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R1560 Rev 1

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City of Joondalup

CHRMAP
Cost Benefit Analysis Technical Summary

marinas

boat harbours

canals

breakwaters

jetties

seawalls

dredging

reclamation

climate change

waves

currents

tides

flood levels

water quality

siltation

erosion

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Table of Contents

Table of Figures

Table of Tables

1. Introduction

To assess the risk to its assets and plan for the future, the City of Joondalup (City) is undertaking the Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) process in line with the recommendation of the State Coastal Planning Policy (SPP2.6, WAPC 2013). The City have engaged specialist coast and port engineers M P Rogers and Associates Pty Ltd (MRA) to assist with the CHRMAP process.

As part of the CHRMAP process, the validity of adaptation options determined using a multi criteria analysis are assessed using a cost benefit analysis (CBA). This report outlines the assumptions, methods and results of the CBA conducted as part of the City's CHRMAP. Further information and context is provided in the overarching *City of Joondalup Coastal Hazard Risk Management & Adaptation Plan* report (MRA 2020).

Separate CBA's have been completed for each of the City's identified coastal nodes. The adaptation options considered for each of the coastal nodes are presented in Table 1.1. The selection of the adaptation options was completed through the use of a Multi Criteria Assessment as part of the City's CHRMAP (MRA 2020).

Table 1.1 Adaptation Options Considered for each Coastal Node (MRA 2020)

Coastal Node	Name	Do Nothing	Seawall	Managed Retreat	Groynes	Headlands	Beach Nourishment
1	Marmion	✓	✓	✓			
2	Sorrento	✓	✓	✓	✓	✓	
3	Hillarys to Pinnaroo Point	✓	✓	✓	✓	✓	✓
4	Mullaloo	✓	✓	✓	✓	✓	✓
5	Ocean Reef	✓					
6	Iluka	✓		✓			✓
7	Burns Beach	✓		✓			

2. General Assumptions

This cost benefit analysis assumes that the coastal erosion hazard lines are realised. It is important to note that this would require a number of factors to occur and that there is a likelihood associated with each of these factors. There are a number of complexities and assumptions associated with the analysis, as outlined herein, and the future costs (especially social and environmental) are relatively uncertain and subject to change.

The costs determined in this analysis have been determined for the City's assets only. The effects of the coastal hazards on private and commercial property and assets have been excluded from the analysis. As such the direct cost to the City has been determined.

It should be noted that there will likely also be a significant cost to private land and infrastructure which has not been considered within this analysis. While this may not cause a direct cost to the City it will likely still have a social and economic cost upon the City.

This analysis serves to outline the high level costs and benefits associated with several potential adaptation options that have been developed at a very early concept level. There are various recommendations regarding appropriate discount rates for local governments, including: https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/FlagPost/2018/October/Discount-rates. All of the costs presented in the analysis are un-escalated over the 100 year planning timeframe. As such, a discount rate of 3% has been adopted. The present value calculations are extremely sensitive to this rate, given the long timeframe being considered. A sensitivity analysis can be completed or cumulative cashflow can be presented rather than Net Present Values (NPV).

Using the costs and benefits across the 100 year planning horizon, a cost benefit ratio was determined for each of the options. These cost benefit ratios have then been used to rank the adaptation options for each of the City's coastal nodes. The Cost Benefit Analyses for each Coastal Node are included in Appendix A.

3. Do Nothing (Baseline) Option

The Do Nothing Option involves allowing the shoreline to recede naturally and doing the bare minimum in terms of mitigation throughout the 100 year planning horizon.

3.1 Adaptation Costs

Given that the erosion of the relevant assets into the ocean is unlikely to be accepted, a cost for the demolition of these assets has been included. The following demolition rates have been adopted:

Table 3.1 Demolition Rates

Asset Type	Demolition Rate ($/Unit)	Demolition Unit	Justification
Foreshore Facilities	10	m	
Path	20	m	RBB (2018): $9/m2, 2 m wide path = $18/m x 1.15 (to include preliminaries) = $20.7/m
Beach Access Way	20	Item	RBB (2018): $9/m2 path x 15m2+ $25/m2 stairs x 5m2 = total x 1.15 = $299
Fencing	20	m	
Landscaped Park	10	m2	RBB (2018): $7/m2 x 1.15 = $8.05/m2 for vegetation, allow more with assets
Carpark	10	m2	RBB (2018): $9/m2 x 1.15 = $10.35/m2
Single storey buildings, toilet, changerooms etc	60	m2	RBB (2018): $35-50/m2 x 1.15 = $40.25-57.5/m2
Major Road	200	m	RBB (2018): $9/m2, 12 m wide path = $108/m x 1.15 = $124.2/m. Allow for services as well.
Minor Road	100	m	RBB (2018): $9/m2, 6 m wide path = $54/m x 1.15 = $62.1/m. Allow for services as well.

Note 1: Rates primarily taken from Ralph Beattie Boseman Compendium (RBB 2018)

The demolition rates provided in Table 3.1 above have been used uniformly for all of the adaptation options and across all timeframes. The demolition costs are calculated for the 2020, 2065 and 2115 timeframes, based on the quantities impacted tabled in the CHRMAP Risk Assessment (MRA 2020) and the demolition rates provided in Table 3.1. These demolition costs are then included in the cost benefit analysis as part of the adaptation costs.

3.2 Economic Costs

In addition to the adaptation cost there is also an economic cost associated with the loss of assets. The economic costs of losing assets were calculated for each of the relevant timeframes, based on the potential costs in the CHRMAP Risk Assessment (MRA 2020). These potential

costs were determined using the City's asset book data and other available costing guidelines as discussed in the CHRMAP report (MRA 2020). The total economic costs were included in the analysis under economic cost, for each of the relevant timeframes.

3.3 Social & Environmental Costs

There is a social and environmental cost associated with the loss of vegetation and foreshore park area. These have been quantified based on available literature, including an economic study in New South Wales to determine such values for the purposes of cost benefit analyses (Pascoe et al 2017). There is also a social and environmental benefit associated with the direct and non-direct use of the available beach and surrounding reserve areas. These have also been quantified by Pascoe et al (2017).

The study outlines use (direct and indirect) and non-use (existence and bequest) economic values for similar cost benefit analyses within the Sydney region, extracts of which are shown in Figure 3.1.

Table 4. Examples of use values for a range of beaches

	Total visits/year[1]	Average group size[1]	Total trip/years	Value/trip	Total value ($m)
North coast					
Byron Bay	161,337	3.4	47,452	$38.41	$1.82
Lennox Head	62,500	3.1	20,161	$38.41	$0.77
Wooli	18,237	3.0	6,079	$38.41	$0.23
Mid-North coast					
Port Macquarie	170,098	3.5	48,599	$38.41	$1.87
Central coast					
Terrigal	571,250	3.4	168,015	$38.41	$6.45
Sydney region					
Narrabeen	603,932	3.3	183,010	$48.20	$8.82
Collaroy	140,858	3.2	44,018	$48.20	$2.12
Manly	1,925,576	3.4	566,346	$48.20	$27.30
Bondi	3,013,635	3.4	886,363	$48.20	$42.72
South coast					
Batemans Bay	65,377	3.5	18,679	$38.41	$0.72
Moruya	7,696	3.2	2,405	$38.41	$0.09

Table 3. Derived non-use values per hectare in a range of NSW coastal regions ($m/ha)

	Sydney coastal regions		
	Waverly	Manly	Warringah
Households	32,300	18,050	58,300
Sandy Beach	$1.44	$0.81	$2.60
Headland	$1.15	$0.64	$2.07
Rocky shoreline	$0.68	$0.38	$1.24
Dunes	$1.01	$0.56	$1.82
Adjacent Scrubland	$0.82	$0.46	$1.48
Freshwater Lakes	$1.12	$0.63	$2.02
Estuary	$0.67	$0.38	$1.22
Saltmarsh	$0.52	$0.29	$0.93
Mangroves	$0.76	$0.43	$1.38
Seagrass	$1.08	$0.61	$1.96
Reefs	$0.80	$0.45	$1.45
Sandy Seabed	$1.16	$0.65	$2.09

	Non-Sydney Coastal LGAs			
	Eurobodalla	Byron	Coffs Harbour	Tweed
Households	16,544	11,197	27,614	35,882
Sandy Beach	$1.91	$1.29	$3.18	$4.13
Headland	$1.51	$1.02	$2.52	$3.28
Rocky shoreline	$0.90	$0.61	$1.51	$1.96
Dunes	$1.33	$0.90	$2.22	$2.89
Adjacent Scrubland	$1.08	$0.73	$1.81	$2.35
Freshwater Lakes	$1.48	$1.00	$2.47	$3.21
Estuary	$0.89	$0.60	$1.48	$1.93
Saltmarsh	$0.68	$0.46	$1.14	$1.48
Mangroves	$1.01	$0.68	$1.68	$2.19
Seagrass	$1.43	$0.97	$2.39	$3.10
Reefs	$1.06	$0.72	$1.77	$2.30
Sandy Seabed	$1.53	$1.03	$2.55	$3.31

Figure 3.1 Example Use & Non Use Values for Beaches (Pascoe et al 2017)

3.3.1 Use Values

In 2018 the City conducted a survey of coastal usage (CoJ 2018). It has been assumed that the 2,158 surveyed people are representative of 50% of the City's population. This is likely an overestimation, however it allows for a surplus to account for outside visitors as well.

The majority (63.8%) of respondents visit the coast multiple times per week or at least once per week throughout the year. As such an average of one visit per week per person has been assumed. Respondents also listed their most visited beach, with respondents able to select more than one option. The information was then used to estimate the percentage of overall beach visits which occur at each of the coastal nodes.

An estimate of the annual visitors to each coastal node was then determined and when multiplied by the expected average economic benefits of each visit (~$7.60) gives the total social and

environmental benefit for each coastal node per 5 year period. The economic benefit for each node is listed in Table 3.2.

Table 3.2 Social & Environmental Benefits

Coastal Node	% of Beach Visits	Economic Benefit / Period
1	1.2	$405,080
2	46.9	$15,808,000
3	57.1	$19,760,000
4	62.1	$21,143,200
5	24.8	$8,556,080
6	28.3	$9,544,080
7	32.9	$11,065,600

A population growth rate of 0.5% per period has been assumed as a conservative estimate for the City based on the recommendations of https://forecast.id.com.au/joondalup/population-summary. Significant decreases have been assumed for some nodes when beach carparking has to be removed due to erosion, or beach areas are entirely lost due to erosion.

3.3.2 Non Use Values

The number of households in the City (60,346 (ABS 2016)) is similar to the number of households in the Warringah area of NSW (58,300). Therefore, it has been assumed that the non-use value for a sandy beach in the Warringah area is appropriate for use in the City. As such a sandy beach non-use value of $260/m^2 has been adopted from Pascoe et al (2017). Using the same method a non-use value of $180/m^2 has been adopted for dunes (including vegetation) and a non-use value of $260/m^2 for foreshore reserve areas given their proximity to the beach (Pascoe et al 2017).

The social and environmental costs included in the CBA were determined using the rates discussed above and the affected areas determined in the CHRMAP risk assessment (MRA 2020). It has been assumed that the beach will retreat maintaining its current size through each of the timeframes, unless there is something that will prevent the beach from retreating (eg seawall, rocky cliff, etc). These values were included in the CBA in the social and environmental costs column for the relevant timeframes.

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4. Seawall Option

This option involves constructing seawalls to protect major infrastructure (roads, carparks and buildings) as per the Multi Criteria Analysis recommendation for further investigation and shown in the sketches provided in Appendix B.

The adaptation capital cost for this option is based on the estimated lengths of seawall constructed and rates from several recently completed projects within the Perth Metropolitan region. In addition seawall maintenance costs equal to 1% of the initial capital costs were included each year for lengths of seawall constructed by the relevant year. This is based on MRA's experience with design, construction and maintenance of rock structures in the Perth Metropolitan Coast and the recommendations of the *Port Designers Handbook: Recommendations and Guidelines* (Thorensen C A 2003). These maintenance costs were tabled as adaptation maintenance costs in the CBA.

All capital costs for the seawalls were input into CBA's at the timeframe for which relevant sections of the seawalls are required, based on the coastal erosion hazard lines. The replacement of the seawalls was assumed at the end of a 50 year design life based on MRA experience with rubble mound structures. At the end of design life, replacement costs were assumed to equal approximately 50% of the initial capital cost, as it is assumed a portion of the rock can be re-used.

There is also an adaptation cost associated with demolishing the minor assets not protected by the seawalls (pathways, beach access ways etc). These have been calculated using the rates discussed in Section 3 and quantities determined based on the quantities tabled in the risk assessment and the proposed seawall placement. These costs are also included in the adaptation capital cost in current year for the relevant time frames.

There is an also an economic cost associated with the loss of these assets. These costs have been calculated for the relevant timeframes based on the potential costs tabled in the CHRMAP Risk Assessment and the quantities determined previously.

There is a social and environmental cost associated with the loss of dunes and foreshore park areas not protected by seawalls as well as the beach areas that would be lost if the shoreline retreats to the seawalls. These costs were determined using the rates outlined in Section 3 and the quantities determined previously.

The social and environmental benefit was calculated using the same procedure outlined in Section 3.

5. Managed Retreat Option

This option involves retreating assets to an appropriate and nearby location behind the relevant hazard lines. The adaptation cost of this option is based on the demolition (or temporary removal if possible) of the assets within the hazard lines, acquisition of land at a nearby location and reconstruction (or relocation if possible) of the assets. It is noted that this cost could be reduced if managed retreat can be timed with the end of the service lives of the relevant assets.

Two versions of the managed retreat option have been presented within the CBA, one considering only the City's (Public) assets and the other including an allowance to purchase private property immediately prior to its loss due to erosion (eg residences, commercial properties, etc).

The demolition costs are based on the rates discussed in Section 3 and the rates to acquire foreshore land and rebuild the relevant assets are displayed in Table 5.1. The costs to purchase private property were taken from the potential costs determined as part of the CHRMAP risk assessment (MRA 2020).

