MARSDEN JACOB ASSOCIATES

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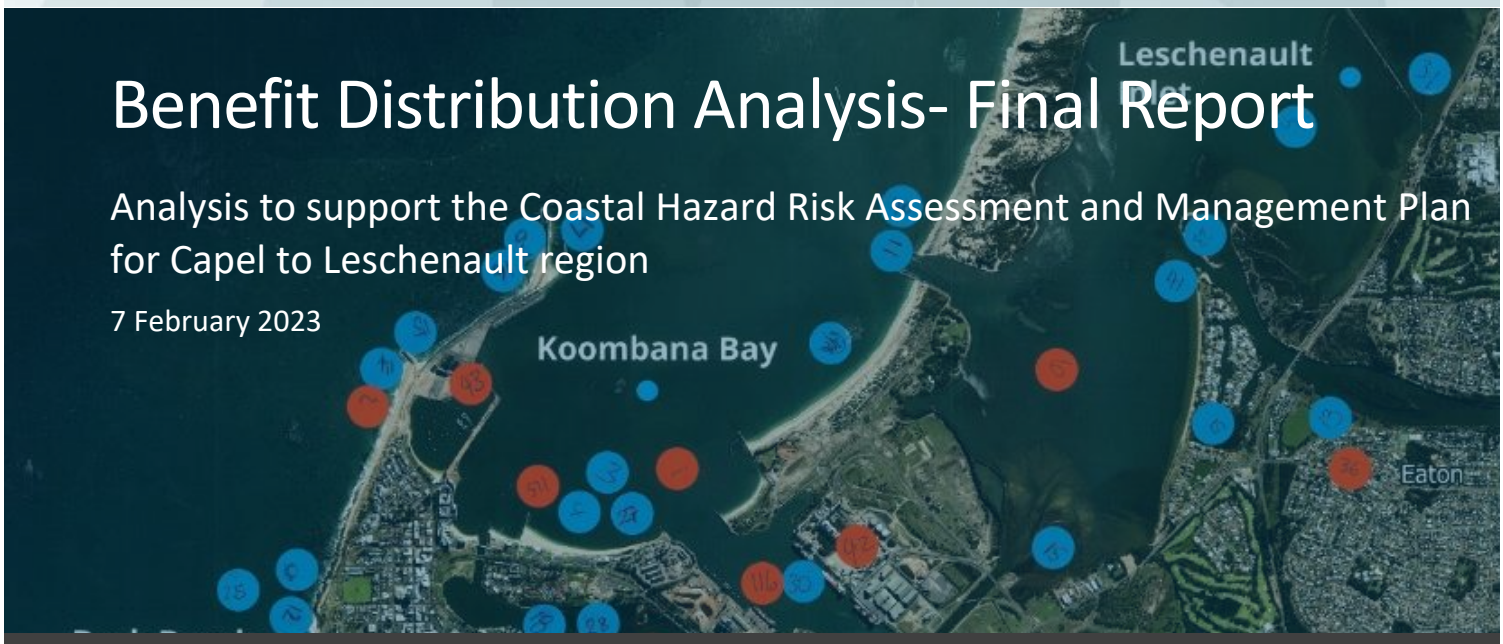
Benefit Distribution Analysis- Final Report

Analysis to support the Coastal Hazard Risk Assessment and Management Plan for Capel to Leschenault region

7 February 2023



A Marsden Jacob Report

Prepared for Peron Naturaliste Partnership

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Acronyms and abbreviations

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CBA Cost-Benefit Analysis

CHRMAP Coastal Risk Management and Adaptation Plan

MU Management Unit

PNP Peron Naturaliste Partnership

SPP State Planning Policy

TEV Total Economic Value

1. Introduction

1.1 Background

To combat rising sea levels, state governments across Australia have introduced obligations that require local governments to consider and plan for these hazards. In Western Australia, the governing policy is the State Planning Policy No. 2.6 (SPP 2.6)[1].

