Ocean Beach and Peaceful Bay
Shire of Denmark

Coastal Hazard Risk Management and Adaptation Plan

Seashore Engineering Pty Ltd
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Report SE050-01-Rev0

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 (Peaceful Bay) adjacent to the RSL Memorial and the Fisherman's Lease. The beach at Peaceful Bay (swimming beach) 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.

This report was adopted by Council at the Ordinary Meeting of Council held on 17 April 2018.

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Adopted by Council at the Ordinary Meeting of Council held on 17 April 2018

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

Index	Author	Date	Review	Date	Comment
Rev A	OS	13/10/2017	ML, SB	03/11/2017	Draft for Client Review
Rev B	SB, MT	12/12/2017	OS	12/12/2017	Revised Draft
Rev 0	OS	31/05/2018	SB	18/06/18	Final
Rev 1	SB			29/06/18	Final (Draft Watermark Removed)

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 Surf Life Saving Club (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 State Planning Policy 2.6 (State Coastal Planning Policy), herein referred to as 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.

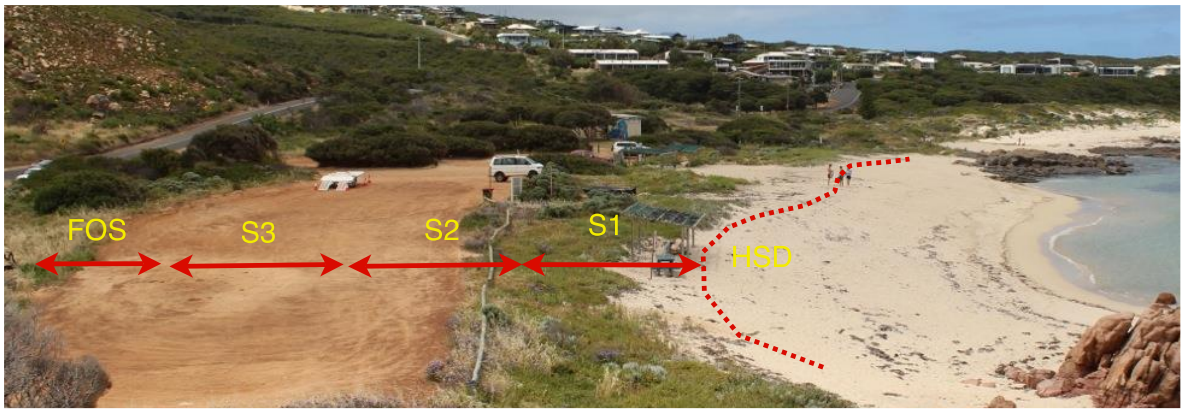

Figure 2.1 Representing Allowance for Erosion on Sandy Coast (incl HSD) S1 + S2 + S3 + FOS

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.
- The Factor of Safety (FoS) is a generic allowance of 0.2m per year as specified in section 4.4 of SPP2.6 to allow for uncertainty.

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 inspection 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.

2.1.2. 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 opens 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[1] 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)

[1] 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).

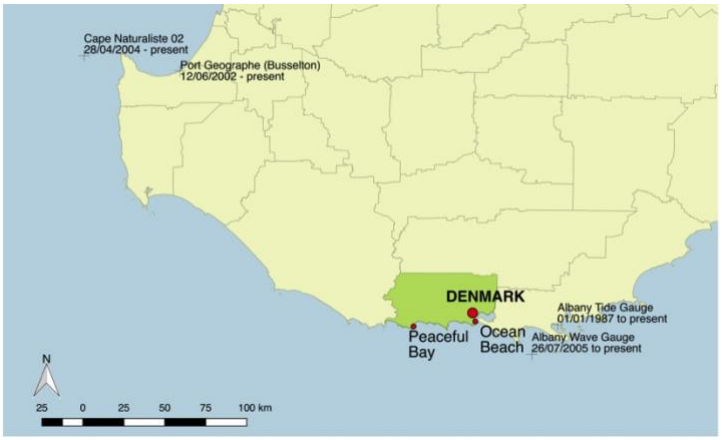

Figure 2.5 Tide and Wave Gauge Locations near Denmark

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]

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

2.2.2. 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 Naturaliste 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.

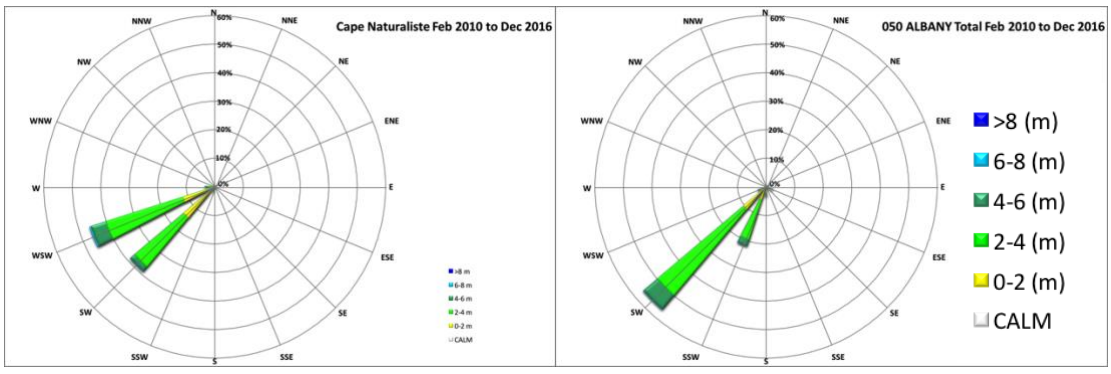

Figure 2.6 Comparison of Wave Roses for Cape Naturaliste (left) and Albany (right) - Annual Wave Climate.

[2] 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.

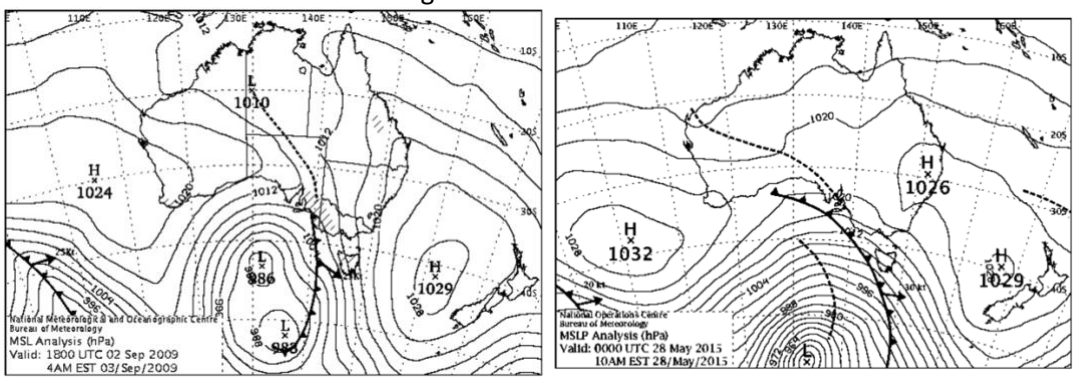

Figure 2.7 Synoptic Charts for Highest Wave Events 2nd September 2009 (left) and 28th May 2015 (right)

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.