Table 5.1 Asset Rebuild Rates

Asset Type	Rate ($/Unit)	Unit	Justification
Acquiring land	Rates vary (Generally around $2,000)	m2	Based on the average cost of undeveloped foreshore land in each coastal node determined from realestate.com.
Path	$250	m	RBB (2018) $208/m x 1.15 (to include preliminaries) = $239.2/m
Beach Access Way	$250	m	Assumed similar cost to Path.
Foreshore Facilities	$25	m	City book value $20/m increased by 25%
Fencing	$50	m	RBB (2018) $40/m x 1.15 = $46/m
Landscaped Park	$60	m2	City book value $50/m2 increased by 20%
Carpark	$120	m2	RBB (2018) $85-$100/m2 x 1.15 = $97.75-$115/m2
Single storey buildings, (toilet, changerooms etc)	$2,000	m2	RBB (2018) social or sporting club $2,300-2,800/m2
Major Road	$5,000	m	Department of Infrastructure and Regional Development. $5 mil/km construction value.
Minor Road	$3,800	m	Department of Infrastructure and Regional Development. $3.8 mil/km construction value.

As all of the assets are maintained (although at a more landward location) there will be no economic cost due to the loss of assets. As such there is no input for economic cost into the CBA for this adaptation option.

As part of the managed retreat, equivalent foreshore reserve and beach areas will be provided, therefore there is no input into the CBA for these items. However, dune areas will still be lost due to erosion and as such the social and environmental costs for the loss of these areas was included in the CBA. These values were determined using the rates and areas outlined in Section 3.

The social and environmental benefit was calculated using the same procedure outlined in Section 3. As carparking and beach is present throughout the 100 year timeframe (although at a retreated location) there is no significant decrease applied.

6. Groynes Option

This option involves constructing groynes to protect all areas of the relevant coastal nodes as determined by the Multi Criteria Analysis. High level concepts of the groynes and accompanying sand nourishment were prepared for each of the relevant Coastal Nodes and used to determine approximate construction costs. Sketches of groyne concepts are included in Appendix B.

It has been assumed that the construction of the groynes will provide protection against the longshore sediment movement, cross shore movement and partial protection against sea level rise (SLR) based on MRA experience with rubble mound structures. As such the coastal erosion hazard allowance for this option has been taken as half of the SLR allowance. It has also been assumed that the additional protection provided by the groynes and sand nourishment would allow any existing seawall's or rocky cliffs to successfully prevent erosion over the 100 year planning horizon.

The adaptation capital cost of this option is based on the estimated lengths of groyne constructed in each time period and rates from several recently completed projects within the Perth Metropolitan region. The replacement of the groynes is also assumed at the end of a 50 year design life. In addition, groyne maintenance costs equal to 1% of the initial capital costs were included each year for lengths of groyne constructed by the relevant year as discussed in Section 4. These maintenance costs were tabled as adaptation maintenance costs in the CBA.

The construction costs for each groyne included an allowance for sand nourishment using a rate of \$60/m^3 of sand. Initial sand nourishment volumes for each of the relevant Coastal Nodes are displayed in Table 6.1. These nourishment volumes were determined by assuming the placement of a triangular one metre high wedge of sand extending between groynes when each groyne is built. The allowance for sand nourishment increases throughout the 100 year timeframe as an allowance for sea level rise is included in each consecutive time period.

Table 6.1 Groyne Initial Sand Nourishment Volumes

Coastal Node	Initial Nourishment Volume (m^3)
2	9,000
3	12,000
4	15,000

At the end of the groynes design life it has been assumed that they are replaced costing approximately 50% of the initial construction costs, as it is assumed a portion of the rock can be re-used. In addition it is assumed that they are moved approximately 20 m landward due to recession of the coastline.

There is also an adaptation cost associated with demolishing the assets that fall within the reduced coastal erosion hazard allowances, including beach access ways, coastal path etc. These have been calculated using the rates discussed in Section 3 and are included in the adaptation capital cost for the relevant timeframes.

It has been assumed that the groyne timing will be adjusted to protect all major assets before they are lost to erosion and with sufficient buffer against the reduced coastal erosion hazard

allowances. The exceptions are assets (Foreshore Facilities, Beach Access Ways, Fencing and Coastal Path) which are already at risk from the reduced coastal erosion hazard allowances and all assets affected by the present day scenario.

There is an economic cost associated with the loss of the assets not protected by the groynes/affected by the reduced coastal erosion hazard. These have been calculated for the relevant timeframes, based on the potential costs in the CHRMAP Risk Assessment and the quantities determined previously.

There is a social and environmental cost associated with the loss of beach, dune and foreshore park as part of both the groyne construction and erosion over the 100 year timeframe. When the groynes are constructed an area of the beach and dunes will be lost and this has been included in the CBA at the relevant timeframes. There is also a social and environmental cost associated with the loss of dune and foreshore park areas due to the reduced coastal erosion hazard. These costs were determined using the rates discussed in Section 3 and areas determined from the reduced coastal erosion hazard allowances.

The social and environmental benefit was calculated using the same procedure outlined in Section 3. As carparking and beach is present throughout the 100 year timeframe there is no significant decrease applied.

7. Headlands Option

This option involves constructing Headlands (Offshore Breakwaters) to protect all areas of the relevant coastal nodes. High level concepts of the headlands and the accompanying sand nourishment were prepared for each of the relevant coastal nodes and used to determine approximate construction costs. The headlands have been assumed to be 100 m long, 21.5 m wide and 5.5 m tall with a crest level of 2.5 mAHD. These dimensions are based on calculations completed by MRA and MRA's experience with rubble mound structures. Sketches of the headland concepts are provided in Appendix B.

Similar to the groynes discussed in Section 6, it has been assumed that the construction of the headlands will provide protection against the longshore sediment movement, cross shore movement and partial protection against SLR. As such the coastal erosion hazard allowance for this adaptation option has been taken as half of the SLR allowance. It has also been assumed that the additional protection provided by the headlands and sand nourishment would allow any existing seawall's or rocky cliffs to successfully prevent erosion over the 100 year planning horizon.

The adaptation capital costs of this option are based on the estimated lengths of headland built in each timeframe along with rates from several recently completed projects within the Perth Metropolitan region. The replacement of the headlands has also been assumed at the end of a 50 year design life. In addition, headland maintenance costs equal to 1% of the initial capital costs were included each year for lengths of headland constructed by the relevant year as discussed in Section 4. These maintenance costs were tabled as adaptation maintenance cost in the CBA.

The construction costs for each groyne included an allowance for sand nourishment using a rate of \$60/m^3 of sand. An initial sand nourishment volume of 3,200 m^3 was used for each of the relevant coastal nodes. These nourishment volumes were determined by assuming the placement of a triangular two metre high salient of sand behind each headland. The assumed salient dimensions are 80 x 40 x 2 m. The allowance for this sand nourishment increases throughout the 100 year timeframe as an allowance for sea level rise is included in each consecutive time period.

At the end of the headlands design life, it has been assumed that they are replaced costing approximately 50% of the initial construction costs, as it is assumed a portion of the rock can be re-used. In addition, it is assumed that they are moved approximately 20 m landward due to recession of the coastline.

There is also an adaptation cost associated with demolishing the assets that fall within the reduced coastal erosion hazard allowances, including beach access ways, coastal path etc. These have been calculated using the rates discussed in Section 3 and are included in the adaptation capital cost for the relevant timeframes in the CBA.

It has been assumed that the headland timing will be adjusted to protect all major assets before they are lost to erosion and with sufficient buffer against the reduced coastal erosion hazard allowances. The exceptions are assets (Foreshore Facilities, Beach Access Ways, Fencing and Coastal Path) which are already at risk from the reduced coastal erosion hazard allowances and all assets affected by the present-day scenario.

There is an economic cost associated with the loss of the assets not protected by the headlands/affected by the reduced coastal erosion hazard. These have been calculated for the

relevant timeframes, based on the potential costs in the CHRMAP Risk Assessment and the quantities determined previously.

There is a social and environmental cost associated with the loss of dune and foreshore park areas due to the reduced coastal erosion hazard. This was determined using the rates determined in Section 3 and areas determined from the reduced coastal erosion hazard allowances.

The social and environmental benefit was calculated using the same procedure outlined in Section 3. As carparking and beach is present throughout the 100 year timeframe there is no significant decrease applied.

8. Beach Nourishment Option

This option involves nourishing the existing beaches with sand to allow for their continued usage throughout the 100 year planning horizon. The adaptation cost of this option is based on the volume of beach nourishment completed in each time period. The assumed initial nourishment volumes for each of the relevant nodes are presented in Table 8.1.

Table 8.1 Beach Nourishment Initial Volumes

Coastal Node	Initial Nourishment Volume (m^3)
1	3,500
3	60,000
4	114,600
6	15,200

For Nodes 1 and 3 the initial nourishment volumes were determined from analysis of the shoreline movement and the resulting predicted annual loss of sediment for these areas. As Nodes 4 and 6 are currently accreting, the initial nourishment volumes were estimated as 1 m^3 of sediment per m^2 of beach area. It has been assumed that nourishment will offset any longshore transport, severe storm erosion and 50% of the predicted SLR. As such the coastal erosion hazard allowance for this option has been taken as half of the SLR allowance. It has also been assumed that the additional protection provided by the sand nourishment would allow any existing seawalls or rocky cliffs to successfully prevent erosion over the 100 year planning horizon.

There are several possible sources of sand for the beach nourishment including terrestrial, offshore (via dredging) and sand back passing. The terrestrial source is usually cheapest and a rate of $60/m3 has been assumed as a conservative minimum. As such the adaptation costs for this option were determined using the volumes and rate discussed above.

There is also an adaptation cost associated with demolishing any assets that fall within the reduced coastal erosion hazard allowances, including beach access ways, coastal path etc. These have been calculated using the rates discussed in Section 3 and are included in the adaptation capital cost for the relevant timeframes in the CBA.

A maintenance cost of 1% of the initial capital costs of nourishment per year was assumed based on MRA experience with beach nourishment projects in the Perth Metropolitan Coast. This maintenance cost will allow for the rearranging / movement of the sand along with the removal of any dangerous scarps which may form due to erosion.

It has been assumed that the nourishment placement and / or volume will be adjusted by the City to protect major assets.

There is an economic cost associated with the loss of the assets not protected by the sand nourishment / affected by the reduced coastal erosion hazard. These costs have been calculated for the relevant timeframes, based on the potential costs in the CHRMAP Risk Assessment and the quantities determined previously.

There is a social and environmental cost associated with the loss of dune and foreshore park areas due to the reduced coastal erosion hazard. This was determined using the rates determined in Section 3 and areas determined from the reduced coastal erosion hazard allowances.

The social and environmental benefit was calculated using the same procedure outlined in Section 3. As carparking and beach is present throughout the 100 year timeframe there is no significant decrease applied.

9. Summary

As part of the City's CHRMAP process MRA was engaged to conduct a CBA of the various adaptation options for each of the City's identified coastal nodes. The adaptation, economic and social and environmental costs of each option were assessed and compared to the predicted social and environmental benefits. Using these overall costs and benefits a cost benefit ratio across the entire 100 year planning horizon was determined and used to rank the adaptation options for each coastal node. The ranked adaptation options are presented in Table 10.1.

Table 9.1 Ranked Adaptation Options

Rank	Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7
1	Beach Nourishment	Groynes	Groynes	Groynes	Do Nothing	Beach Nourishment	Retreat (Public Only)
2	Retreat (Public Only)	Retreat (Public Only)	Beach Nourishment	Offshore Headlands		Retreat (Public Only)	Retreat (Including Private)
3	Retreat (Including Private)	Offshore Headlands	Seawalls	Beach Nourishment			
4	Seawalls	Retreat (Including Private)	Offshore Headlands	Retreat (Public Only)			
5		Seawalls	Retreat (Public Only)	Seawalls			
6			Retreat (Including Private)	Retreat (Including Private)			
7							

This ranking of the adaptation options for each node considers only the cost benefit ratio and as such the consideration of various other factors (including but not limited to; public perception, community values, ease of application and the City's goals / desired outcomes) will be needed when determining the final ranking.