SPP 2.6 requires adequate risk management planning is undertaken where existing or proposed development is in an area at risk of being affected by coastal hazards over the 100-years planning timeframe. SPP 2.6 and the Coastal Risk Management and Adaptation Plan (CHRMAP) Guidelines[2] provide the risk assessment framework to be applied to identify risks that are intolerable to the community, and other stakeholders such as local governments, indigenous and cultural interests, and private enterprise. Risk management measures are then developed according to the adaptation hierarchy outlined in SPP 2.6.

1.1.1 Coastal Risk Management and Adaptation Plan (CHRMAP)

WA guidelines for CHRMAP set out an 8-stage process for developing CHRMAPs. The stages are as follows:

1. Establish the context
2. Risk identification
3. Vulnerability analysis
4. Risk evaluation
5. **Risk treatment**
6. **Implementation plan**
7. Monitor and review
8. Final CHRMAP

A Cost-Benefit Analysis (CBA) fits within Stage 5 (Risk treatment). A Benefit Distribution Analysis (BDA) fits within Stage 6 (implementation plan). The outputs of these two stages are:

- A CBA that identifies the preferred risk management measures; and
- A BDA that forms the basis for the funding proposal for the identified risk management measures.

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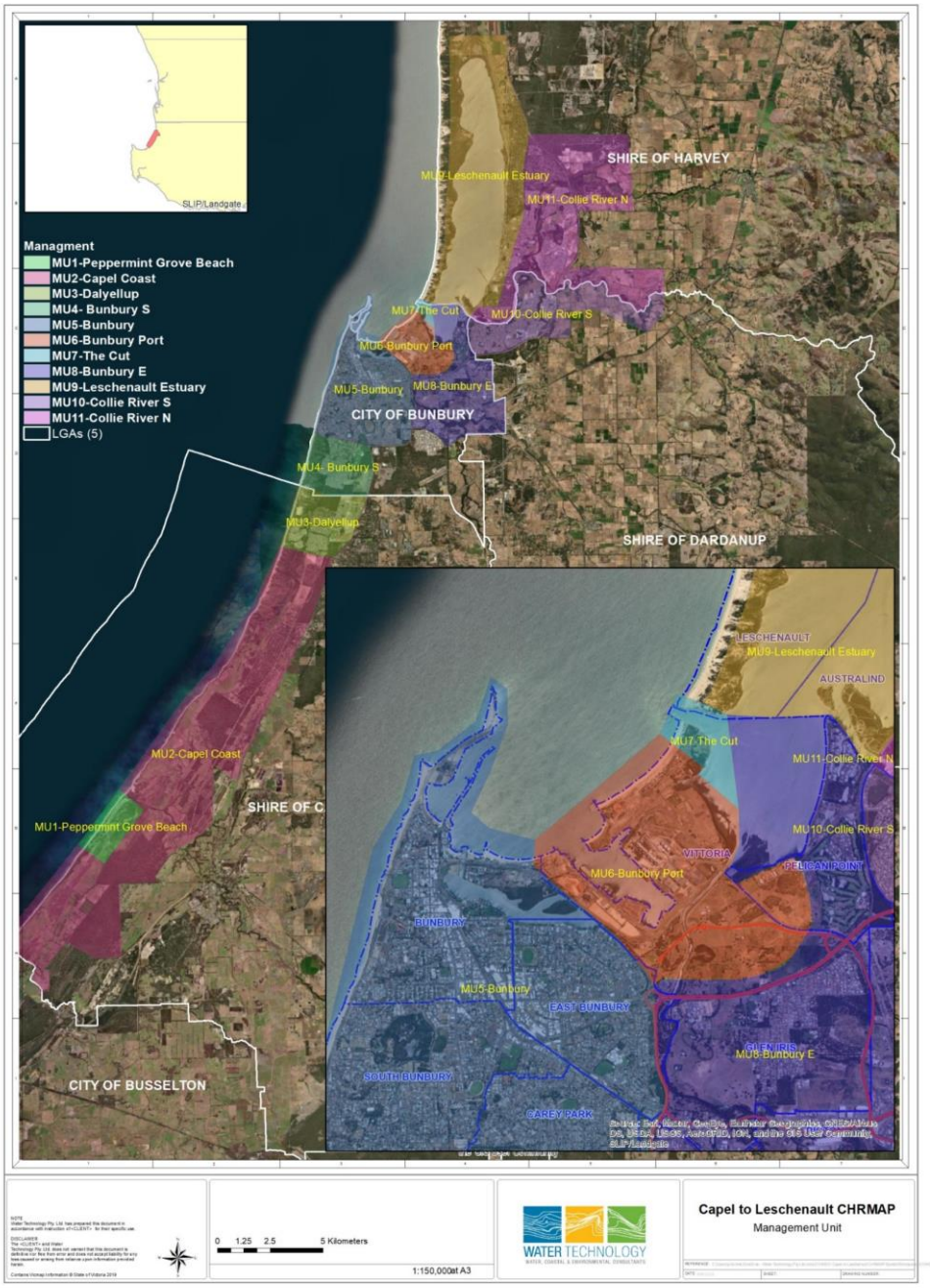
[1] State Coastal Planning Policy Guidelines www.wa.gov.au/system/files/2021-06/GD-state-coastal-planning-policy-guidelines-Published-Version-Feb-2021.pdf