2.2.2.1. 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)

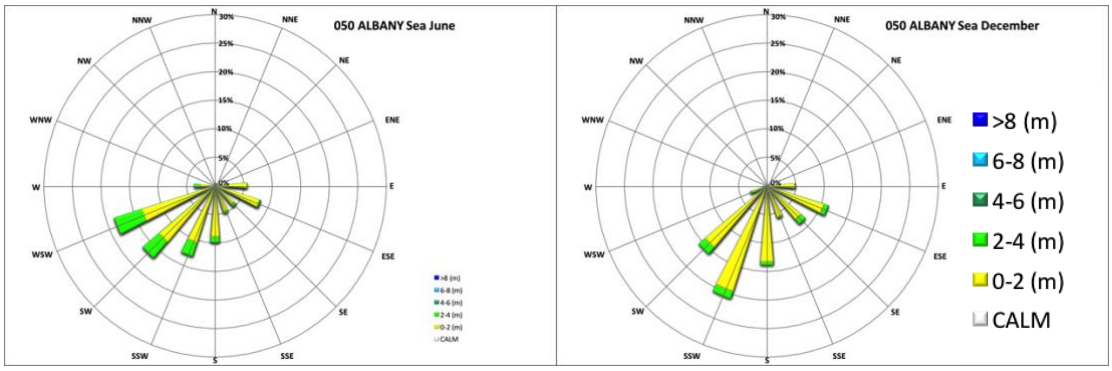

Figure 2.8 Comparison of June (winter) and December (summer) Wave Roses for the Sea Component from Albany Wave Buoy

2.2.2.2. 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.

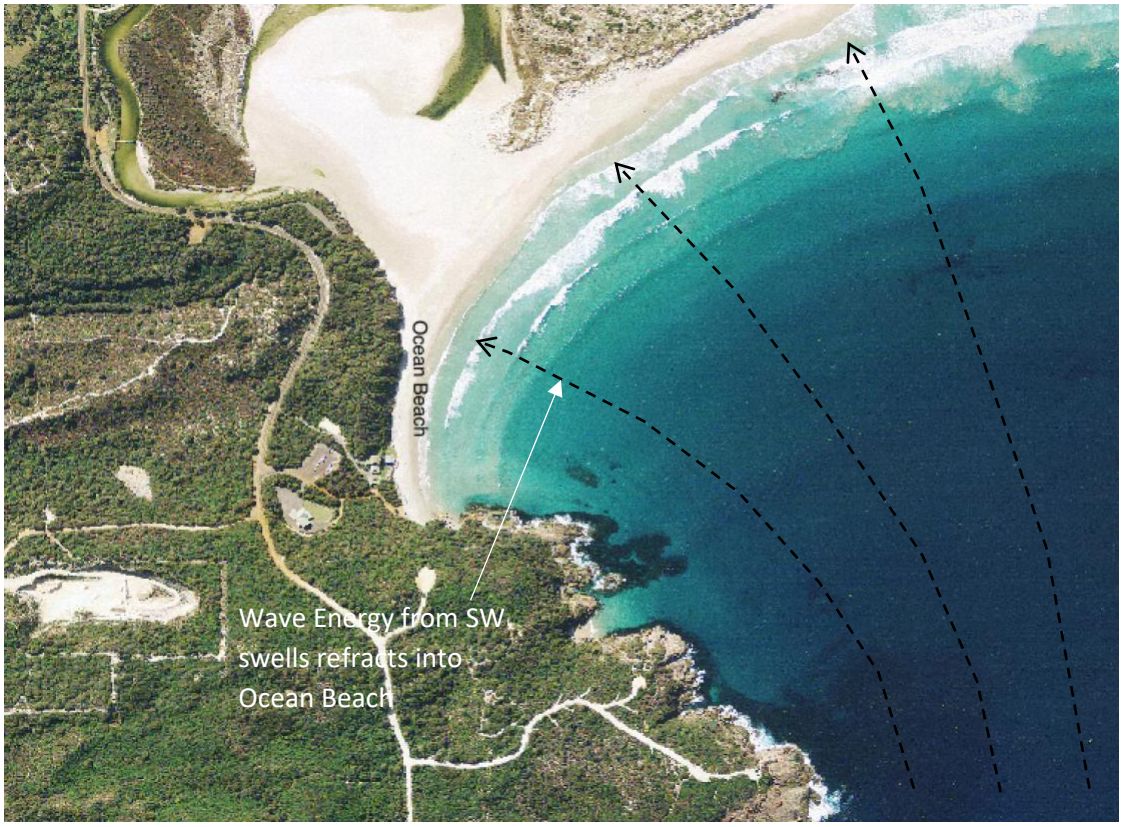

Figure 2.9 Refraction of Waves into Ocean Beach (September 2010)

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.

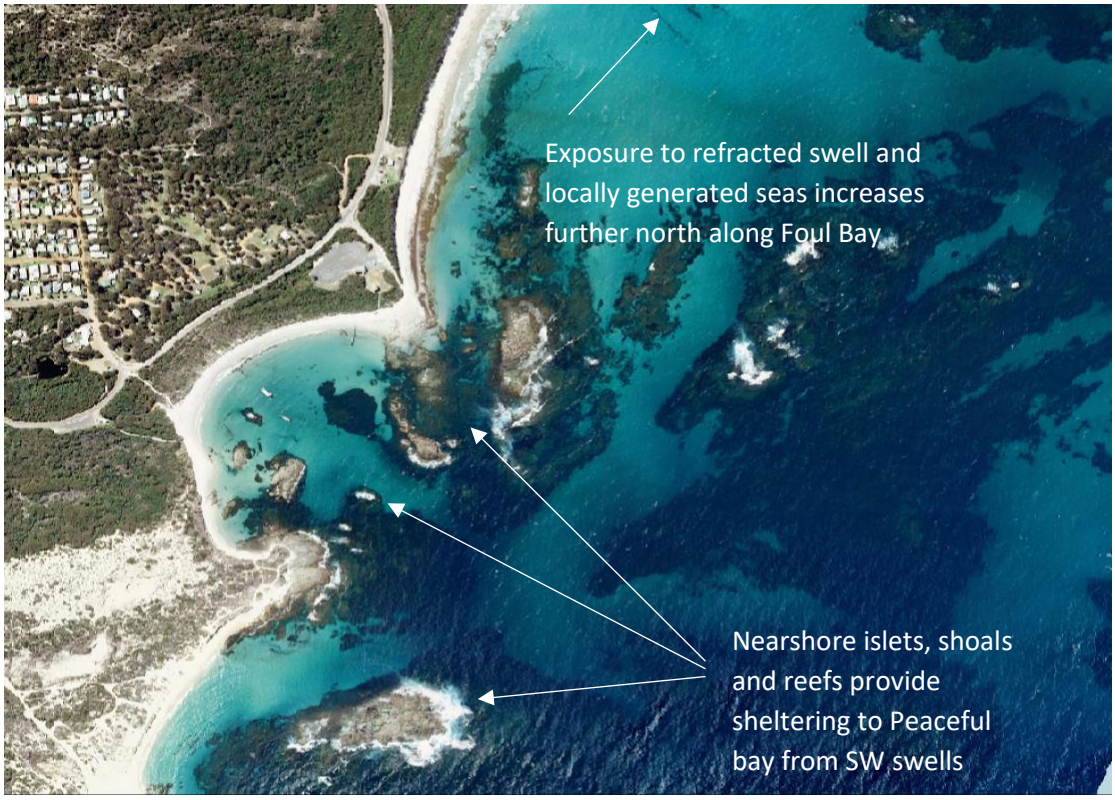

Figure 2.10 Illustration of Sheltering at Peaceful Bay

2.2.3. 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.