10. References

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11. Appendices

Appendix A **Cost Benefit Analyses**

Appendix B **Adaptation Option Sketches**

Appendix A Cost Benefit Analyses

K1570 Joondalup CHRMAP
Preliminary Cost Benefit Analysis - Node 1 (Marmion)

Version: V1.1 - - - Scenario 1 - Initial - - - 31 May 2021

	Baseline - Do Nothing							Protect - Seawalls									Planned / Managed Retreat (Public Only)					
	Inputs				Discount Rate	3%	3%	Inputs						Discount Rate	3%	3%	Inputs			Discount Rate	3%	3%
Year	Adaptation Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Seawall Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
2020	($300)	($6,000)	($570,240)	$405,080	($171,460)	($576,540)	$405,080	100	($300)	($36,000)	($6,000)	($570,240)	$405,080	($207,460)	($612,540)	$405,080	($5,300)	($570,240)	$405,080	($170,460)	($575,540)	$405,080
2025				$407,105	$235,645		$351,173	185	($1,332,000)	($36,000)			$407,105	($1,168,355)	($1,180,049)	$351,173			$407,105	$236,645		$351,173
2030				$409,141	$644,786		$304,439			($66,600)			$409,141	($825,814)	($49,557)	$304,439			$409,141	$645,786		$304,439
2035				$411,187	$1,055,973		$263,925			($66,600)			$411,187	($481,227)	($42,748)	$263,925			$411,187	$1,056,973		$263,925
2040				$41,119	$1,097,092		$22,766			($66,600)			$41,119	($506,708)	($36,875)	$22,766			$41,119	$1,098,092		$22,766
2045				$41,324	$1,138,416		$19,737			($66,600)			$41,324	($531,984)	($31,809)	$19,737			$41,324	$1,139,416		$19,737
2050				$41,531	$1,179,947		$17,110			($66,600)			$41,531	($557,053)	($27,438)	$17,110			$41,531	$1,180,947		$17,110
2055				$41,739	$1,221,685		$14,833			($66,600)			$41,739	($581,915)	($23,669)	$14,833			$41,739	$1,222,685		$14,833
2060				$41,947	$1,263,633		$12,859			($66,600)			$41,947	($606,567)	($20,417)	$12,859			$41,947	$1,264,633		$12,859
2065			($2,576,000)	$42,157	($1,270,211)	($681,194)	$11,148			($66,600)		($2,576,000)	$42,157	($3,207,011)	($698,806)	$11,148		($2,576,000)	$42,157	($1,269,211)	($681,194)	$11,148
2070				$42,368	($1,227,843)		$9,664			($66,600)			$42,368	($3,231,243)	($15,192)	$9,664			$42,368	($1,226,843)		$9,664
2075				$42,580	($1,185,263)		$8,378		($666,000)	($66,600)			$42,580	($3,921,263)	($144,152)	$8,378			$42,580	($1,184,263)		$8,378
2080				$42,792	($1,142,471)		$7,263			($66,600)			$42,792	($3,945,071)	($11,304)	$7,263			$42,792	($1,141,471)		$7,263
2085				$43,006	($1,099,464)		$6,297			($66,600)			$43,006	($3,968,664)	($9,751)	$6,297			$43,006	($1,098,464)		$6,297
2090				$43,221	($1,056,243)		$5,459			($66,600)			$43,221	($3,992,043)	($8,411)	$5,459			$43,221	($1,055,243)		$5,459
2095				$43,438	($1,012,805)		$4,732			($66,600)			$43,438	($4,015,205)	($7,256)	$4,732			$43,438	($1,011,805)		$4,732
2100				$43,655	($969,150)		$4,103			($66,600)			$43,655	($4,038,150)	($6,259)	$4,103			$43,655	($968,150)		$4,103
2105				$43,873	($925,277)		$3,557			($66,600)			$43,873	($4,060,877)	($5,399)	$3,557			$43,873	($924,277)		$3,557
2110				$44,092	($881,185)		$3,083			($66,600)			$44,092	($4,083,385)	($4,657)	$3,083			$44,092	($880,185)		$3,083
2115	($88,540)	($890,920)	($720,000)	$44,313	($2,536,332)	($102,512)	$2,673		($60,190)	($66,600)	($607,420)	($720,000)	$44,313	($5,493,282)	($87,718)	$2,673	($11,759,515)	($720,000)	$44,313	($13,315,387)	($752,768)	$2,673
	($88,840)	**($896,920)**	**($3,866,240)**	**$2,315,668**	**($2,536,332)**	**($1,360,246)**	**$1,478,280**	**285**	**($2,058,490)**	**($1,270,800)**	**($613,420)**	**($3,866,240)**	**$2,315,668**	**($5,493,282)**	**($3,024,005)**	**$1,478,280**	**($11,764,815)**	**($3,866,240)**	**$2,315,668**	**($13,315,387)**	**($2,009,502)**	**$1,478,280**
	Total Net Present Value					**$118,034**									**($1,545,726)**						**($531,223)**	
	Benefit / Cost Ratio					**1.1**									**0.5**						**0.7**	

Planned / Managed Retreat (Purchase Private Property)

Inputs			Discount Rate	3%	3%
Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
($5,300)	($570,240)	$405,080	($170,460)	($575,540)	$405,080
		$407,105	$236,645		$351,173
		$409,141	$645,786		$304,439
		$411,187	$1,056,973		$263,925
		$41,119	$1,098,092		$22,766
		$41,324	$1,139,416		$19,737
		$41,531	$1,180,947		$17,110
		$41,739	$1,222,685		$14,833
		$41,947	$1,264,633		$12,859
	($2,576,000)	$42,157	($1,269,211)	($681,194)	$11,148
		$42,368	($1,226,843)		$9,664
		$42,580	($1,184,263)		$8,378
		$42,792	($1,141,471)		$7,263
		$43,006	($1,098,464)		$6,297
		$43,221	($1,055,243)		$5,459
		$43,438	($1,011,805)		$4,732
		$43,655	($968,150)		$4,103
		$43,873	($924,277)		$3,557
		$44,092	($880,185)		$3,083
($19,759,515)	($720,000)	$44,313	($21,315,387)	($1,235,331)	$2,673
($19,764,815)	**($3,866,240)**	**$2,315,668**	**($21,315,387)**	**($2,492,065)**	**$1,478,280**
				($1,013,785)	
				0.6	

Accommodate Beach Nourishment

Inputs						Discount Rate	3%	3%
Nourishment Volume (m3)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
	($300)		($6,000)	($570,240)	$405,080	($171,460)	($576,540)	$405,080
3535	($212,100)				$407,105	$23,545	($182,959)	$351,173
3588	($215,250)	($10,605)			$409,141	$206,831	($168,057)	$304,439
3640	($218,400)	($10,763)			$411,187	$388,855	($147,091)	$263,925
3693	($221,550)	($10,920)			$413,243	$569,628	($128,713)	$228,802
3745	($224,700)	($11,078)			$415,309	$749,159	($112,609)	$198,354
3815	($228,900)	($11,235)			$417,385	$926,410	($98,932)	$171,957
3903	($234,150)	($11,445)			$419,472	$1,100,287	($87,280)	$149,073
3990	($239,400)	($11,708)			$421,570	$1,270,749	($76,979)	$129,235
4078	($244,650)	($11,970)			$423,677	$1,437,806	($67,860)	$112,037
4165	($249,900)	($12,233)			$211,839	$1,387,513	($59,794)	$48,322
4253	($255,150)	($12,495)			$212,898	$1,332,766	($52,664)	$41,891
4358	($261,450)	($12,758)			$213,962	$1,272,521	($46,542)	$36,317
4463	($267,750)	($13,073)			$215,032	$1,206,730	($41,116)	$31,484
4568	($274,050)	($13,388)			$216,107	$1,135,400	($36,303)	$27,294
4673	($280,350)	($13,703)			$217,188	$1,058,536	($32,036)	$23,662
4778	($286,650)	($14,018)			$218,274	$976,142	($28,256)	$20,513
4865	($291,900)	($14,333)			$219,365	$889,275	($24,825)	$17,783
4970	($298,200)	($14,595)			$43,873	$620,353	($21,873)	$3,068
5075	($304,500)	($14,910)		($2,576,000)	$44,092	($2,230,965)	($174,652)	$2,660
80,150	**($4,809,300)**	**($225,225)**	**($6,000)**	**($3,146,240)**	**$5,955,800**	**($2,230,965)**	**($2,165,081)**	**$2,567,068**
							$401,987	
							1.2	

K1570 Joondalup CHRMAP
Preliminary Cost Benefit Analysis - Node 2 (Sorrento)

Version: V1.1 - - - Scenario 1 - Initial - - - 31 May 2021

	Baseline - Do Nothing							Protect - Seawalls									Planned / Managed Retreat (Public Only)					
	Inputs				Discount Rate	3%	3%	Inputs						Discount Rate	3%	3%	Inputs			Discount Rate	3%	3%
Year	Adaptation Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Seawall Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
2020	($23,450)	($59,280)	($1,551,600)	$15,808,000	$14,173,670	($1,634,330)	$15,808,000	270	($18,855)	($20,250)	($50,090)	($1,551,600)	$15,808,000	$14,167,205	($1,640,795)	$15,808,000	($86,325)	($1,551,600)	$15,808,000	$14,170,075	($1,637,925)	$15,808,000
2025				$15,887,040	$30,060,710		$13,704,300	220	($1,650,000)	($20,250)		($2,860,000)	$15,887,040	$25,523,995	($3,907,833)	$13,704,300			$15,887,040	$30,057,115		$13,704,300
2030				$15,966,475	$46,027,185		$11,880,557			($20,250)			$15,966,475	$41,470,220	($15,068)	$11,880,557			$15,966,475	$46,023,590		$11,880,557
2035				$16,046,308	$62,073,493		$10,299,514			($20,250)			$16,046,308	$57,496,278	($12,998)	$10,299,514			$16,046,308	$62,069,898		$10,299,514
2040				$16,126,539	$78,200,032		$8,928,874	240	($1,800,000)	($20,250)		($2,535,000)	$16,126,539	$69,267,567	($2,411,396)	$8,928,874			$16,126,539	$78,196,437		$8,928,874
2045				$16,207,172	$94,407,204		$7,740,636			($38,250)			$16,207,172	$85,436,489	($18,268)	$7,740,636			$16,207,172	$94,403,609		$7,740,636
2050				$16,288,208	$110,695,411		$6,710,526	460	($3,450,000)	($38,250)		($5,980,000)	$16,288,208	$92,256,446	($3,900,794)	$6,710,526			$16,288,208	$110,691,816		$6,710,526
2055				$16,369,649	$127,065,060		$5,817,501	50	($375,000)	($38,250)		($650,000)	$16,369,649	$107,562,845	($377,861)	$5,817,501			$16,369,649	$127,061,465		$5,817,501
2060				$16,451,497	$143,516,557		$5,043,319			($38,250)			$16,451,497	$123,976,092	($11,726)	$5,043,319			$16,451,497	$143,512,962		$5,043,319
2065	($90,770)	($1,060,950)	($13,331,600)	$16,533,754	$145,566,991	($3,829,949)	$4,372,163		($2,700)	($38,250)	($54,000)	($9,737,100)	$16,533,754	$130,677,796	($2,599,974)	$4,372,163	($9,821,220)	($13,247,100)	$16,533,754	$136,978,396	($6,100,155)	$4,372,163
2070				$16,616,423	$162,183,415		$3,790,324			($38,250)			$4,133,439	$134,772,985	($8,725)	$942,867			$16,616,423	$153,594,820		$3,790,324
2075				$16,699,505	$178,882,920		$3,285,914		($825,000)	($38,250)			$4,154,106	$138,063,841	($169,859)	$817,392			$16,699,505	$170,294,325		$3,285,914
2080				$4,174,876	$183,057,796		$708,615			($38,250)			$4,174,876	$142,200,467	($6,492)	$708,615			$16,783,003	$187,077,328		$2,848,631
2085				$4,195,751	$187,253,547		$614,314			($38,250)			$4,195,751	$146,357,968	($5,600)	$614,314			$16,866,918	$203,944,246		$2,469,540
2090				$4,216,729	$191,470,277		$532,562		($900,000)	($38,250)			$4,216,729	$149,636,447	($118,498)	$532,562			$16,951,252	$220,895,498		$2,140,898
2095				$4,237,813	$195,708,090		$461,689			($38,250)			$4,237,813	$153,836,010	($4,167)	$461,689			$17,036,009	$237,931,507		$1,855,992
2100				$4,259,002	$199,967,092		$400,249	110	($2,550,000)	($38,250)		($1,430,000)	$4,259,002	$154,076,763	($377,623)	$400,249			$17,121,189	$255,052,696		$1,609,000
2105				$4,280,297	$204,247,389		$346,984		($187,500)	($46,500)			$4,280,297	$158,123,060	($18,969)	$346,984			$17,206,795	$272,259,490		$1,394,877
2110				$4,301,699	$208,549,088		$300,808			($46,500)			$4,301,699	$162,378,259	($3,252)	$300,808			$17,292,829	$289,552,319		$1,209,249
2115	($298,760)	($2,711,100)	($3,858,500)	$4,323,207	$206,003,935	($414,302)	$260,777		($56,930)	($46,500)	($284,650)	($2,268,080)	$4,323,207	$164,045,306	($160,220)	$260,777	($50,018,920)	($821,700)	$17,379,293	$256,090,992	($3,066,723)	$1,048,325
	($412,980)	**($3,831,330)**	**($18,741,700)**	**$228,989,945**	**$206,003,935**	**($5,878,581)**	**$101,007,626**	**1,350**	**($11,815,985)**	**($699,750)**	**($388,740)**	**($27,011,780)**	**$203,961,561**	**$164,045,306**	**($15,770,121)**	**$95,691,646**	**($59,926,465)**	**($15,620,400)**	**$331,637,857**	**$256,090,992**	**($10,804,802)**	**$111,958,140**
Total Net Present Value						**$95,129,045**									**$79,921,526**						**$101,153,338**	
Benefit / Cost Ratio						**17.2**									**6.1**						**10.4**	

Planned / Managed Retreat (includingPurchasing Private Property)						Protect Groynes								
Inputs			Discount Rate	3%	3%	Inputs						Discount Rate	3%	3%
Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Groyne Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
($86,325)	($1,551,600)	$15,808,000	$14,170,075	($1,637,925)	$15,808,000	270	($23,450)	($405,000)	($59,280)	($1,551,600)	$15,808,000	$13,768,670	($2,039,330)	$15,808,000
		$15,887,040	$30,057,115		$13,704,300			($405,000)			$15,887,040	$29,250,710	($349,357)	$13,704,300
		$15,966,475	$46,023,590		$11,880,557		($4,050,000)	($405,000)			$15,966,475	$40,762,185	($3,314,938)	$11,880,557
		$16,046,308	$62,069,898		$10,299,514			($405,000)			$16,046,308	$56,403,493	($259,954)	$10,299,514
		$16,126,539	$78,196,437		$8,928,874			($405,000)			$16,126,539	$72,125,032	($224,239)	$8,928,874
		$16,207,172	$94,403,609		$7,740,636			($405,000)			$16,207,172	$87,927,204	($193,430)	$7,740,636
		$16,288,208	$110,691,816		$6,710,526			($405,000)			$16,288,208	$103,810,411	($166,855)	$6,710,526
		$16,369,649	$127,061,465		$5,817,501			($405,000)			$16,369,649	$119,775,060	($143,930)	$5,817,501
		$16,451,497	$143,512,962		$5,043,319			($405,000)			$16,451,497	$135,821,557	($124,156)	$5,043,319
($9,821,220)	($13,247,100)	$16,533,754	$136,978,396	($6,100,155)	$4,372,163			($405,000)		($6,890,400)	$16,533,754	$145,059,911	($1,929,186)	$4,372,163
		$16,616,423	$153,594,820		$3,790,324			($405,000)			$16,616,423	$161,271,335	($92,383)	$3,790,324
		$16,699,505	$170,294,325		$3,285,914			($405,000)			$16,699,505	$177,565,840	($79,691)	$3,285,914
		$16,783,003	$187,077,328		$2,848,631		($4,050,000)	($405,000)		($324,000)	$16,783,003	$189,569,843	($811,154)	$2,848,631
		$16,866,918	$203,944,246		$2,469,540			($405,000)			$16,866,918	$206,031,761	($59,297)	$2,469,540
		$16,951,252	$220,895,498		$2,140,898			($405,000)			$16,951,252	$222,578,013	($51,150)	$2,140,898
		$17,036,009	$237,931,507		$1,855,992			($405,000)			$17,036,009	$239,209,022	($44,123)	$1,855,992
		$17,121,189	$255,052,696		$1,609,000			($405,000)			$17,121,189	$255,925,211	($38,061)	$1,609,000
		$17,206,795	$272,259,490		$1,394,877			($405,000)			$17,206,795	$272,727,005	($32,832)	$1,394,877
		$17,292,829	$289,552,319		$1,209,249			($405,000)			$17,292,829	$289,614,834	($28,321)	$1,209,249
($108,903,420)	($821,700)	$17,379,293	$197,206,492	($6,618,655)	$1,048,325		($49,850)	($405,000)	($462,250)	($4,038,100)	$17,379,293	$302,038,927	($298,899)	$1,048,325
($118,810,965)	**($15,620,400)**	**$331,637,857**	**$197,206,492**	**($14,356,734)**	**$111,958,140**	**270**	**($8,173,300)**	**($8,100,000)**	**($521,530)**	**($12,804,100)**	**$331,637,857**	**$302,038,927**	**($10,281,285)**	**$111,958,140**
				$97,601,406									**$101,676,855**	
				7.8									**10.9**	