[2] https://www.wa.gov.au/government/document-collections/coastal-hazard-risk-management-and-adaptation-planning-guidelines

1.1.2 Study area

The Peron Naturaliste Partnership (PNP) comprises membership of nine local government authorities. The PNP's Coastal Adaptation Pathways Project identified the coastal areas of Capel, Leschenault and Greater Bunbury as being particularly exposed to coastal hazards and climate change, which triggered the need for this CHRMAP. The aim of the present study is therefore to investigate the nature and severity of coastal hazards which are likely to affect these regions from Capel to Leschenault over future planning horizons. Figure 1 illustrates the locality, study area extent and management units (MUs).

Figure 1: Study area and the identified Management Units (MU)



1.2 Cost Benefit Analysis (CBA)

As part of the CBA, Water Technology undertook the following steps:

- Identifying the full range of risk treatment options;
- Using Multi-Criteria analysis to identify a short list of the most important areas and highest-ranking treatment options; and
- Using the CBA to identify preferred treatment options for addressing short, medium, and long-term risk and whether the preferred treatment will deliver a net benefit.

The CBA considered each option against a base case scenario. Usually the base-case scenario will be a 'Do nothing' scenario. Under each of these options, the full range of quantifiable costs and benefits were identified and collated. The full list of identified options and assets deemed to be at risk are detailed in the following section.

1.2.1 Scope of analysis

The full list of options that were considered as part of the CBA are listed in Table 1.

Table 1: Full list of options considered in the CBA

Option Category	Option Name	Option Code
Planned / Managed Retreat	Voluntary acquisition	PMR4
Protect	Beach nourishment or replenishment	PR1
	Groyne	PR2
	Seawall	PR3
	Artificial reef	PR4
	Offshore breakwater	PR5
	Levy / Weir / Storm Surge Barrier	PR6

The CBA identified the following asset types as being under threat:

- Roads
- Residential properties
- Commercial properties
- Public and Community
- Foreshore - Developed
- Foreshore - Undeveloped
- Environmental

- Agricultural / Rural
- Aboriginal Heritage

1.3 Benefit Distribution Analysis (BDA)

A BDA is undertaken to allocate the derived benefits from the options identified to the relevant stakeholder. The relevant stakeholders are all those who are expected to benefit from the protection of the identified area. Key beneficiaries are likely to include:

- Private land holders
- Utility providers (such as State government departments)
- Industry and businesses that either operate or directly linked to the area under threat
- Local community (Direct users of the area under threat)
- Broader community (Indirect users)

It is important to identify the beneficiaries and accurately evaluate their individual share of benefits. This paves the way for the next step in the BDA which is identifying funding options and a funding model. CHRMAP follows a "beneficiary pay principle" and thus, requires the accurate allocation of the proportion of benefits to the beneficiaries.