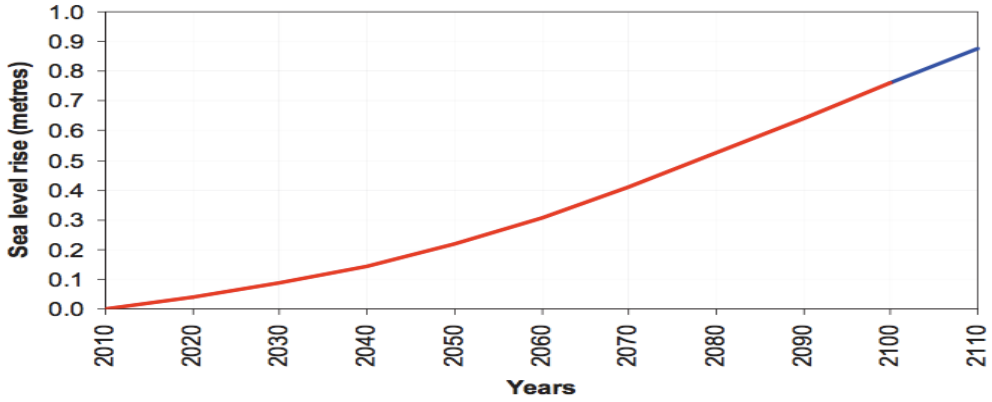

Figure 2.11 Recommended Allowance for Sea Level Rise in Coastal Planning for WA

Note: red line SRES scenario A1FI 95th 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.

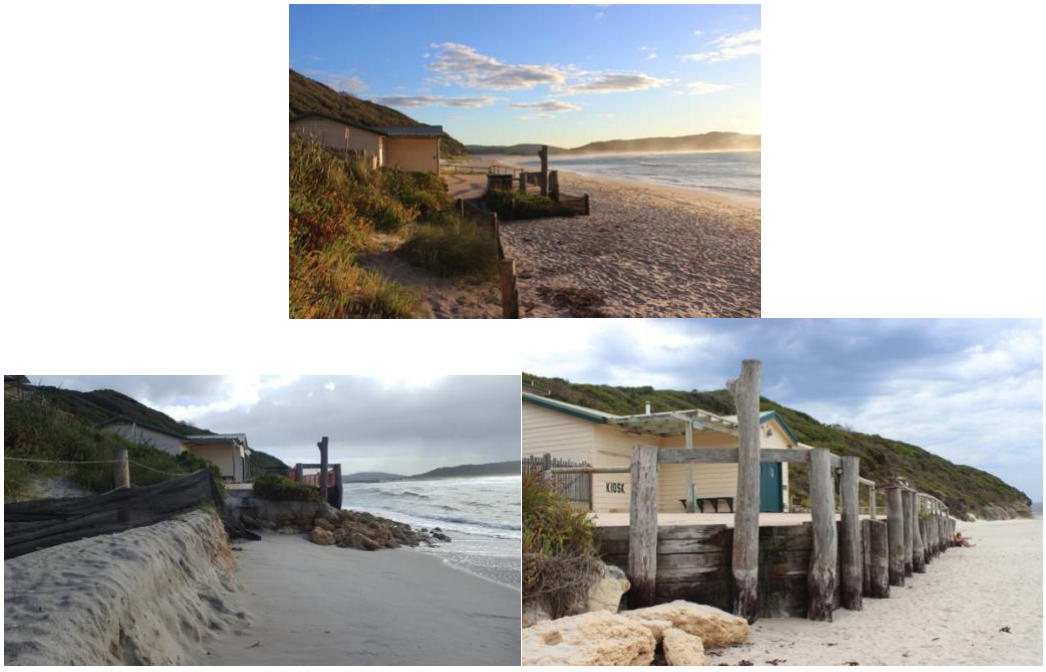

Figure 2.13 Erosion Event at Ocean Beach Timber Retaining Wall Pre (SE top June 2016) During (August 2016) and Recovered (March 2017)

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 (Attachment E).

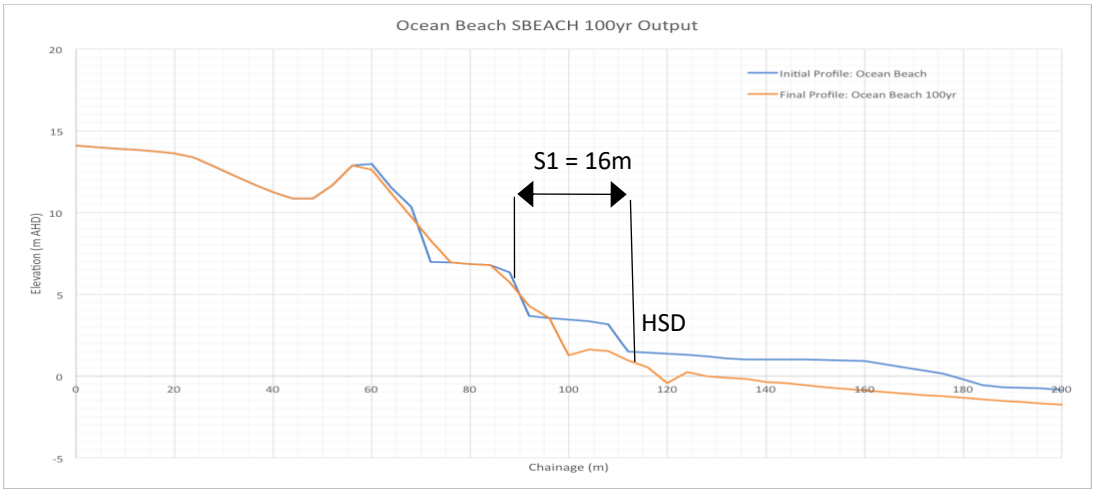

Figure 2.14 Ocean Beach SBEACH Erosion Modelling for 100yrARI erosion event (modelling assumes retaining wall not present)

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.

The influence of Wilson Inlet entrance behaviour on the dynamics of southern end of the beach was noted during the Stakeholder Consultation. This process has not been modelled in this CHRMAP due scope limitations and data availability, but should be monitored by the Shire.

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.

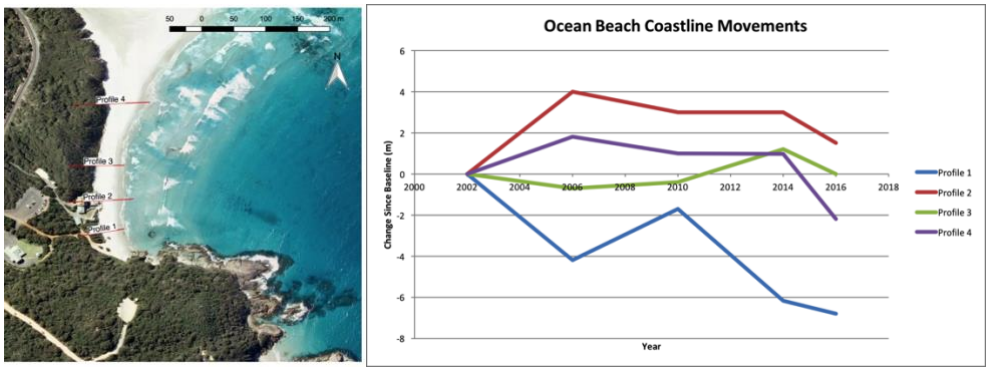

Figure 2.15 Ocean Beach – Historic Shoreline Movement Trends

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 also 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 US Army Corps of Engineering'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.