Protect Headlands

Inputs						Discount Rate	3%	3%
Headland Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
	($23,450)		($59,280)	($1,551,600)	$15,808,000	$14,173,670	($1,634,330)	$15,808,000
100	($2,300,000)				$15,887,040	$27,760,710	($1,984,000)	$13,704,300
		($115,000)			$15,966,475	$43,612,185	($85,571)	$11,880,557
		($115,000)			$16,046,308	$59,543,493	($73,814)	$10,299,514
200	($4,600,000)	($115,000)			$16,126,539	$70,955,032	($2,610,581)	$8,928,874
		($345,000)			$16,207,172	$86,817,204	($164,774)	$7,740,636
		($345,000)			$16,288,208	$102,760,411	($142,135)	$6,710,526
		($345,000)			$16,369,649	$118,785,060	($122,607)	$5,817,501
100	($2,300,000)	($345,000)			$16,451,497	$132,591,557	($810,843)	$5,043,319
		($460,000)		($6,890,400)	$16,533,754	$141,774,911	($1,943,730)	$4,372,163
200	($5,750,000)	($460,000)			$16,616,423	$152,181,335	($1,416,545)	$3,790,324
		($690,000)			$16,699,505	$168,190,840	($135,769)	$3,285,914
		($690,000)			$16,783,003	$184,283,843	($117,116)	$2,848,631
	($2,300,000)	($690,000)			$16,866,918	$198,160,761	($437,776)	$2,469,540
		($690,000)			$16,951,252	$214,422,013	($87,145)	$2,140,898
		($690,000)			$17,036,009	$230,768,022	($75,172)	$1,855,992
		($690,000)			$17,121,189	$247,199,211	($64,844)	$1,609,000
	($1,150,000)	($690,000)			$17,206,795	$262,566,005	($149,160)	$1,394,877
		($690,000)			$17,292,829	$279,168,834	($48,250)	$1,209,249
	($2,250,150)	($690,000)	($462,250)	($4,038,100)	$17,379,293	$289,107,627	($448,813)	$1,048,325
600	**($20,673,600)**	**($8,855,000)**	**($521,530)**	**($12,480,100)**	**$331,637,857**	**$289,107,627**	**($12,552,977)**	**$111,958,140**
							$99,405,163	
							8.9	

K1570 Joondalup CHRMAP
Preliminary Cost Benefit Analysis - Node 3 (Pinnaroo Point to Hillarys)

Version: V1.5 - - - Scenario 2 - SFA Proposed Changes - - - 31 May 2021

	Baseline - Do Nothing							Protect - Seawalls									Planned / Managed Retreat (Public Only)					
	Inputs				Discount Rate	3%	3%	Inputs						Discount Rate	3%	3%	Inputs			Discount Rate	3%	3%
Year	Adaptation Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nominal)	Cost Present Value (Real)	Benefit Present Value (Real)	Seawall Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nominal)	Cost Present Value (Real)	Benefit Present Value (Real)	Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nominal)	Cost Present Value (Real)	Benefit Present Value (Real)
2020	($49,470)	($108,970)	($17,120,700)	$19,760,000	$2,480,860	($17,279,140)	$19,760,000		($49,470)		($108,970)	($17,120,700)	$19,760,000	$2,480,860	($17,279,140)	$19,760,000	($189,145)	($17,120,700)	$19,760,000	$2,450,155	($17,309,845)	$19,760,000
2025				$19,858,800	$22,339,660		$17,130,375						$19,858,800	$22,339,660		$17,130,375			$19,858,800	$22,308,955		$17,130,375
2030				$19,958,094	$42,297,754		$14,850,696	480	($3,600,000)			($2,496,000)	$19,958,094	$36,201,754	($4,535,997)	$14,850,696			$19,958,094	$42,267,049		$14,850,696
2035				$20,057,884	$62,355,638		$12,874,393			($180,000)			$20,057,884	$56,079,638	($115,535)	$12,874,393			$20,057,884	$62,324,933		$12,874,393
2040				$5,014,471	$67,370,110		$2,776,391	485	($3,637,500)	($180,000)		($2,262,000)	$20,158,174	$70,158,312	($3,366,072)	$11,161,092			$20,158,174	$82,483,107		$11,161,092
2045				$5,039,543	$72,409,653		$2,406,914			($361,875)			$20,258,965	$90,055,402	($172,834)	$9,675,794			$20,258,965	$102,742,072		$9,675,794
2050				$5,064,741	$77,474,394		$2,086,606			($361,875)			$20,360,260	$110,053,787	($149,088)	$8,388,157			$20,360,260	$123,102,332		$8,388,157
2055				$5,090,065	$82,564,459		$1,808,925			($361,875)			$20,462,061	$130,153,973	($128,604)	$7,271,877			$20,462,061	$143,564,393		$7,271,877
2060				$5,115,515	$87,679,974		$1,568,196	395	($2,962,500)	($361,875)		($2,054,000)	$20,564,371	$145,339,969	($1,648,778)	$6,304,149			$20,564,371	$164,128,764		$6,304,149
2065	($476,610)	($4,998,021)	($43,915,840)	$5,141,093	$43,430,596	($13,060,748)	$1,359,504		($243,020)	($510,000)	($1,298,498)	($40,439,340)	$20,667,193	$123,516,304	($11,236,224)	$5,465,204	($87,571,640)	($39,380,400)	$20,667,193	$57,843,917	($33,571,023)	$5,465,204
2070				$5,166,798	$48,597,394		$1,178,583			($510,000)			$20,770,529	$143,776,833	($116,335)	$4,737,905			$20,770,529	$78,614,446		$4,737,905
2075				$5,192,632	$53,790,027		$1,021,740			($510,000)			$20,874,382	$164,141,214	($100,351)	$4,107,393			$20,874,382	$99,488,827		$4,107,393
2080				$5,218,595	$59,008,622		$885,768	1,090	($9,975,000)	($510,000)		($5,668,000)	$20,978,754	$168,966,968	($2,741,699)	$3,560,789			$20,978,754	$120,467,581		$3,560,789
2085				$5,244,688	$64,253,310		$767,892			($918,750)			$21,083,647	$189,131,865	($134,517)	$3,086,925			$21,083,647	$141,551,228		$3,086,925
2090				$5,270,912	$69,524,222		$665,702		($1,818,750)	($918,750)			$21,189,066	$207,583,431	($345,739)	$2,676,123			$21,189,066	$162,740,294		$2,676,123
2095				$5,297,266	$74,821,489		$577,112			($918,750)			$21,295,011	$227,959,692	($100,093)	$2,319,989			$21,295,011	$184,035,305		$2,319,989
2100				$5,323,753	$80,145,241		$500,311			($918,750)			$21,401,486	$248,442,428	($86,341)	$2,011,250			$21,401,486	$205,436,791		$2,011,250
2105				$5,350,371	$85,495,613		$433,730			($918,750)			$21,508,493	$269,032,171	($74,479)	$1,743,596			$21,508,493	$226,945,284		$1,743,596
2110				$5,377,123	$90,872,736		$376,010		($1,481,250)	($918,750)			$21,616,036	$288,248,207	($167,827)	$1,511,562			$21,616,036	$248,561,320		$1,511,562
2115	($780,950)	($7,536,200)	($42,272,440)	$5,404,009	$45,687,155	($3,051,580)	$325,972		($298,280)	($918,750)	($1,491,400)	($31,052,240)	$21,724,116	$276,211,653	($2,036,454)	$1,310,406	($127,857,080)	($35,420,400)	$21,724,116	$107,007,956	($9,848,950)	$1,310,406
	($1,307,030)	**($12,643,191)**	**($103,308,980)**	**$162,946,356**	**$45,687,155**	**($33,391,469)**	**$83,354,820**	**2,450**	**($24,065,770)**	**($10,278,750)**	**($2,898,868)**	**($101,092,280)**	**$414,547,321**	**$276,211,653**	**($44,536,106)**	**$139,947,675**	**($215,617,865)**	**($91,921,500)**	**$414,547,321**	**$107,007,956**	**($60,729,818)**	**$139,947,675**
	Total Net Present Value					**$49,963,352**									**$95,411,569**						**$79,217,857**	
	Benefit / Cost Ratio					**2.5**									**3.1**						**2.3**	

Planned / Managed Retreat (Including Purchasing Private Property)

Inputs			Discount Rate	3%	3%
Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nominal)	Cost Present Value (Real)	Benefit Present Value (Real)
($189,145)	($17,120,700)	$19,760,000	$2,450,155	($17,309,845)	$19,760,000
		$19,858,800	$22,308,955		$17,130,375
		$19,958,094	$42,267,049		$14,850,696
		$20,057,884	$62,324,933		$12,874,393
		$20,158,174	$82,483,107		$11,161,092
		$20,258,965	$102,742,072		$9,675,794
		$20,360,260	$123,102,332		$8,388,157
		$20,462,061	$143,564,393		$7,271,877
		$20,564,371	$164,128,764		$6,304,149
($87,571,640)	($39,380,400)	$20,667,193	$57,843,917	($33,571,023)	$5,465,204
		$20,770,529	$78,614,446		$4,737,905
		$20,874,382	$99,488,827		$4,107,393
		$20,978,754	$120,467,581		$3,560,789
		$21,083,647	$141,551,228		$3,086,925
		$21,189,066	$162,740,294		$2,676,123
		$21,295,011	$184,035,305		$2,319,989
		$21,401,486	$205,436,791		$2,011,250
		$21,508,493	$226,945,284		$1,743,596
		$21,616,036	$248,561,320		$1,511,562
($167,457,080)	($35,420,400)	$21,724,116	$67,407,956	($12,237,635)	$1,310,406
($255,217,865)	**($91,921,500)**	**$414,547,321**	**$67,407,956**	**($63,118,503)**	**$139,947,675**
				$76,829,172	
				2.2	

Protect Groynes

Inputs						Discount Rate	3%	3%
Groyne Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nominal)	Cost Present Value (Real)	Benefit Present Value (Real)
	($49,470)		($108,970)	($17,120,700)	$19,760,000	$2,480,860	($17,279,140)	$19,760,000
240	($8,160,000)	($408,000)		($950,400)	$19,858,800	$12,821,260	($8,210,655)	$17,130,375
		($408,000)			$19,958,094	$32,371,354	($303,590)	$14,850,696
		($408,000)			$20,057,884	$52,021,238	($261,880)	$12,874,393
180	($6,120,000)	($408,000)		($712,800)	$20,158,174	$64,938,612	($4,009,055)	$11,161,092
		($714,000)			$20,258,965	$84,483,577	($341,010)	$9,675,794
		($714,000)			$20,360,260	$104,129,837	($294,159)	$8,388,157
		($714,000)			$20,462,061	$123,877,898	($253,744)	$7,271,877
240	($8,160,000)	($714,000)		($950,400)	$20,564,371	$134,617,869	($3,011,737)	$6,304,149
		($1,122,000)		($3,276,900)	$20,667,193	$150,886,162	($1,163,239)	$5,465,204
		($1,122,000)			$20,770,529	$170,534,691	($255,936)	$4,737,905
	($4,080,000)	($1,122,000)		($388,800)	$20,874,382	$185,818,272	($1,100,086)	$4,107,393
		($1,122,000)			$20,978,754	$205,675,026	($190,441)	$3,560,789
		($1,122,000)			$21,083,647	$225,636,673	($164,276)	$3,086,925
	($3,060,000)	($1,122,000)		($291,600)	$21,189,066	$242,352,139	($565,004)	$2,676,123
		($1,122,000)			$21,295,011	$262,525,150	($122,237)	$2,319,989
		($1,122,000)			$21,401,486	$282,804,636	($105,442)	$2,011,250
		($1,122,000)			$21,508,493	$303,191,129	($90,955)	$1,743,596
	($4,080,000)	($1,122,000)		($388,800)	$21,616,036	$319,216,365	($390,952)	$1,511,562
	($5,860)	($1,122,000)	($8,501)	($17,093,600)	$21,724,116	$322,710,520	($1,099,637)	$1,310,406
	($33,715,330)	**($16,830,000)**	**($117,471)**	**($41,174,000)**	**$414,547,321**	**$322,710,520**	**($39,213,175)**	**$139,947,675**
							$100,734,500	
							3.6	