1.3.1 Scope of analysis

Following completion of the CBA and review of the results, Water Technology discussed possible options to proceed to Benefit Distribution Analysis (BDA). The Cost Benefit Analysis report recommended that the BDA is conducted for the following Management Units (MU):

- MU 1 and 2 – Peppermint Grove beach and Capel coast
- MU 3 – Dalyellup
- MU 5 – Bunbury

Within these areas, the treatment options to be assess for the BDA were:

- Levy / Weir / Storm Surge Barrier (PR 6) for Peppermint Grove beach and Capel coast (MU 1 and 2)
- Groynes (PR 2) for Dalyellup (MU 3) and Bunbury (MU 5)

It should be noted that while the Management Unit areas may be subject to both inundation and erosion risks, the treatment options only address one or other of the risks (either inundation or erosion).

Levy / weir / storm surge barriers reduce the risk of inundation while groynes reduce the risk of erosion.

1.4 Uncertainties/constraints with analysis

This report sets out Marsden Jacob's analysis of the distribution of the benefits – as identified by Water Technology in the Cost Benefit Analysis. As discussed in detail in section 2.5, the cost benefit analysis was undertaken at a high level due to large number of management units and possible interventions considered. Given the uncertainties in the exact timing and scale of the benefits, the analysis should not be relied upon for final decision making at this point. Instead, the analysis sets out the Benefit Distribution Analysis process and the approach can be updated once revised risk and intervention costs and benefits are produced.

2. Framework and Approach

2.1 Cost sharing principles such as 'beneficiary pays'

Cost allocation is typically generally done on a User pays / Impactor pays / Beneficiary pays approach for environmental projects with high infrastructure cost. Coastal adaption principles and Stage 6 of the CHRMAP process set out that risk management plans be implemented using a 'beneficiary pays' approach. In this way the funding arrangements reflect the benefit derived from coastal management actions, minimise subsidies, and avoid additional burden on taxpayers and ratepayers.

Under a beneficiary pays approach, the cost of works is recovered from identified beneficiaries. Beneficiaries generally include those who directly and indirectly benefit from the proposed works. A direct beneficiary of the proposed works can be someone whose land/property is situated in the identified threatened area. An indirect beneficiary can be someone who derives value from knowing that the coastal line is preserved. Indirect beneficiaries are usually from the wider community.

Key beneficiaries are likely to include:

- State Government (Utilities such as roads, Water, Electricity)
- Business and industry (Cafés etc)
- Private land holders (Private property that is saved)
- Local community (local users of beaches, parks, estuaries etc. - provided proposed treatment enhances rather detracts from the value of these assets)
- Broader community (wider users of green assets including non-uses such as altruism)

Benefits and the beneficiaries can be identified by considering the community values of the assets that are being protected. Often, the list of beneficiaries does not include beneficiaries of second and further round effects. These beneficiaries are those, for example, who benefit from the protection of a café or improved productivity from lands that are preserved. Inability to identify these beneficiaries becomes an issue when there is a mix of direct and indirect beneficiaries.

Using a beneficiary pays approach, a funding model can then be developed to determine how the infrastructure is paid for. The BDA will point towards how funding should be organised i.e., what proportion of the cost of works should be paid for by each beneficiary. The funding model will initially begin with funding assessment. Marsden Jacob's approach to funding assessment is based on experience as well as processes used in other jurisdictions, and is as follows:

- Step 1 – Current status of council resources for coastal management actions.
- Step 2 – Are there any potential opportunities to align actions and leverage funding from neighbouring local, state or Commonwealth programs?
- Steps 3 – Are there any relevant grant programs that could provide funding?

- Step 4 – Potential for voluntary contributions from interested parties.
- Step 5 – Considering the previous steps, what mechanisms could be used to equitable secure contributions?

The equity of funding arrangements needs to be considered and documented. The mechanisms used to enable funding arrangements will be most acceptable where they are efficient, transparent to the community and relatively easy to understand.

To assist apportioning the costs (capital and recurrent costs) of constructing coastal protection works based on the beneficiary pays principle, a benefit distribution analysis should be completed and accompany an application to construct the works. A benefit distribution analysis assesses the distribution of benefits between stakeholders from implementing risk treatment options such as coastal protection works.