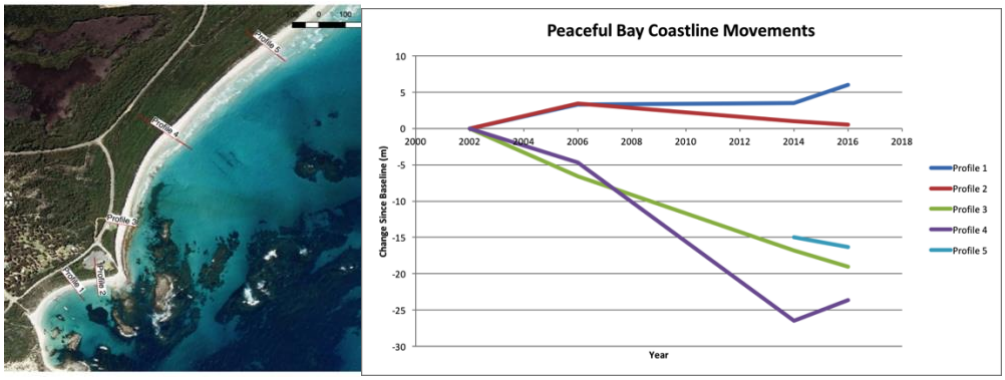

Figure 2.17 Peaceful Bay – Historic Shoreline Movement Trends

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 1.5mAHD. Wave runup is unlikely to inundate high dunes at the site. The boat ramp and memorial site are above 5.0mAHD.

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

	Peaceful Bay (Swimming Beach)			**Foul Bay (Beach North of Boat Ramp)**		
Coastal Processes Allowances	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
Subtotal (m)	30	91	156	38	139	274
Assumed Allowance (m)	30	90	155	40	140	275

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
Mean Sea Level	Increase in Mean Sea Level of 0.9m over 100 years from 2010 to 2100 as outlined in 2.2.3	-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.
Ocean Currents and Temperature	By 2030 the best estimate of sea surface temperature (SST) change is 0.4-1.0^{o}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.
Wind Climate	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.
Wave Climate	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.
Rainfall Runoff	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.
Air Temperature	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.

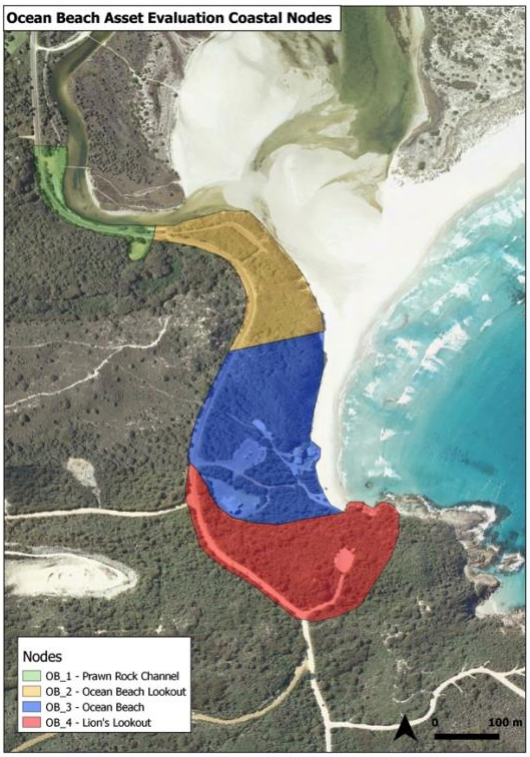

Figure 3.1 Ocean Beach Coastal Nodes

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.

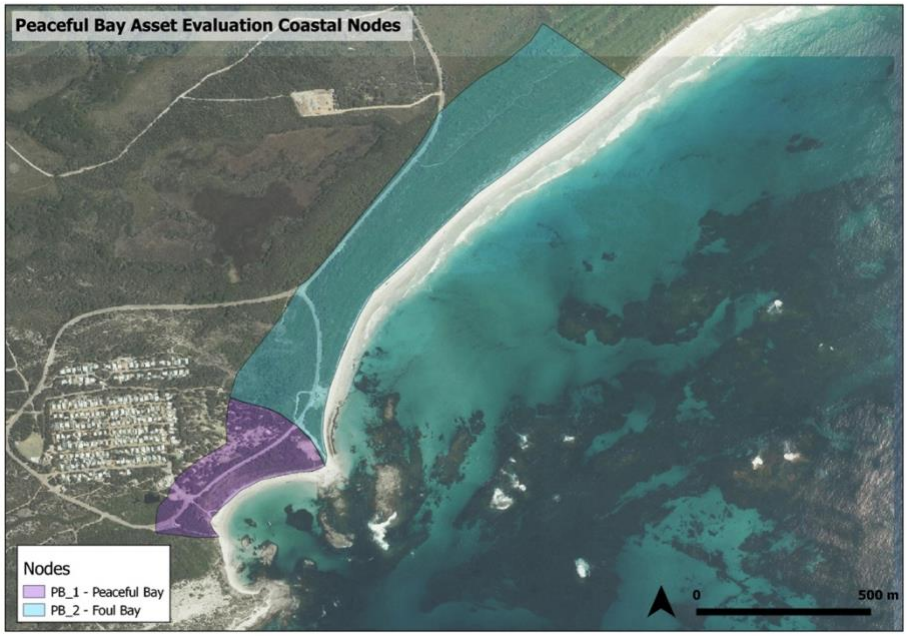

Figure 3.2 Peaceful Bay Coastal Nodes (Note: northern extent of PB_2 is the reserve boundary, not limit of coastal exposure)

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 3rd 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 5th June 2107. 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
Do you live in the Shire of Denmark	Majority Yes (86%) compared to No (14%)
How well informed do you consider yourself to be on coastal impacts (erosion, storm surges) that may happen due to rising sea levels?	Majority • 'Well Informed' (38%) • 'Have some Idea' (33%). Only one respondent replied 'Expert' and none replied 'Uninformed'.
How much do you agree with the following statements?	Majority strongly agreed with the statement: • 'The coast is an important part of the Shire of Denmark lifestyle' Majority disagreed with the statement: • 'access should be provided to all parts of the coast' More strongly agreed that: • 'access should only be provided to specific areas of the coast'.
What are your main activities at the Ocean Beach and foreshore?	Majority responses: • 'Swimming' (24%) • 'walking' (24%).

