, which is moving. There haven't been issues with this, since the top building is constructed from timber. There is a peat layer about 2 m below the surface behind this building. When constructing the top SLSC building, limestone was encountered ~ 4 m below the surface
- The ocean has come in behind the bottom building.
- Bottom wall should last another 30 years.
- Bannister has given a historical account of natural openings of the Wilson Inlet. Natural openings occur in the east when there are large flows. The opening moves west when flow starts to decrease. The catchment was reforested in the 1990s, which has decreased flows.
- First memories of the beach are from 1968 – doesn't think the foredune location has changed
- The pedestrian ramp at the SLSC (end closest to the Inlet) is flexible at the moment (bottom not fixed)
- A small blowout between the SLSC and the inlet has rehabilitated itself
- In the 1960s, the limestone cliffs between the SLSC and the Inlet were covered by sand
  - There is limestone in this area about 1.5 m below the sand
- Sand from the opening of the inlet ends up at Ocean Beach
- Plans for the SLSC redevelopment – wall of the existing top building will be new front ie. Veranda to be removed. Seeking a 30 – 40 year life for 'new' building.
  - If had to replace the lower building, would move it further inland. The building is used for gear. Happy for gear storage and kiosk to be located further inland. Estimates cost would be \$500k to replace the building – is protection cheaper?
- Annette Harbron - Disabled access from the car park to the beach is an issue
  - Activities at Prawn Rock Channel – swimming (protected), dog exercise area, paddle boards, kayaking
    - Water can inundate road adjacent to Prawn Rock Channel when inlet levels are high (prior to inlet opening).
  - SLSC to consider whether to include redevelopment into the concept planning process.
  - The Denmark Boating and Angling Club car park is used for overflow parking
    - Completion of the Wilderness Ocean Walk Trail Stage 2 will place additional pressure on car parking
- Mike Neunuebel – over the last 10 – 15 years the beach is getting 'higher'
  - In 2013, the beach never returned after winter, so had to be replaced manually.
  - Beach access from the boat launch area is an issue.
- Lee Shelley – boats can't launch from the beach when there is a lot of weed or sand on the beach. Launching can only occur under certain wave

conditions. There is no boat ramp – it is an over-beach launch. 4WD is required to launch from the beach. Need to be experienced.





- Parking for vehicles with boat trailers can occur in the bottom car park. Can't park on beach when there is no sand.
- Interactions with swimmers, surfers and other boat launchers causes issues. The Ocean Beach User Group attempts to address this conflict.
- In 2013, could drive onto the beach from the car park.
- The big logs around the edge of the car park were installed in 2008. The boat launch and car park have been manually built up over time.
- The Denmark Boating and Angling Club (DBAC) has a live-in caretaker.
  - Shed is used for boat storage.
  - Hall is available.
  - 150 members.
  - Host monthly competitions and annual open competitions, which aren't necessarily held at Ocean Beach
  - New 9 m boat can't use the dedicated access to the beach from behind the DBAC building (boat too big and track too narrow)
- Brett Dal Pozzo – in 2015, a sand trap fence was installed along the base of the foredunes to exclude people.
- Martin Norwood – seeking a new access for the SLSC behind the public toilets to the beach when moving equipment, to avoid conflict with pedestrians on the path
  - Plans for the redevelopment of the SLSC are being compiled now, but will not be finalised until after the CHRMAP project. The design will include some commercial component

#### **4.3 Site visit – Peaceful Bay.**

- Mavis Jones – swimming beach has not changed over the past 50 years. Changes to the beach at Foul Bay have occurred more recently.
  - Erosion at the base of the steps from the toilets seasonally (Peaceful Bay). Shire will manually push up sand to replenish on occasion.
- Janine Phillips – Peaceful Bay – dunes less steep in past.
  - Erosion under cutting foredunes to about head height – risk of dune failure (southern extent more so)
  - Creek flows most of the year
  - Rock never observed at surface on swimming beach
  - Southern headland used to be bare sand – now colonized by marram grass
  - Would like to see disabled access to swimming beach
  - Sand drift issues on vehicle access ramp to beach
  - New car park behind Sea Rescue building – more so provides overflow parking when no room to park on the beach
  - Concerned with mixing swimmers and boats
  - User conflicts on boat ramp
- Ray Walker - Marram grass was used in the past to stabilise dunes
  - Around 60 – 80 years ago, used to be steep dunes in front of the Sea Rescue building – was able to go straight from dunes into water (no beach). Over time, beach has increased (water receded)
  - Estimates ~ 20 feet of land lost (seaward side) within RSL Memorial area – 2 side boundary fence panels removed
  - RSL memorial constructed in 2007
    - Contains 2 pine tree seedlings from Gallipoli
    - Relocation of the memorial is a more cost efficient option
- Bevans have fished in the area since 1952

- Have in the past sand bagged in front of the foredune – protection was destroyed by ocean
- Beach in front of Bevans' lease area was twice as wide in past – used to process fish there. Not enough room on beach now.
- In the last 12 – 18 months, there has been no erosion and some recovery
- Dunes erode during big SW swells
- Accessibility issues – no direct access from beach to lease area.
- When the ocean is up to the dunes, aren't able to fish (can't access water with boat from beach)
- Concerned with failure of overhangs (safety for kids). Warning signs needed for overhanging dunes?
- Original hut on lease area has been moved 3 times
- Lease area used to contain 3 additional huts (removed)
- Sand lost from Foul Bay may be depositing around inlet
- Annette Harbron – opportunities to move the fishing lease area?
  - Realigning Peaceful Bay Road or a portion of?