Protect Headlands

Inputs						Discount Rate	3%	3%
Headland Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nominal)	Cost Present Value (Real)	Benefit Present Value (Real)
	($49,470)		($108,970)	($17,120,700)	$19,760,000	$2,480,860	($17,279,140)	$19,760,000
600	($13,200,000)	($660,000)			$19,858,800	$8,479,660	($11,955,758)	$17,130,375
		($660,000)			$19,958,094	$27,777,754	($491,102)	$14,850,696
		($660,000)			$20,057,884	$47,175,638	($423,629)	$12,874,393
700	($15,400,000)	($660,000)			$20,158,174	$51,273,812	($8,892,033)	$11,161,092
		($1,430,000)			$20,258,965	$70,102,777	($682,976)	$9,675,794
		($1,430,000)			$20,360,260	$89,033,037	($589,141)	$8,388,157
		($1,430,000)			$20,462,061	$108,065,098	($508,198)	$7,271,877
300	($6,600,000)	($1,430,000)			$20,564,371	$120,599,469	($2,461,651)	$6,304,149
		($1,760,000)		($3,276,900)	$20,667,193	$136,229,762	($1,331,951)	$5,465,204
		($1,760,000)			$20,770,529	$155,240,291	($401,468)	$4,737,905
	($6,600,000)	($1,760,000)			$20,874,382	$167,754,672	($1,644,974)	$4,107,393
		($1,760,000)			$20,978,754	$186,973,426	($298,730)	$3,560,789
		($1,760,000)			$21,083,647	$206,297,073	($257,687)	$3,086,925
	($7,700,000)	($1,760,000)			$21,189,066	$218,026,139	($1,194,773)	$2,676,123
		($1,760,000)			$21,295,011	$237,561,150	($191,744)	$2,319,989
		($1,760,000)			$21,401,486	$257,202,636	($165,400)	$2,011,250
		($1,760,000)			$21,508,493	$276,951,129	($142,675)	$1,743,596
100	($5,500,000)	($1,760,000)			$21,616,036	$291,307,165	($507,676)	$1,511,562
	($5,860)	($1,760,000)	($8,501)	($17,093,600)	$21,724,116	$294,163,320	($1,138,121)	$1,310,406
	($55,055,330)	**($27,720,000)**	**($117,471)**	**($37,491,200)**	**$414,547,321**	**$294,163,320**	**($50,558,827)**	**$139,947,675**
							$89,388,848	
							2.8	

Accommodate Beach Nourishment

Inputs						Discount Rate	3%	3%
Nourishment Volume (m3)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nominal)	Cost Present Value (Real)	Benefit Present Value (Real)
	($49,470)		($108,970)	($17,120,700)	$19,760,000	$2,480,860	($17,279,140)	$19,760,000
60,600	($3,636,000)	($181,800)			$19,858,800	$18,521,860	($3,293,268)	$17,130,375
61,500	($3,690,000)	($184,500)			$19,958,094	$34,605,454	($2,882,992)	$14,850,696
62,400	($3,744,000)	($187,200)			$20,057,884	$50,732,138	($2,523,288)	$12,874,393
63,300	($3,798,000)	($189,900)			$20,158,174	$66,902,412	($2,208,004)	$11,161,092
64,200	($3,852,000)	($192,600)			$20,258,965	$83,116,777	($1,931,723)	$9,675,794
65,400	($3,924,000)	($196,200)			$20,360,260	$99,356,837	($1,697,468)	$8,388,157
66,900	($4,014,000)	($200,700)			$20,462,061	$115,604,198	($1,497,834)	$7,271,877
68,400	($4,104,000)	($205,200)			$20,564,371	$131,859,369	($1,321,015)	$6,304,149
69,900	($4,194,000)	($209,700)		($3,276,900)	$20,667,193	$144,845,962	($2,031,047)	$5,465,204
71,400	($4,284,000)	($214,200)			$20,770,529	$161,118,291	($1,026,071)	$4,737,905
72,900	($4,374,000)	($218,700)			$20,874,382	$177,399,972	($903,693)	$4,107,393
74,700	($4,482,000)	($224,100)			$20,978,754	$193,672,626	($798,781)	$3,560,789
76,500	($4,590,000)	($229,500)			$21,083,647	$209,936,773	($705,639)	$3,086,925
78,300	($4,698,000)	($234,900)			$21,189,066	$226,192,939	($623,012)	$2,676,123
80,100	($4,806,000)	($240,300)			$21,295,011	$242,441,650	($549,770)	$2,319,989
81,900	($4,914,000)	($245,700)			$21,401,486	$258,683,436	($484,894)	$2,011,250
83,400	($5,004,000)	($250,200)			$21,508,493	$274,937,729	($425,934)	$1,743,596
85,200	($5,112,000)	($255,600)			$21,616,036	$291,186,165	($375,344)	$1,511,562
87,000	($5,225,860)	($261,000)	($8,501)	($17,093,600)	$21,724,116	$290,321,320	($1,362,573)	$1,310,406
	($82,495,330)	**($4,122,000)**	**($117,471)**	**($37,491,200)**	**$414,547,321**	**$290,321,320**	**($43,921,490)**	**$139,947,675**
							$96,026,185	
							3.2	

K1570 Joondalup CHRMAP
Preliminary Cost Benefit Analysis - Node 4 (Mullaloo)

Version: V1.1 - - - Scenario 1 - Initial - - - 31 May 2021

	Baseline - Do Nothing							Protect - Seawalls									Planned / Managed Retreat (Public Only)					
	Inputs				Discount Rate	3%	3%	Inputs						Discount Rate	3%	3%	Inputs			Discount Rate	3%	3%
Year	Adaptation Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Seawall Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
2020	($51,120)	($122,190)	($5,186,700)	$21,143,200	$15,783,190	($5,360,010)	$21,143,200	130	($51,280)	($9,750)	($122,190)	($5,186,700)	$21,143,200	$15,773,280	($5,369,920)	$21,143,200	($188,420)	($5,186,700)	$21,143,200	$15,768,080	($5,375,120)	$21,143,200
2025				$21,248,916	$37,032,106		$18,329,502			($9,750)			$21,248,916	$37,012,446	($8,410)	$18,329,502			$21,248,916	$37,016,996		$18,329,502
2030				$21,355,161	$58,387,267		$15,890,245			($9,750)			$21,355,161	$58,357,857	($7,255)	$15,890,245			$21,355,161	$58,372,157		$15,890,245
2035				$21,461,936	$79,849,203		$13,775,600	140	($1,050,000)	($9,750)		($1,170,000)	$21,461,936	$77,590,043	($1,431,192)	$13,775,600			$21,461,936	$79,834,093		$13,775,600
2040				$21,569,246	$101,418,449		$11,942,369			($10,500)			$21,569,246	$99,148,789	($5,814)	$11,942,369			$21,569,246	$101,403,339		$11,942,369
2045				$21,677,092	$123,095,541		$10,353,100			($10,500)			$21,677,092	$120,815,381	($5,015)	$10,353,100			$21,677,092	$123,080,431		$10,353,100
2050				$21,785,478	$144,881,019		$8,975,328			($10,500)			$21,785,478	$142,590,359	($4,326)	$8,975,328			$21,785,478	$144,865,909		$8,975,328
2055				$21,894,405	$166,775,424		$7,780,908			($10,500)			$21,894,405	$164,474,264	($3,732)	$7,780,908			$21,894,405	$166,760,314		$7,780,908
2060				$22,003,877	$188,779,301		$6,745,439			($10,500)			$22,003,877	$186,467,641	($3,219)	$6,745,439			$22,003,877	$188,764,191		$6,745,439
2065	($68,400)	($3,262,297)	($14,842,040)	$22,113,897	$192,720,461	($4,805,574)	$5,847,768	280	($2,100,660)	($10,500)	($5,500)	($17,382,760)	$22,113,897	$189,082,118	($5,156,400)	$5,847,768	($7,049,080)	($14,522,760)	$22,113,897	$189,306,248	($5,704,428)	$5,847,768
2070				$5,528,474	$198,248,935		$1,261,084	300	($2,275,640)	($31,500)		($3,250,000)	$22,224,466	$205,749,444	($1,267,623)	$5,069,558			$22,224,466	$211,530,714		$5,069,558
2075				$5,556,117	$203,805,052		$1,093,261	285	($2,137,500)	($54,000)		($3,705,000)	$22,335,588	$222,188,532	($1,160,238)	$4,394,911			$22,335,588	$233,866,302		$4,394,911
2080				$5,583,897	$209,388,949		$947,772			($75,375)			$22,447,266	$244,560,424	($12,794)	$3,810,044			$22,447,266	$256,313,569		$3,810,044
2085				$5,611,817	$215,000,765		$821,644	560	($4,725,000)	($75,375)		($7,280,000)	$6,734,180	$239,214,229	($1,768,727)	$985,973			$22,559,503	$278,873,071		$3,303,010
2090				$5,639,876	$220,640,641		$712,301			($106,875)			$6,767,851	$245,875,204	($13,498)	$854,762			$22,672,300	$301,545,371		$2,863,452
2095				$5,668,075	$226,308,716		$617,510			($106,875)			$6,801,690	$252,570,019	($11,644)	$741,012			$22,785,662	$324,331,033		$2,482,389
2100				$5,696,415	$232,005,131		$535,333			($106,875)			$6,835,698	$259,298,843	($10,044)	$642,399			$22,899,590	$347,230,623		$2,152,037
2105				$5,724,897	$237,730,029		$464,092			($106,875)			$6,869,877	$266,061,845	($8,664)	$556,910			$23,014,088	$370,244,711		$1,865,648
2110				$5,753,522	$243,483,551		$402,331	90	($675,000)	($106,875)		($650,000)	$6,904,226	$271,534,196	($100,128)	$482,797			$23,129,158	$393,373,869		$1,617,371
2115	($461,380)	($4,521,930)	($23,867,060)	$5,782,290	$220,415,470	($1,740,264)	$348,790		($1,050,330)	($113,625)	($490,350)	($18,327,600)	$6,938,748	$258,491,039	($1,205,315)	$418,547	($77,933,470)	($20,746,800)	$23,244,804	$317,938,404	($5,952,426)	$1,402,134
	($580,900)	**($3,384,487)**	**($43,895,800)**	**$272,798,587**	**$224,937,400**	**($11,905,847)**	**$127,987,577**	**1,785**	**($14,065,410)**	**($986,250)**	**($618,040)**	**($56,952,060)**	**$331,112,799**	**$258,491,039**	**($17,553,955)**	**$138,740,372**	**($85,170,970)**	**($40,456,260)**	**$443,565,634**	**$317,938,404**	**($17,031,973)**	**$149,744,012**
Total Net Present Value						**$116,081,730**									**$121,186,417**						**$132,712,039**	
Benefit / Cost Ratio						**10.7**									**7.9**						**8.8**	

Planned / Managed Retreat (Including Purchasing Private Property)

Inputs			Discount Rate	3%	3%
Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
($188,420)	($5,186,700)	$21,143,200	$15,768,080	($5,375,120)	$21,143,200
		$21,248,916	$37,016,996		$18,329,502
		$21,355,161	$58,372,157		$15,890,245
		$21,461,936	$79,834,093		$13,775,600
		$21,569,246	$101,403,339		$11,942,369
		$21,677,092	$123,080,431		$10,353,100
		$21,785,478	$144,865,909		$8,975,328
		$21,894,405	$166,760,314		$7,780,908
		$22,003,877	$188,764,191		$6,745,439
($13,049,080)	($14,522,760)	$22,113,897	$183,306,248	($7,291,059)	$5,847,768
		$22,224,466	$205,530,714		$5,069,558
		$22,335,588	$227,866,302		$4,394,911
		$22,447,266	$250,313,569		$3,810,044
		$22,559,503	$272,873,071		$3,303,010
		$22,672,300	$295,545,371		$2,863,452
		$22,785,662	$318,331,033		$2,482,389
		$22,899,590	$341,230,623		$2,152,037
		$23,014,088	$364,244,711		$1,865,648
		$23,129,158	$387,373,869		$1,617,371
($119,133,470)	($20,746,800)	$23,244,804	$270,738,404	($8,437,623)	$1,402,134
($132,370,970)	**($40,456,260)**	**$443,565,634**	**$270,738,404**	**($21,103,802)**	**$149,744,012**
				$128,640,210	
				7.1	

Protect Groynes

Inputs						Discount Rate	3%	3%
Groyne Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
	($51,120)		($122,190)	($5,186,700)	$21,143,200	$15,783,190	($5,360,010)	$21,143,200
90	($1,800,000)			($459,000)	$21,248,916	$34,773,106	($1,948,633)	$18,329,502
		($90,000)			$21,355,161	$56,038,267	($66,968)	$15,890,245
		($90,000)			$21,461,936	$77,410,203	($57,768)	$13,775,600
		($90,000)			$21,569,246	$98,889,449	($49,831)	$11,942,369
		($90,000)			$21,677,092	$120,476,541	($42,985)	$10,353,100
180	($3,600,000)	($90,000)		($918,000)	$21,785,478	$137,654,019	($1,898,435)	$8,975,328
		($270,000)			$21,894,405	$159,278,424	($95,954)	$7,780,908
90	($1,800,000)	($270,000)		($459,000)	$22,003,877	$178,753,301	($775,282)	$6,745,439
		($360,000)		($852,300)	$22,113,897	$199,654,898	($320,579)	$5,847,768
180	($3,600,000)	($360,000)		($918,000)	$22,224,466	$217,001,364	($1,112,706)	$5,069,558
	($900,000)	($540,000)		$108,000	$22,335,588	$238,004,952	($262,094)	$4,394,911
		($540,000)			$22,447,266	$259,912,219	($91,656)	$3,810,044
		($540,000)			$22,559,503	$281,931,721	($79,063)	$3,303,010
		($540,000)			$22,672,300	$304,064,021	($68,201)	$2,863,452
		($540,000)			$22,785,662	$326,309,683	($58,830)	$2,482,389
	($1,800,000)	($540,000)		$216,000	$22,899,590	$347,085,273	($199,607)	$2,152,037
		($540,000)			$23,014,088	$369,559,361	($43,775)	$1,865,648
	($900,000)	($540,000)		$108,000	$23,129,158	$391,356,519	($93,144)	$1,617,371
	($1,100)	($540,000)	($5,500)	($8,606,800)	$23,244,804	$405,447,924	($552,136)	$1,402,134
540	**($14,452,220)**	**($6,570,000)**	**($127,690)**	**($16,967,800)**	**$443,565,634**	**$405,447,924**	**($13,177,657)**	**$149,744,012**
							$136,566,355	
							11.4	