Question	Response
	The least common responses were: • 'sandboarding' (0%) • BBQ (3.5%). Some additional uses included birdwatching, surf club and dog exercise.
How often to you visit the beach and foreshore at Ocean Beach?	Majority 'weekly' (61%). The least common responses were 'never' (0%) and 'yearly' (3%).
Which of these threats/activities currently impact your use of the coastal areas of Ocean Beach?	All options received a similar rating, however • 'development on or close to the beach' • 'beach erosion' • 'vehicle access to the beach' received slightly more votes as a greater threat than: • 'flooding' • 'population pressure'. Overall, 'beach erosion' is identified as the greatest threat. Other threats identified included dogs in habitat areas and jet skis.
Which activities do you think are likely to impact the coastal areas of Ocean Beach in the future?	Activities identified as the greatest threat in the future are: • 'development on or close to the beach' • 'beach erosion'.
Which of these uses or assets do you think should be safeguarded so they continue to be available at Ocean Beach and foreshore?	The use with the majority vote was: • 'safe swimming areas with seasonal patrols and swimming lessons' (24.5%) • 'buildings (cafes, clubs, SLSC), ablution blocks, parking and playgrounds' (22%) • 'important environmental sites and plant and animal communities (22%).
What facilities, uses or assets would you like to see at the beach and foreshore at Ocean Beach over the next 10 years?	Majority response were: • 'ablution blocks' (13%) • 'safe swimming areas with seasonal patrols and swimming lessons' (12.5%) • 'club buildings, surf lifesaving clubs' (12%). The least common response was 'playgrounds' (4%). Other responses were 'BBQ facilities' and 'an alternative boat launching area'.
Do you think erosion of the coast at Ocean Beach is	Majority responded 'the result of normal coastal processes' followed by 'likely to get worse in the future'.
What options would you like the Shire to consider to adapt to coastal erosion over the next 50 years?	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'.

Table 3.4 Community Survey Results – Peaceful Bay

Question	Response
Do you live in the Shire of Denmark	Majority Yes (62.5%) compared to No (37.5%)
How well informed do you consider yourself to be on coastal impacts (erosion, storm surges) that may happen due to rising sea levels?	Majority • 'Have some Idea' (42%) • 'Well Informed' (29%) Only one respondent replied 'Uninformed' and no respondents replied with 'not well informed' or 'expert'.
How much do you agree with the following statements?	Majority strongly agreed with the statement: • 'The coast is an important part of the Shire of Denmark lifestyle' Majority disagreed with the statement: • 'access should be provided to all parts of the coast' More agreed that: • 'access should only be provided to specific areas of the coast'.
What are your main activities at the Peaceful Bay and foreshore?	Majority responses: • 'Swimming' (15%) • 'walking' (14%). The least common responses were: • 'horse-riding' (0.6%) • 'sandboarding' (3%). Some additional uses included camping, snorkelling, scuba diving and memorial services.
How often to you visit the beach and foreshore at Peaceful Bay?	Majority 'monthly' (25%). The least common responses were 'never' (0%) and 'daily' (12.5%).
Which of these threats/activities currently impact your use of the coastal areas of Peaceful Bay?	All options received a similar rating, however activities resulting in the greatest threat were identified as: • 'beach erosion' The activities identified as least threat were: • 'flooding' • 'vehicle access to the beach and dunes'.
Which activities do you think are likely to impact the coastal areas of Peaceful Bay in the future?	Activities identified as the greatest threat in the future are: • 'beach erosion' • 'development on or close to the beach'. The least threat identified for the future is: • 'flooding' • 'population pressure'.
Which of these uses or assets do you think should be safeguarded so they continue to be available at Peaceful Bay and foreshore?	The use with the majority vote was: • 'safe swimming areas with seasonal patrols and swimming lessons' (19.5%) • 'places to safely launch recreational boats' (18%)

Question	Response
	• 'Buildings, ablution blocks, parking and playgrounds' (17%).
What facilities, uses or assets would you like to see at the beach and foreshore at Peaceful Bay over the next 10 years?	Majority response were: • 'pathways, cycleways etc.' (14.5%) • 'safe swimming areas with seasonal patrols and swimming lessons' (14.5%) • 'ablution blocks' (14%). The least common responses were: • 'more parking' (4%). • 'club buildings, surf lifesaving club' (4.4%)
Do you think erosion of the coast at Peaceful Bay is	Majority responded 'the result of normal coastal processes'.
What options would you like the Shire to consider to adapt to coastal erosion over the next 50 years?	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
Prawn Rock Channel	• Coastal Stairs and Platforms. • Carparks. • Roads and Adjacent Paths.	• Floating walkway. • Gravel carpark. • Ocean Beach Rd (300m).
Ocean Beach Lookout	• Coastal Stairs and Platforms. • Carparks • Coastal Access Paths	• Timber lookout platform. • Bitumen carpark. • Access path to lookout platform.
Ocean Beach	• Coastal Stairs and Platforms, • Coastal Access Paths • Buildings	• Timber stairs and ramps. • Access paths to stairs. • SLSC Boat Shed / Kiosk
Lions Lookout	n/a	

Table 4.2 Peaceful Bay High Exposure Assets

Coastal Node	High Exposure Assets	Description
Peaceful Bay	• Coastal Stairs and Platforms, • Coastal Access Paths • Public Marine Structures	• Timber stairs • Access paths to stairs. • Finger jetty
Foul Bay	• Coastal Access Paths • Leasehold or Residential Property • Landscaping	• Vehicle access track. • Fisherman's Lease • RSL memorial.

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.

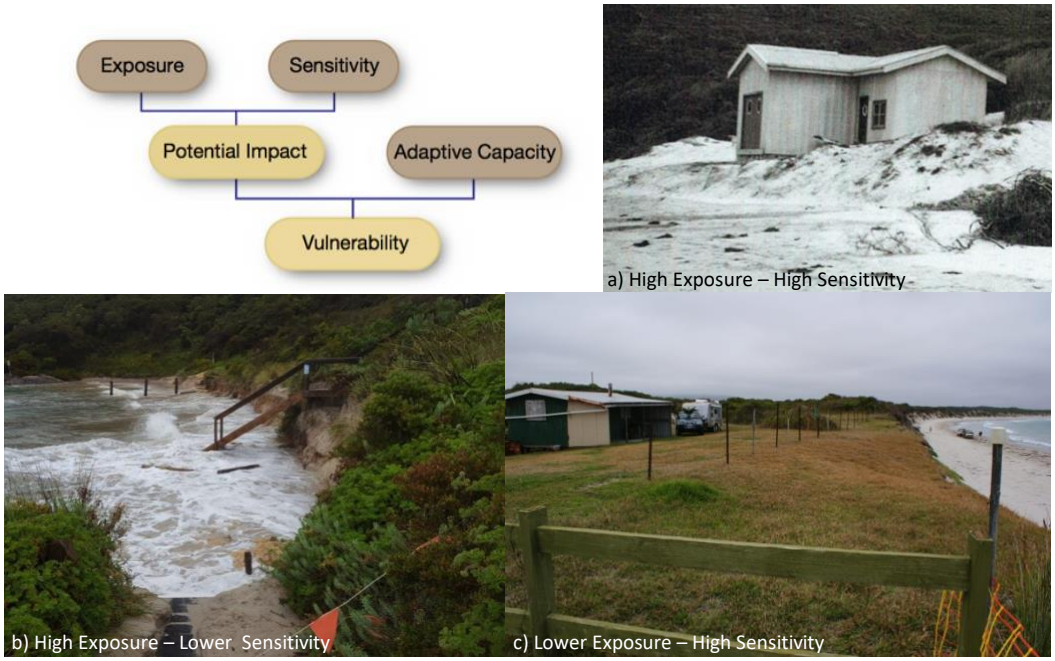

Figure 4.2 Potential Impact based on Exposure and Sensitivity for Old Boat Shed at Ocean Beach (a), Beach Access Stair (b) and Leasehold Buildings at Foul Bay (c)

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

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

The following is noted regarding the sensitivity of assets:

- **×** - coastal asset is moderately sensitive to coastal erosion and/or inundation.
- **××** - 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

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

The following is noted regarding the sensitivity of assets:

- **×** - coastal asset is moderately sensitive to coastal erosion and/or inundation.
- **××** - 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.