**Legend**

-  BBQ
-  Shade shelter
-  Wilderness
-  Ocean Walk Trail Stage 2 (future)

**Notes**

- Public toilet facilities to be incorporated into new SLSC building once constructed.
- Lower SLSC building and timber wall to be retained until managed retreat is triggered in accordance with the Ocean Beach Coastal Hazard Risk Management and Adaptation Plan.
- Track to boat launch area and associated car park to be retained as gravel surface.
- Only vehicles carrying boats and watercraft permitted entry to boat launch area.
- Drop off bay for surf boards etc. in boat launch car park.
- Main car park to be improved to maximise the number of bays.
- Continue to explore options for new boat launch areas in Denmark.

Concept plan should be read in conjunction with the Ocean Beach and Peaceful Bay Coastal Hazard Risk Management and Adaptation Plan.



Ocean Beach Road

Parallel vehicle parking

Improve car park layout

Boat access only signage

Denmark Boating and Angling Club

Car park extension

New Surf Life Saving Club (SLSC) building footprint

Widen gravel track

Consider disabled access to SLSC from car park

Demolish building. Green space

Demolish building. Green space

Improve car park layout

Reinforce entry point to beach

Commercial vehicle parking

Future removal of building. Green space (refer to notes)

Drop off bay

25 0 25 50 75 100 m



**DRAFT Ocean Beach Foreshore Concept Plan**

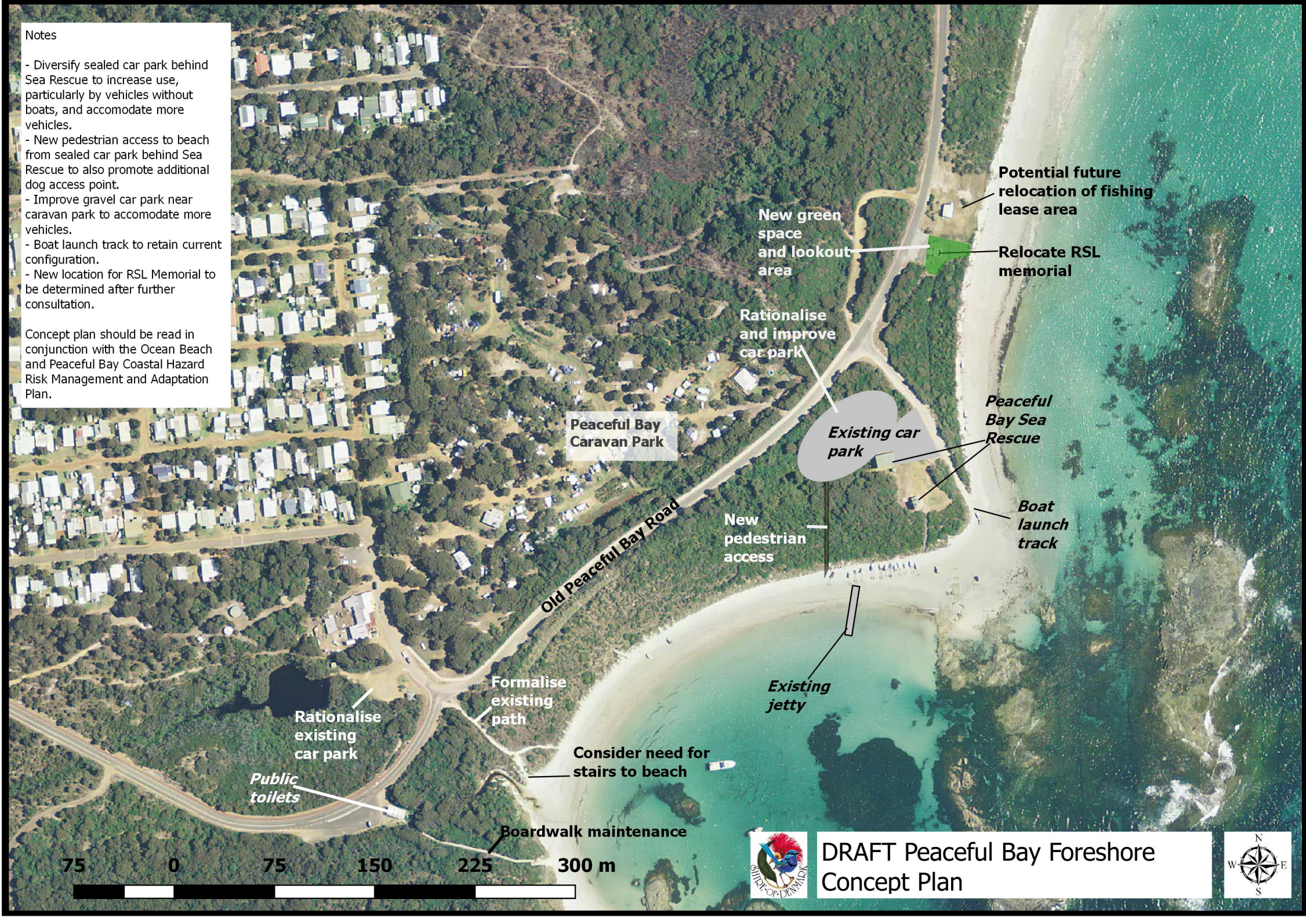




Notes

- Diversify sealed car park behind Sea Rescue to increase use, particularly by vehicles without boats, and accommodate more vehicles.
- New pedestrian access to beach from sealed car park behind Sea Rescue to also promote additional dog access point.
- Improve gravel car park near caravan park to accommodate more vehicles.
- Boat launch track to retain current configuration.
- New location for RSL Memorial to be determined after further consultation.

Concept plan should be read in conjunction with the Ocean Beach and Peaceful Bay Coastal Hazard Risk Management and Adaptation Plan.



75 0 75 150 225 300 m



DRAFT Peaceful Bay Foreshore Concept Plan