Protect Headlands

Inputs						Discount Rate	3%	3%
Headland Length (m)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
	($52,120)		($122,190)	($5,186,700)	$21,143,200	$15,782,190	($5,361,010)	$21,143,200
100	($2,300,000)				$21,248,916	$34,731,106	($1,984,000)	$18,329,502
		($115,000)			$21,355,161	$55,971,267	($85,571)	$15,890,245
		($115,000)			$21,461,936	$77,318,203	($73,814)	$13,775,600
200	($4,600,000)	($115,000)			$21,569,246	$94,172,449	($2,610,581)	$11,942,369
		($345,000)			$21,677,092	$115,504,541	($164,774)	$10,353,100
		($345,000)			$21,785,478	$136,945,019	($142,135)	$8,975,328
		($345,000)			$21,894,405	$158,494,424	($122,607)	$7,780,908
200	($4,600,000)	($345,000)			$22,003,877	$175,553,301	($1,515,924)	$6,745,439
		($575,000)		($852,300)	$22,113,897	$196,239,898	($377,433)	$5,847,768
		($575,000)			$22,224,466	$217,889,364	($131,162)	$5,069,558
	($1,150,000)	($575,000)			$22,335,588	$238,499,952	($339,423)	$4,394,911
400	($9,200,000)	($575,000)			$22,447,266	$251,172,219	($1,659,141)	$3,810,044
		($1,035,000)			$22,559,503	$272,696,721	($151,538)	$3,303,010
	($2,300,000)	($1,035,000)			$22,672,300	$292,034,021	($421,202)	$2,863,452
		($1,035,000)			$22,785,662	$313,784,683	($112,758)	$2,482,389
		($1,035,000)			$22,899,590	$335,649,273	($97,266)	$2,152,037
		($1,035,000)			$23,014,088	$357,628,361	($83,903)	$1,865,648
	($2,300,000)	($1,035,000)			$23,129,158	$377,422,519	($233,209)	$1,617,371
	($1,100)	($1,035,000)	($5,500)	($8,606,800)	$23,244,804	$391,018,924	($581,995)	$1,402,134
900	**($26,503,220)**	**($11,270,000)**	**($127,690)**	**($14,645,800)**	**$443,565,634**	**$391,018,924**	**($16,249,446)**	**$149,744,012**
							$133,494,566	
							9.2	

Accommodate Beach Nourishment

Inputs						Discount Rate	3%	3%
Nourishment Volume (m3)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
	($52,120)		($122,190)	($5,186,700)	$21,143,200	$15,782,190	($5,361,010)	$21,143,200
1,375	($82,512)	($4,126)			$21,248,916	$36,944,468	($74,734)	$18,329,502
3,438	($206,280)	($10,314)			$21,355,161	$58,083,035	($161,166)	$15,890,245
5,501	($330,048)	($16,502)			$21,461,936	$79,198,421	($222,438)	$13,775,600
7,564	($453,816)	($22,691)			$21,569,246	$100,291,160	($263,830)	$11,942,369
9,626	($577,584)	($28,879)			$21,677,092	$121,361,789	($289,650)	$10,353,100
12,377	($742,608)	($37,130)			$21,785,478	$142,367,529	($321,242)	$8,975,328
15,815	($948,888)	($47,444)			$21,894,405	$163,265,601	($354,080)	$7,780,908
19,253	($1,155,168)	($57,758)			$22,003,877	$184,056,552	($371,831)	$6,745,439
22,691	($1,361,448)	($68,072)		($14,842,040)	$22,113,897	$189,898,888	($4,302,829)	$5,847,768
26,129	($1,567,728)	($78,386)			$22,224,466	$210,477,240	($375,490)	$5,069,558
29,567	($1,774,008)	($88,700)			$22,335,588	$230,950,120	($366,520)	$4,394,911
33,692	($2,021,544)	($101,077)			$22,447,266	$251,274,765	($360,279)	$3,810,044
37,818	($2,269,080)	($113,454)			$22,559,503	$271,451,734	($348,835)	$3,303,010
41,944	($2,516,616)	($125,831)			$22,672,300	$291,481,587	($333,734)	$2,863,452
46,069	($2,764,152)	($138,208)			$22,785,662	$311,364,889	($316,198)	$2,482,389
50,195	($3,011,688)	($150,584)			$22,899,590	$331,102,207	($297,181)	$2,152,037
53,633	($3,217,968)	($160,898)			$23,014,088	$350,737,428	($273,909)	$1,865,648
57,758	($3,465,504)	($173,275)			$23,129,158	$370,227,807	($254,452)	$1,617,371
61,884	($3,714,140)	($185,652)	($5,500)	($23,867,060)	$23,244,804	$365,700,260	($1,675,237)	$1,402,134
536,328	**($32,232,900)**	**($1,608,984)**	**($127,690)**	**($43,895,800)**	**$443,565,634**	**$365,700,260**	**($16,324,646)**	**$149,744,012**
							$133,419,366	
							9.2	

K1570 Joondalup CHRMAP
Preliminary Cost Benefit Analysis - Node 5 (Ocean Reef)

Version: V1.1 - - - Scenario 1 - Initial - - - 21 May 2021

Baseline - Do Nothing

Year	Inputs				Discount Rate	3%	3%
	Adaptation Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
2020	($4,040)	($14,040)	($1,425,600)	$8,556,080	$7,112,400	($1,443,680)	$8,556,080
2025				$8,598,860	$15,711,260		$7,417,453
2030				$8,641,855	$24,353,115		$6,430,351
2035				$8,685,064	$33,038,179		$5,574,612
2040				$8,728,489	$41,766,668		$4,832,753
2045				$8,772,132	$50,538,800		$4,189,619
2050				$8,815,992	$59,354,793		$3,632,072
2055				$8,860,072	$68,214,865		$3,148,723
2060				$8,904,373	$77,119,238		$2,729,696
2065	($29,830)	($1,002,102)	($3,278,880)	$8,948,895	$81,757,320	($1,139,945)	$2,366,433
2070				$8,993,639	$90,750,959		$2,051,513
2075				$9,038,607	$99,789,567		$1,778,501
2080				$4,519,304	$104,308,870		$767,075
2085				$4,541,900	$108,850,770		$664,994
2090				$4,564,610	$113,415,380		$576,498
2095				$4,587,433	$118,002,813		$499,779
2100				$4,610,370	$122,613,182		$433,269
2105				$4,633,422	$127,246,604		$375,611
2110				$4,656,589	$131,903,193		$325,625
2115	($34,790)	($1,292,552)	($7,044,540)	$4,679,872	$128,211,183	($504,995)	$282,291
	($68,660)	**($2,308,694)**	**($11,749,020)**	**$142,337,557**	**$128,211,183**	**($3,088,620)**	**$56,632,949**
	Total Net Present Value					**$53,544,329**	
	Benefit / Cost Ratio					**18.3**	

K1570 Joondalup CHRMAP
Preliminary Cost Benefit Analysis - Node 6 (Iluka)

Version: V1.1 - - - Scenario 1 - Initial - - - 31 May 2021

	Baseline - Do Nothing							Planned / Managed Retreat (Public Only)						Accommodate Sand Nourishment								
	Inputs				Discount Rate	3%	3%	Inputs			Discount Rate	3%	3%	Inputs						Discount Rate	3%	3%
Year	Adaptation Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Nourishment Volume (m3)	Adaptation Capital Cost in Current Year (Nominal)	Adaptation Maintenance Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
2020	($5,530)	($59,380)	($1,144,440)	$9,544,080	$8,334,730	($1,209,350)	$9,544,080	($153,755)	($1,144,440)	$9,544,080	$8,245,885	($1,298,195)	$9,544,080		($5,530)		($59,380)	($1,144,040)	$9,544,080	$8,335,130	($1,208,950)	$9,544,080
2025				$9,591,800	$17,926,530		$8,273,971			$9,591,800	$17,837,685		$8,273,971	345	($20,688)	($1,034)			$9,591,800	$17,905,208	($18,738)	$8,273,971
2030				$9,639,759	$27,566,290		$7,172,886			$9,639,759	$27,477,445		$7,172,886	862	($51,720)	($2,586)			$9,639,759	$27,490,661	($40,409)	$7,172,886
2035				$9,687,958	$37,254,248		$6,218,332			$9,687,958	$37,165,403		$6,218,332	1379	($82,752)	($4,138)			$9,687,958	$37,091,730	($55,771)	$6,218,332
2040				$4,843,979	$42,098,227		$2,681,994			$4,843,979	$42,009,382		$2,681,994	1896	($113,784)	($5,689)			$9,736,398	$46,708,655	($66,149)	$5,390,808
2045				$4,868,199	$46,966,426		$2,325,079			$4,868,199	$46,877,581		$2,325,079	2414	($144,816)	($7,241)			$9,785,080	$56,341,678	($72,623)	$4,673,409
2050				$4,892,540	$51,858,966		$2,015,662			$4,892,540	$51,770,121		$2,015,662	3103	($186,192)	($9,310)			$9,834,005	$65,980,182	($80,544)	$4,051,480
2055				$4,917,003	$56,775,969		$1,747,421			$4,917,003	$56,687,124		$1,747,421	3965	($237,912)	($11,896)			$9,883,175	$75,613,550	($88,777)	$3,512,316
2060				$4,941,588	$61,717,556		$1,514,878			$4,941,588	$61,628,711		$1,514,878	4827	($289,632)	($14,482)			$9,932,591	$85,242,027	($93,228)	$3,044,904
2065	($17,950)	($89,750)	($3,588,980)	$4,966,296	$62,987,172	($977,545)	$1,313,280	($3,755,560)	($2,548,980)	$4,966,296	$60,290,467	($1,667,164)	$1,313,280	5689	($341,352)	($17,068)			$9,982,254	$94,865,862	($94,780)	$2,639,694
2070				$4,991,127	$67,978,299		$1,138,511			$4,991,127	$65,281,594		$1,138,511	6551	($393,072)	($19,654)			$10,032,166	$104,485,302	($94,146)	$2,288,408
2075				$5,016,083	$72,994,382		$987,000			$5,016,083	$70,297,677		$987,000	7413	($444,792)	($22,240)			$10,082,326	$114,100,597	($91,896)	$1,983,871
2080				$5,041,163	$78,035,545		$855,652			$5,041,163	$75,338,840		$855,652	8448	($506,856)	($25,343)			$10,132,738	$123,701,136	($90,332)	$1,719,861
2085				$5,066,369	$83,101,914		$741,784			$5,066,369	$80,405,209		$741,784	9482	($568,920)	($28,446)			$10,183,402	$133,287,171	($87,462)	$1,490,985
2090				$5,091,701	$88,193,615		$643,068			$5,091,701	$85,496,910		$643,068	10516	($630,984)	($31,549)			$10,234,319	$142,858,957	($83,676)	$1,292,567
2095				$5,117,159	$93,310,774		$557,490			$5,117,159	$90,614,069		$557,490	11551	($693,048)	($34,652)			$10,285,490	$152,416,747	($79,279)	$1,120,555
2100				$5,142,745	$98,453,519		$483,300			$5,142,745	$95,756,814		$483,300	12585	($755,112)	($37,756)			$10,336,918	$161,960,797	($74,511)	$971,434
2105				$5,168,459	$103,621,978		$418,984			$5,168,459	$100,925,273		$418,984	13447	($806,832)	($40,342)			$10,388,602	$171,502,226	($68,677)	$842,157
2110				$5,194,301	$108,816,279		$363,226			$5,194,301	$106,119,574		$363,226	14482	($868,896)	($43,445)			$10,440,545	$181,030,430	($63,798)	$730,084
2115	($60,520)	($456,600)	($5,665,120)	$5,220,273	$107,854,312	($372,915)	$314,889	($12,569,340)	($5,444,640)	$5,220,273	$93,325,867	($1,086,609)	$314,889	15516	($939,940)	($46,548)	($1,010,050)	($2,272,100)	$5,220,273	$181,982,065	($257,486)	$314,889
	($84,000)	**($605,730)**	**($10,398,540)**	**$118,942,582**	**$107,854,312**	**($2,559,810)**	**$49,311,487**	**($16,478,655)**	**($9,138,060)**	**$118,942,582**	**$93,325,867**	**($4,051,968)**	**$49,311,487**	**134,472**	**($8,082,830)**	**($403,416)**	**($1,069,430)**	**($3,416,140)**	**$194,953,881**	**$181,982,065**	**($2,811,233)**	**$67,276,690**
	Total Net Present Value					**$46,751,677**						**$45,259,519**									**$64,465,456**	
	Benefit / Cost Ratio					**19.3**						**12.2**									**23.9**	

K1570 Joondalup CHRMAP
Preliminary Cost Benefit Analysis - Node 7 (North Burns Beach)