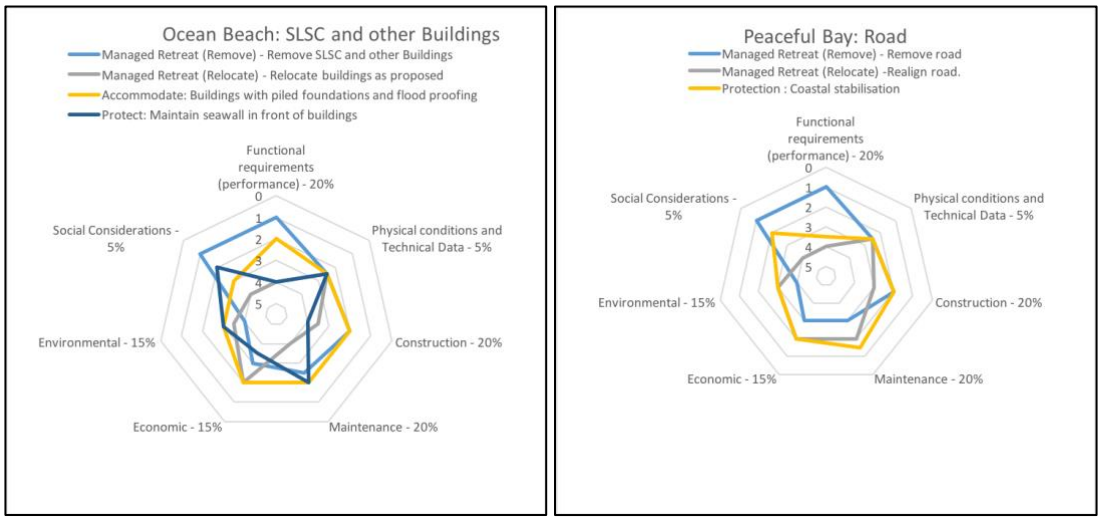

Figure 5.2 Multi-Criteria Analysis for Ocean Beach SLSC and Buildings (left) and Peaceful Bay Road (right)

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 ration 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
Prawn Rock Channel 300m Length of Ocean Beach Road and Adjacent Paths	$50,000.00	$292,300	6
Ocean Beach buildings (SLSC, Boat Shed/Kiosk, Toilet Block)	$2,392,800.00	$2,392,800.00	1
Ocean Beach Coastal Stairs and Platforms at the SLSC	$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
Peaceful Bay Finger Jetty	$200,000.00	$438,900.00	2
Foul Bay 1,200m Length of Old Peaceful Bay Road and Adjacent Paths	$724,100.00	$724,100.00	1
Peaceful Bay 2 x Coastal Stairs	$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.

Alternative design options may be available for observation areas for the Surf Life Saving Club (SLSC) if required and in the case of removal of the lower SLSC building. Alternate options should ensure they accommodate coastal hazards and have relatively low maintenance.

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.

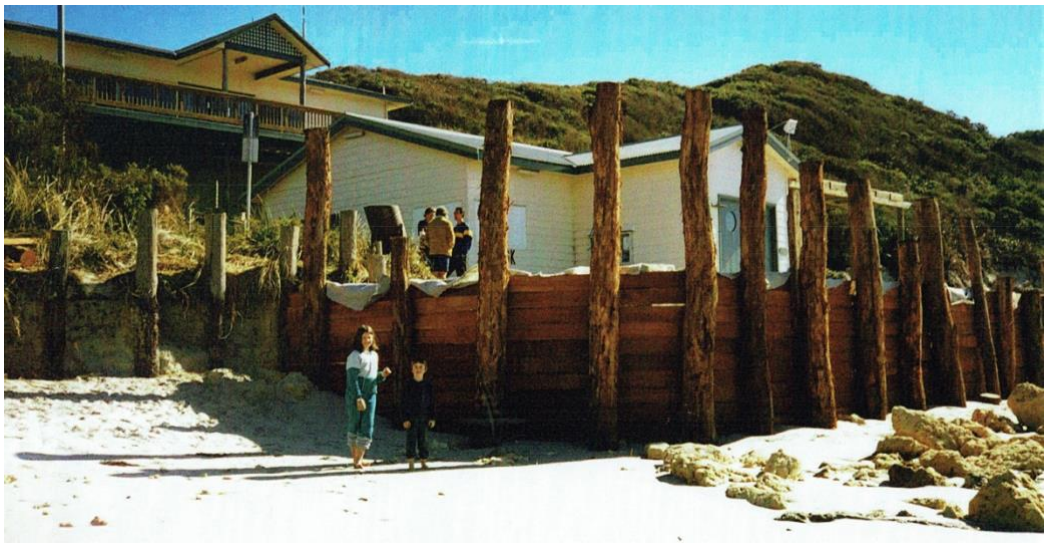

Figure 5.3 Timber Retaining Wall in front of the Ocean Beach SLSC Buildings (date unknown, courtesy of the Denmark SLSC)

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
Measure 5.2 – Development and Settlement	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.
Measure 5.4 – Building Height Limits	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. The amenity of the coastal foreshore is not detrimentally affected by any significant overshadowing of the foreshore There is overall visual permeability of the foreshore and ocean from nearby residential areas, roads and public spaces.	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. 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.
Measure 5.5 – Coastal Hazard Risk Management and Adaptation Planning	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: • Avoid	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
	• Retreat • Accommodate • Protect	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 Parka 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 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.

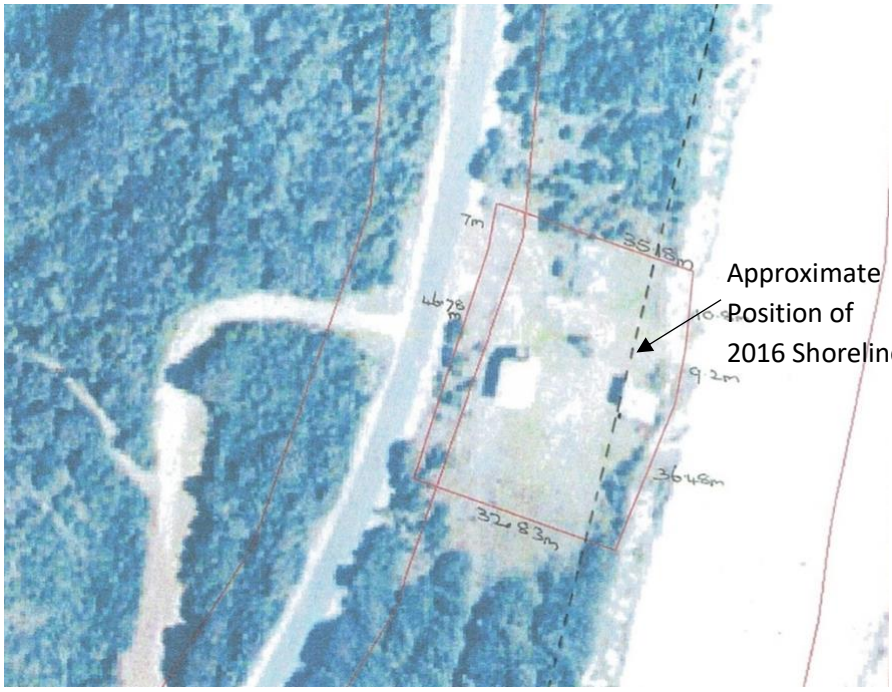

Figure 5.4 Schematic of Fisherman's Lease Boundary with Approximate Position of Shoreline in 2016

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.

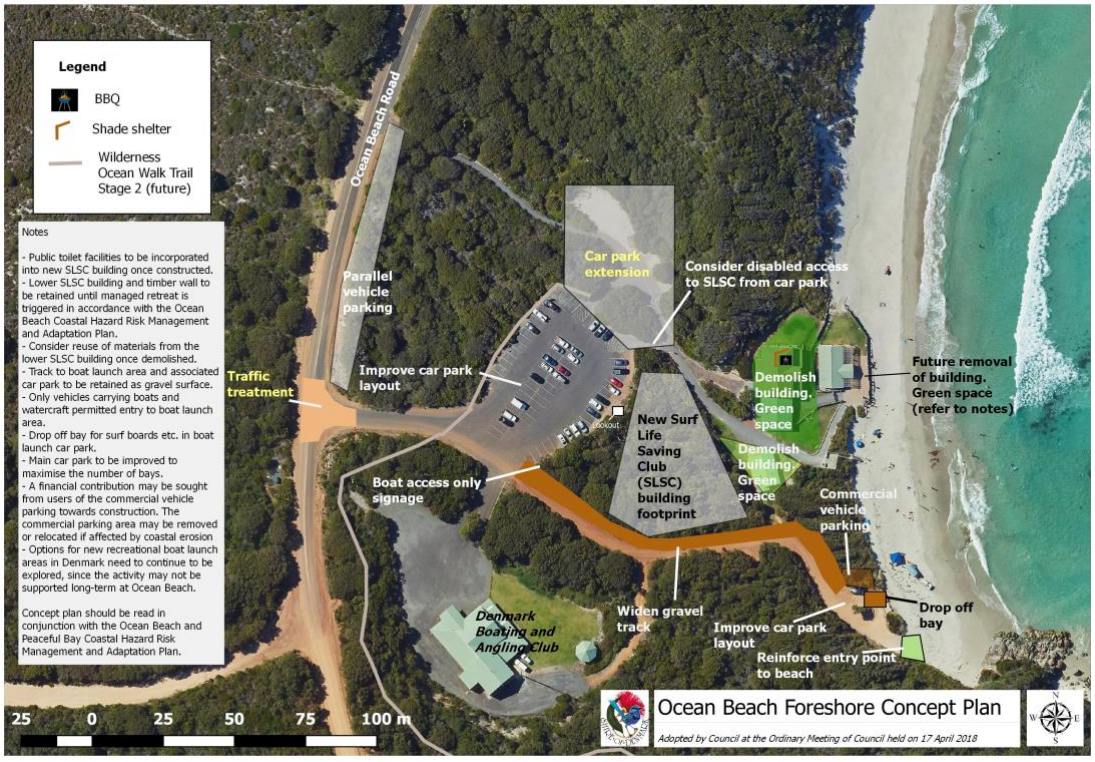

Figure 5.5 Ocean Beach 10 year Foreshore Concept Plan

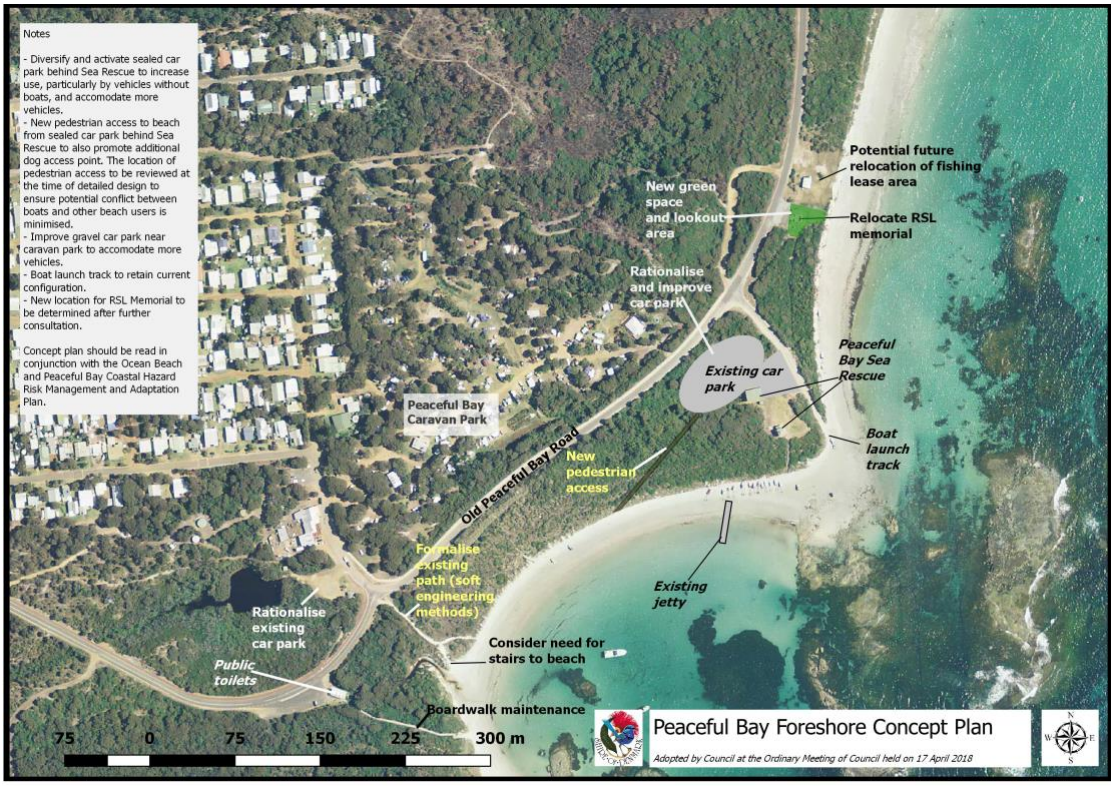

Figure 5.6 Peaceful Bay 10 year Foreshore Concept Plan

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.

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. Existing voluntary dune revegetation and rehabilitation should continue to be supported, to assist foredune protection and post-storm recovery

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, beach profile surveys and Wilson Inlet entrance behaviour.
    - 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 asset's design life.

The socio-economic value of the beach itself will require consideration by the Shire in this decision making process and selection of preferred adaptation responses.

The voluntary contribution of community members to dune rehabilitation and revegetation and supporting organisations at Peaceful Bay and Ocean Beach is also acknowledged,

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.