Version: V1.1 - - - Scenario 1 - Initial - - - 31 May 2021

	Baseline - Do Nothing							Planned / Managed Retreat (Public Only)						Planned / Managed Retreat (Including Purchasing Private Property)					
	Inputs				Discount Rate	3%	3%	Inputs			Discount Rate	3%	3%	Inputs			Discount Rate	3%	3%
Year	Adaptation Cost in Current Year (Nominal)	Economic Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)	Adaptation Cost in Current Year (Nominal)	Social & Environmental Cost in Current Year (Nominal)	Social & Environmental Benefit in Current Year (Nominal)	Cumulative Cashflow (Nomindal)	Cost Present Value (Real)	Benefit Present Value (Real)
2020	($3,800)	($9,500)	($7,776,000)	$11,440,000	$3,650,700	($7,789,300)	$11,440,000	($13,300)	($7,776,000)	$11,440,000	$3,650,700	($7,789,300)	$11,440,000	($13,300)	($7,776,000)	$11,440,000	$3,650,700	($7,789,300)	$11,440,000
2025				$11,497,200	$15,147,900		$9,917,586			$11,497,200	$15,147,900		$9,917,586			$11,497,200	$15,147,900		$9,917,586
2030				$11,554,686	$26,702,586		$8,597,772			$11,554,686	$26,702,586		$8,597,772			$11,554,686	$26,702,586		$8,597,772
2035				$11,612,459	$38,315,045		$7,453,596			$11,612,459	$38,315,045		$7,453,596			$11,612,459	$38,315,045		$7,453,596
2040				$11,670,522	$49,985,567		$6,461,685			$11,670,522	$49,985,567		$6,461,685			$11,670,522	$49,985,567		$6,461,685
2045				$11,728,874	$61,714,441		$5,601,776			$11,728,874	$61,714,441		$5,601,776			$11,728,874	$61,714,441		$5,601,776
2050				$11,787,519	$73,501,960		$4,856,302			$11,787,519	$73,501,960		$4,856,302			$11,787,519	$73,501,960		$4,856,302
2055				$11,846,456	$85,348,417		$4,210,034			$11,846,456	$85,348,417		$4,210,034			$11,846,456	$85,348,417		$4,210,034
2060				$11,905,689	$97,254,105		$3,649,770			$11,905,689	$97,254,105		$3,649,770			$11,905,689	$97,254,105		$3,649,770
2065	($6,280)	($35,400)	($22,109,320)	$11,965,217	$87,068,322	($5,857,580)	$3,164,066	($1,107,350)	($21,999,600)	$11,965,217	$86,112,372	($6,110,370)	$3,164,066	($1,107,350)	($21,999,600)	$11,965,217	$86,112,372	($6,110,370)	$3,164,066
2070				$12,025,043	$99,093,365		$2,742,997			$12,025,043	$98,137,415		$2,742,997			$12,025,043	$98,137,415		$2,742,997
2075				$12,085,168	$111,178,534		$2,377,964			$12,085,168	$110,222,584		$2,377,964			$12,085,168	$110,222,584		$2,377,964
2080				$3,021,292	$114,199,826		$512,813			$12,145,594	$122,368,178		$2,061,509			$12,145,594	$122,368,178		$2,061,509
2085				$3,036,399	$117,236,224		$444,569			$12,206,322	$134,574,500		$1,787,167			$12,206,322	$134,574,500		$1,787,167
2090				$3,051,581	$120,287,805		$385,407			$12,267,354	$146,841,854		$1,549,334			$12,267,354	$146,841,854		$1,549,334
2095				$3,066,838	$123,354,643		$334,117			$12,328,691	$159,170,544		$1,343,152			$12,328,691	$159,170,544		$1,343,152
2100				$3,082,173	$126,436,816		$289,654			$12,390,334	$171,560,878		$1,164,408			$12,390,334	$171,560,878		$1,164,408
2105				$3,097,583	$129,534,399		$251,107			$12,452,286	$184,013,164		$1,009,450			$12,452,286	$184,013,164		$1,009,450
2110				$3,113,071	$132,647,471		$217,690			$12,514,547	$196,527,711		$875,115			$12,514,547	$196,527,711		$875,115
2115	($140,560)	($1,283,600)	($34,015,760)	$3,128,637	$100,336,187	($2,137,747)	$188,720	($25,217,640)	($32,164,560)	$12,577,120	$151,722,631	($3,461,313)	$758,656	($43,217,640)	($32,164,560)	$12,577,120	$133,722,631	($4,547,079)	$758,656
	($150,640)	**($1,328,500)**	**($63,901,080)**	**$165,716,407**	**$100,336,187**	**($15,784,627)**	**$73,097,624**	**($26,338,290)**	**($61,940,160)**	**$240,001,081**	**$151,722,631**	**($17,360,983)**	**$81,022,338**	**($44,338,290)**	**($61,940,160)**	**$240,001,081**	**$133,722,631**	**($18,446,749)**	**$81,022,338**
	Total Net Present Value					**$57,312,997**						**$63,661,355**						**$62,575,589**	
	Benefit / Cost Ratio					**4.6**						**4.7**						**4.4**	

Appendix B Adaptation Option Sketches

AT CORRECT SCALE THIS IS 100 mm

SEAWALL SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2025	100
2	2025	85

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- EXISTING SEAWALL
- ROCK
- NODE BOUNDARY
- SEAWALL

NOTE:

1. AERIAL PHOTOGRAPH PROVIDED BY CITY OF JOONDALUP TAKEN IN AUGUST 2020.

AT CORRECT SCALE THIS IS 100 mm

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DRAWN R BORJA
CHECKED T HUNT

MARMION (NODE 1) - SEAWALLS

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

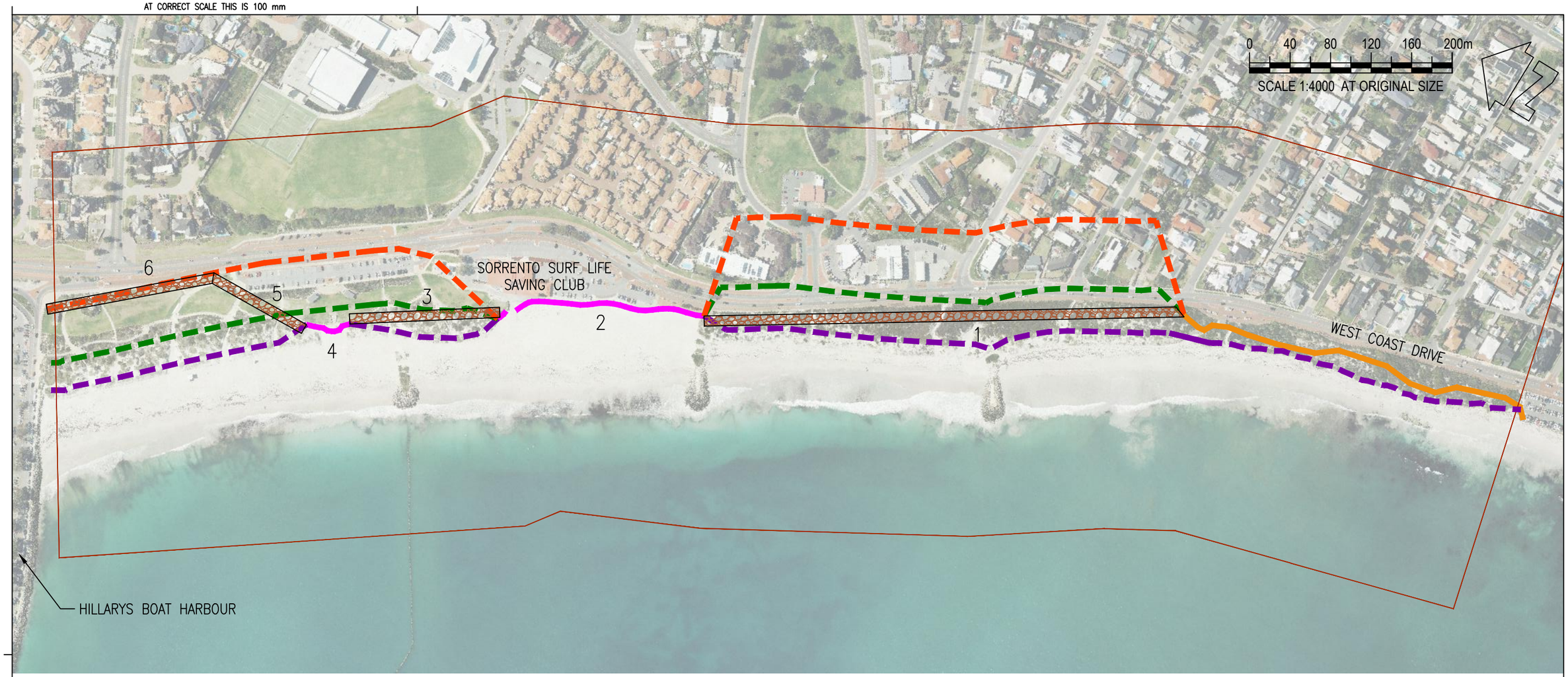
SCALE AT A3 1:2,500

MARCH 2021

SK1570–10–01A

P:\MRA Paying Jobs\K1570 Joondalup CAP\5 MRA Dwgs\Sketches\SK1570–10 Node Sketches

AT CORRECT SCALE THIS IS 100 mm



SEAWALL SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2050	460
2	2025	220
3	2040	145
4	2055	50
5	2040	95
6	2100	110

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- EXISTING SEAWALL
- ROCK
- NODE BOUNDARY
- SEAWALLS

NOTE:

1. AERIAL PHOTOGRAPH PROVIDED BY CITY OF JOONDALUP TAKEN IN AUGUST 2020.

AT CORRECT SCALE THIS IS 100 mm

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SORRENTO (NODE 2) - SEAWALLS

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

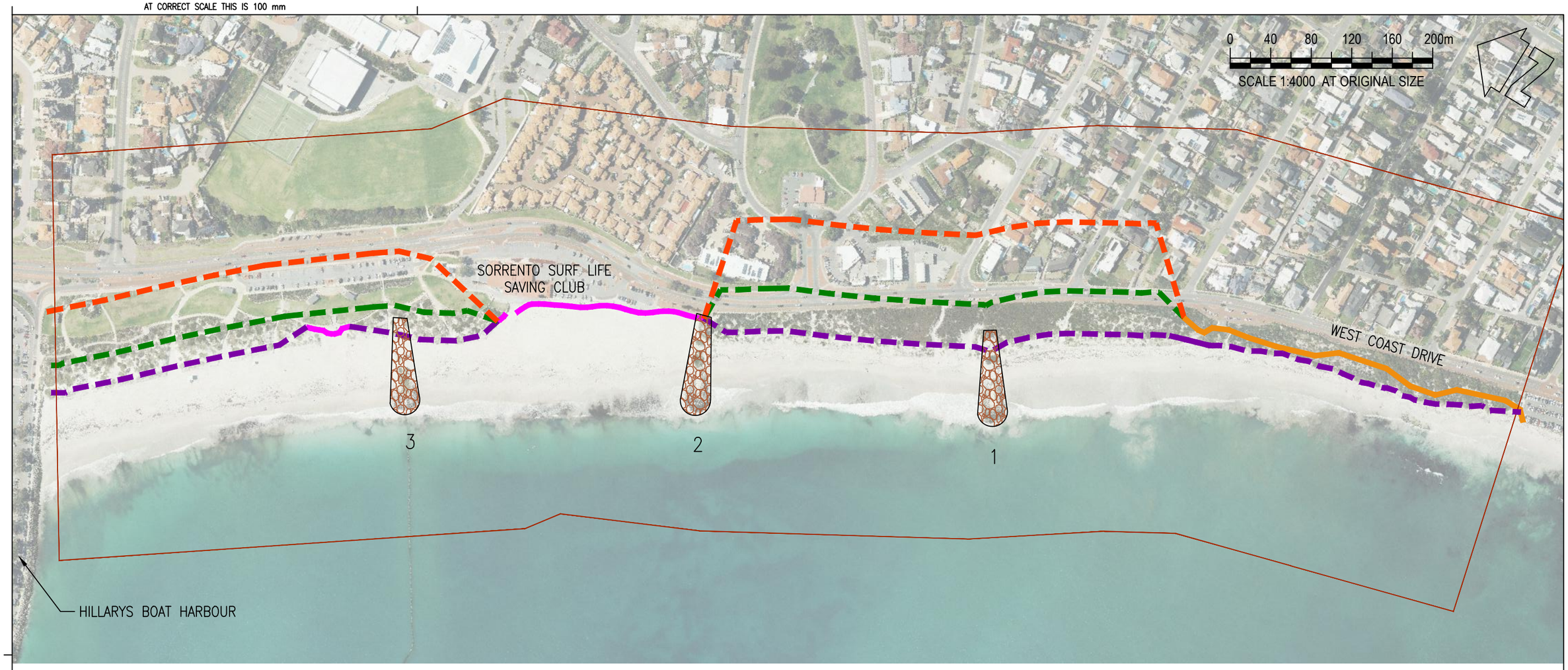
SCALE AT A3 1:4,000

MARCH 2021

SK1570–10–02A

P:\MRA Paying Jobs\K1570 Joondalup CAP\5 MRA Dwgs\Sketches\SK1570–10 Node Sketches

AT CORRECT SCALE THIS IS 100 mm



GROYNE SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2030	90
2		
3		

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- EXISTING SEAWALL
- ROCK
- NODE BOUNDARY
- GROYNES

NOTE:

1. AERIAL PHOTOGRAPH PROVIDED BY CITY OF JOONDALUP TAKEN IN AUGUST 2020.

AT CORRECT SCALE THIS IS 100 mm

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SORRENTO (NODE 2) - GROYNES

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

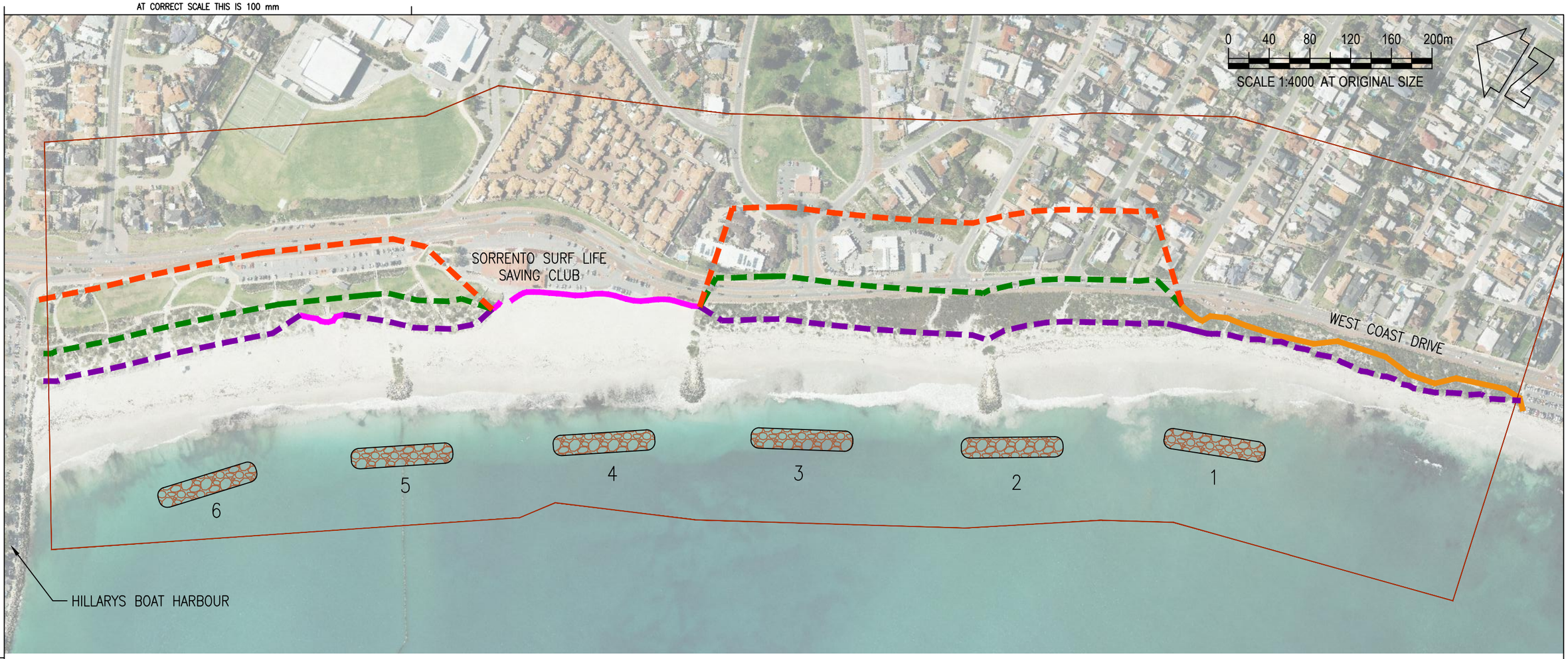
SCALE AT A3 1:4,000

MARCH 2021

SK1570–10–03A

P:\MRA Paying Jobs\K1570 Joondalup CAP\5 MRA Dwgs\Sketches\SK1570–10 Node Sketches

AT CORRECT SCALE THIS IS 100 mm



HEADLAND SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2070	100
2	2040	
3	2040	
4	2025	
5	2060	
6	2070	

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- EXISTING SEAWALL
- ROCK
- NODE BOUNDARY
- HEADLANDS

NOTE:

1. AERIAL PHOTOGRAPH PROVIDED BY CITY OF JOONDALUP TAKEN IN AUGUST 2020.

AT CORRECT SCALE THIS IS 100 mm

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SORRENTO (NODE 2) - HEADLANDS
CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

SCALE AT A3 1:4,000

MARCH 2021
SK1570–10–04A

P:\MRA Paying Jobs\K1570 Joondalup CAP\5 MRA Dwgs\Sketches\SK1570–10 Node Sketches

AT CORRECT SCALE THIS IS 100 mm

SEAWALL SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2040	170
2	2080	190
3	2060	395
4	2030	480
5	2040	315
6	2080	900

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- NODE BOUNDARY
- SEAWALLS
- VEGETATION PROTECTED BY SEAWALLS

NOTE:

1. AERIAL PHOTOGRAPH PROVIDED BY CITY OF JOONDALUP TAKEN IN AUGUST 2020.

AT CORRECT SCALE THIS IS 100 mm

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PINNAROO POINT TO HILLARYS (NODE 3) - SEAWALLS

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

SCALE AT A3 1:10,000

MARCH 2021

SK1570–10–05A

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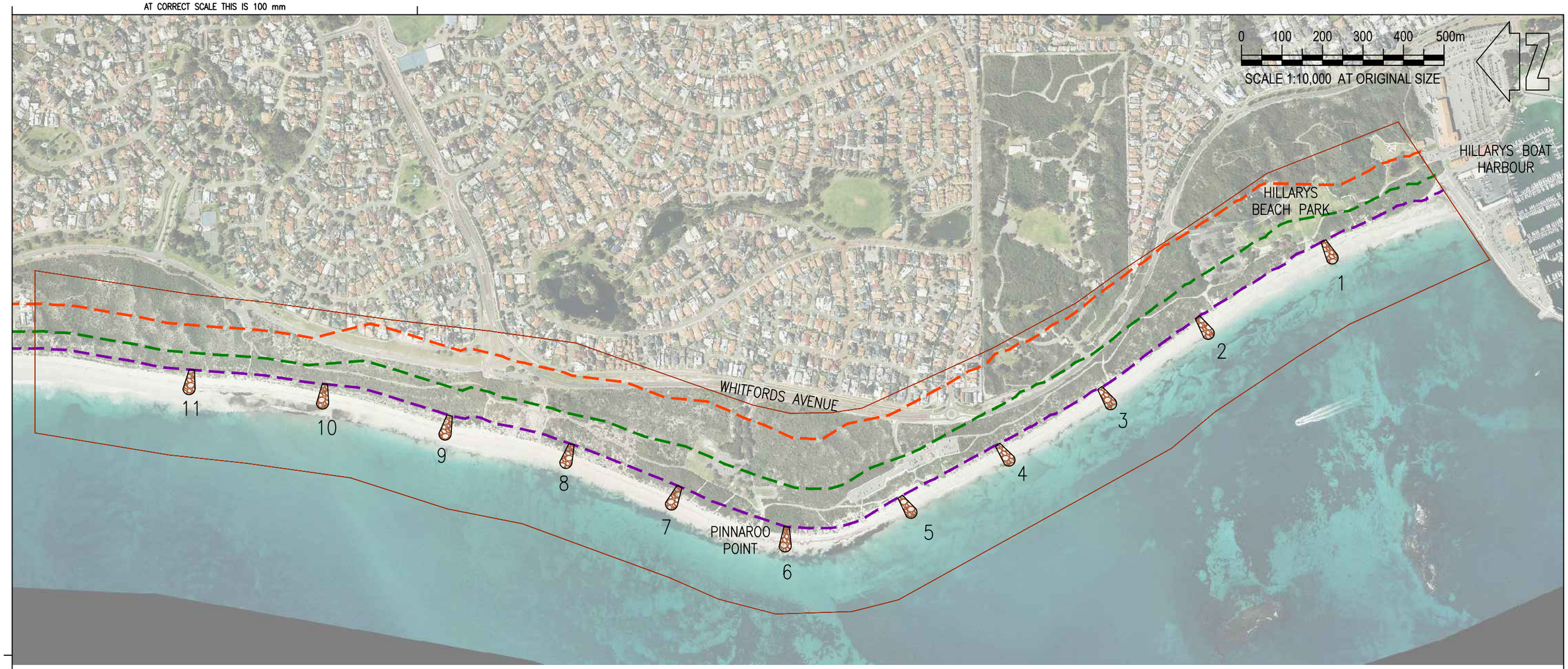
AT CORRECT SCALE THIS IS 100 mm



GROYNE SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2025	60
2	2025	
3	2060	
4	2040	
5	2025	
6	2040	
7	2025	
8	2060	
9	2060	
10	2040	
11	2060	

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- NODE BOUNDARY
- GROYNES

NOTE:

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AT CORRECT SCALE THIS IS 100 mm

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PINNAROO POINT TO HILLARYS (NODE 3) - GROYNES

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

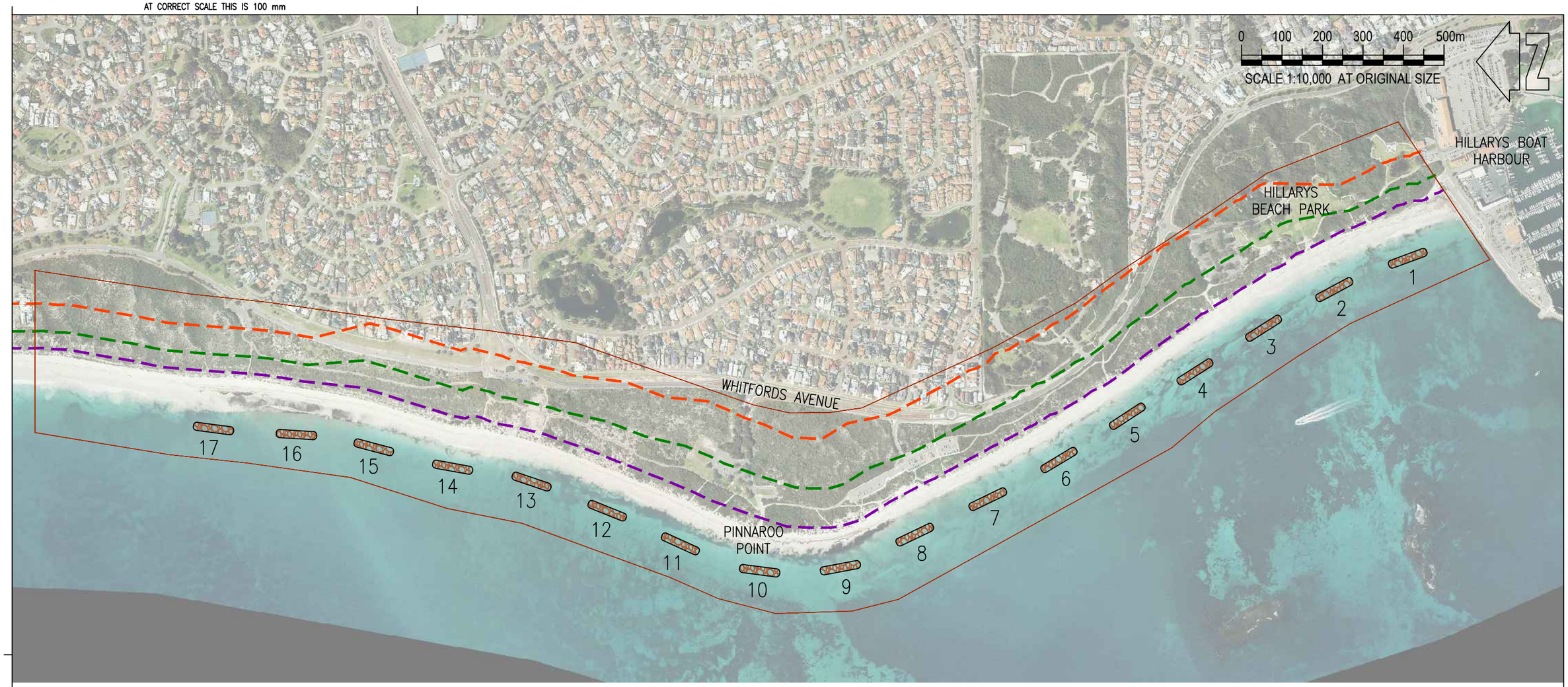
SCALE AT A3 1:10,000

MARCH 2021

SK1570–10–06A

P:\MRA Paying Jobs\K1570 Joondalup CAP\5 MRA Dwgs\Sketches\SK1570–10 Node Sketches

AT CORRECT SCALE THIS IS 100 mm



HEADLAND SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2060	100
2	2025	
3	2025	
4	2060	
5	2040	
6	2040	
7	2025	
8	2025	
9	2040	

HEADLAND SECTION	YEAR BUILT/REBUILT	LENGTH (m)
10	2025	100
11	2025	
12	2040	
13	2060	
14	2040	
15	2040	
16	2040	
17	2110	

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- NODE BOUNDARY
- HEADLANDS

NOTE:

1. AERIAL PHOTOGRAPH PROVIDED BY CITY OF JOONDALUP TAKEN IN AUGUST 2020.

AT CORRECT SCALE THIS IS 100 mm

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PINNAROO POINT TO HILLARYS (NODE 3) - HEADLANDS

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

SCALE AT A3 1:10,000

MARCH 2021

SK1570-10-07A

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AT CORRECT SCALE THIS IS 100 mm

SEAWALL SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2075	285
2	2035	140
3	2070	300
4	2085	560
5	2065	280
6	2110	90

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- ROCK
- NODE BOUNDARY
- SEAWALLS
- VEGETATION PROTECTED BY SEAWALLS

NOTE:

1. AERIAL PHOTOGRAPH PROVIDED BY CITY OF JOONDALUP TAKEN IN AUGUST 2020.

AT CORRECT SCALE THIS IS 100 mm

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DRAWN R BORJA
CHECKED T HUNT

MULLALOO (NODE 4) - SEAWALLS

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

SCALE AT A3 1:5,000

MARCH 2021

SK1570–10–08A

P:\MRA Paying Jobs\K1570 Joondalup CAP\5 MRA Dwgs\Sketches\SK1570–10 Node Sketches

AT CORRECT SCALE THIS IS 100 mm

GROYNE SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2060	90
2	2025	
3	2050	
4	2070	
5	2070	
6	2050	

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- ROCK
- NODE BOUNDARY
- GROYNES

NOTE:

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MULLALOO (NODE 4) - GROYNES

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

SCALE AT A3 1:5,000

MARCH 2021

SK1570–10–09A

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AT CORRECT SCALE THIS IS 100 mm

HEADLAND SECTION	YEAR BUILT/REBUILT	LENGTH (m)
1	2040	100
2	2025	
3	2040	
4	2080	
5	2080	
6	2080	
7	2060	
8	2060	
9	2080	

LEGEND:

- 2015 COASTAL EROSION
- 2065 COASTAL EROSION
- 2115 COASTAL EROSION
- ROCK
- NODE BOUNDARY
- HEADLANDS

NOTE:

1. AERIAL PHOTOGRAPH PROVIDED BY CITY OF JOONDALUP TAKEN IN AUGUST 2020.

AT CORRECT SCALE THIS IS 100 mm

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MULLALOO (NODE 4) - HEADLANDS

CITY OF JOONDALUP – COASTAL ADAPTATION PLAN

SCALE AT A3 1:5,000

MARCH 2021

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