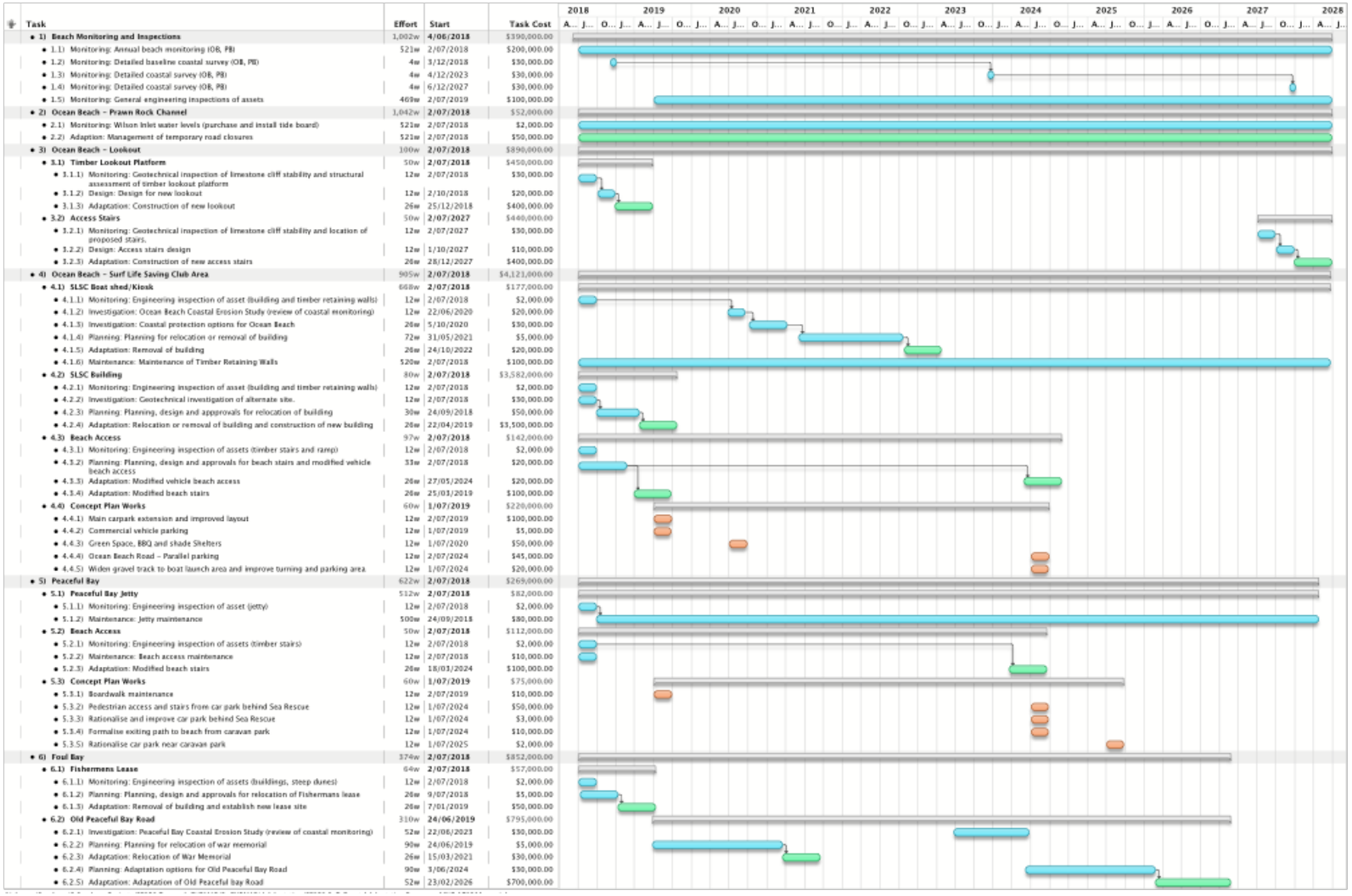

Figure 6.1 10 Year Works Program for Short Term Planning Horizon (10 years)

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 public open space 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

<table>
<tr><th></th><th colspan="11">Planning Horizon (years)</th></tr>
<tr><th>Coastal Asset</th><th>5</th><th>10</th><th>20</th><th>30</th><th>40</th><th>50</th><th>60</th><th>70</th><th>80</th><th>90</th><th>100</th></tr>
<tr><td>Prawn Rock Channel: Ocean Beach Road and footpath along channel, including wooden bridge</td><td colspan="5">Accommodate*</td><td colspan="6">Protect</td></tr>
<tr><td>Ocean Beach: Carpark and Lookout</td><td colspan="2">Monitor</td><td colspan="9">Managed Retreat</td></tr>
<tr><td>Ocean Beach: SLSC and Sea Rescue Buildings (incl. toilets, change rooms etc.)</td><td colspan="2">Monitor / Protect</td><td colspan="9">Managed Retreat / Protect</td></tr>
<tr><td>Ocean Beach: Coastal stairs and platforms</td><td colspan="3">Accommodate</td><td colspan="8">Managed Retreat</td></tr>
</table>

*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

	Planning Horizon (years)										
Coastal Asset	**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/imarine/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/imarine/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

It should be noted that current state government grant programs cannot be guaranteed as a permanent funding source for implementation of the CHRMAP in the future, as competition for funding exists

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.

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 adaption 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.

8. References

[1] **Land Insights.** *Shire of Denmark Coastal Reserves Management Strategy and Action Plan 2010 - 2020.* 2011.

[2] **WAPC.** *Statement of Planning Policy 2.6 (State Coastal Planning Policy).* s.l. : Western Australia Planning Commission, 2013a. Replaces WAPC 2003.

[3] —**WAPC.** *Coastal Hazard Risk Management and Adaptation Planning Guidelines.* 2016 : Western Australia Planning Commission.

[4] **University of Tasmania.** *The Australian Coastal Smartline Geomorphic and Stability Map Version 1: Project Report.* School of Geography & Environmental Studies (Spatial Sciences), University of Tasmania. 2009. for Geoscience Australia & Department of Climate Change.

[5] **DoT.** *Augusta Boat Harbour Design Wave and Water Level Analysis.* 2012. DoT Report #487.

[6] **Richardson, L, Mathews, E and Heap, A.** *Geomorphology and Sedimentology of the South Western Planning Area of Australia: Review and Synthesis of Relevant Literature in Support of Regional Marine Planning.* s.l. : Geoscience Australia, 2005. 2005/17.

[7] **MRA.** *Ocean Beach Alternate Boat Launching Facility Study.* 2016.

[8] **Department of Transport.** *Sea Level Change in Western Australia Application to Coastal Planning.* 2010.

[9] **Hunter, J.** *Estimating sea-level extremes under conditions of uncertain sea-level rise.* s.l. : published online at www.springerlink.com. Climatic Change.

[10] **Department of Water.** *Wilson Inlet Sandbar Opening Protocol.* 2009.

[11] **Larson, et al.** *Numerical Modelling for Simulating Storm Induced Beach Change.* 1990 : USACE. Technical Report CERC 98-9.

[12] **Engineers Australia.** *Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering.* Engineers Australia. s.l. : Engineers Australia, 2013.

[13] **CSIRO.** *Climate Change in Australia, Technical Report.* 2007.

[14] **Landinsights.** *Ocean Beach and Peaceful Bay Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) - Stakeholder and Community Engagement Strategy.* 2017.

[15] **Shore Coastal.** *Shire of Augusta Margaret River - Coastal Hazard Risk Management and Adaptation Plan.* 2015.

[16] **Gordon Geological Consultants.** *Limestone Hazards Ocean BEach Cliffs Denmark.* 1998.

[17] **Shire of Denmark.** *Ocean Beach and Peaceful Bay Concept Plan Working Group Meeting Minutes.* 2017.

[18] **G. P. Walker & Associates.** *Inspection of Existing Denmark Surf Club Building, Denmark.* 2016.

[19] **Neil Blake and Associates.** *Shire of Denmark Coastal Management Plan 2003 - 2008.* 2003.

[20] **AACE.** *COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES.* 2005.

[21] **Department of Transport.** *How to Photo Monitor Beaches.* s.l. : Department of Transport, 2012.

[22] **Quantum GIS Development Team.** Quantum GIS Geographic Information System. *Open Source Geospatial Foundation Project.* [Online] 2015. http://qgis.osgeo.org.

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