2.2 Total economic valuation (TEV) framework

In order to identify the full range of benefits and beneficiaries that will arise from climate interventions, it is firstly important to ensure the full range of uses and values are identified. This is particularly important for public assets – which may have multiple values and uses.

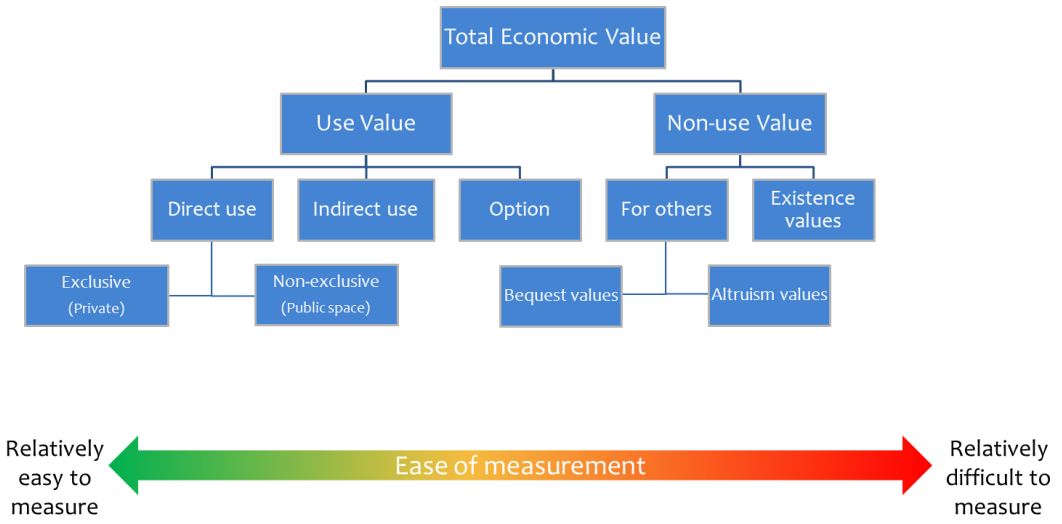
The concept of total economic value (TEV) is a well-established and useful framework for identifying the various values associated with protected areas.[3] This framework is a useful tool for economic valuation, which measures market and non-market values that people hold for the study area and can be applied to value coastal areas and other natural resources such as wetlands, parks etc.

The TEV framework provides a useful classification for the full range of community values. This is shown in Figure 2. The basic premise of the framework is that the total economic value of an area is a function of its use and non-use values. The use values are made up of its direct use values, indirect use values, and option values. Non-use values typically include bequest and existence values.

The framework also helps to avoid double counting of ecosystem functions, intermediate services, and final services.

[3] Economic values of protected areas, IUCN – https://portals.iucn.org/library/efiles/documents/PAG-002.pdf

Figure 2: Total economic value (TEV) framework



Source: Adapted from Phillips (1998)

TEV includes both use values, which measure the value of using assets that are protected, and non-use values, which refer to an individual's willingness to contribute to the cost of protecting public assets (such as beaches and estuaries), even if the individual will not use the areas themselves.

2.2.1 Valuation methods

On the left-hand side of the TEV framework there are values for the exclusive direct use of assets – such as private land. The value the community places on these assets may be impacted from the market price paid for private land. For all the other uses, there is no direct market value for the benefit obtained. These are often referred to as non-market values.

There are various methods for valuing the benefits described in the TEV framework – where there is no direct market. Some of these are described below.

1. **Contingent valuation method** – This uses a direct approach to valuing an environmental good or service in that it asks people through surveys or experiments what they are willing to pay for the good or willing to accept for the loss of the good. This method uses the concepts of willingness to pay (WTP) and willingness to accept (WTA).
2. **Hedonic pricing** – This method uses existing markets (housing or labour) to determine the values of an environmental good. The underlying assumption is that property values or wages reflect a stream of benefits, some of which can be attributed to the environment.
3. **Travel cost method** – This method also uses existing markets by evaluating people's travel in terms of time, expenditure, and entry fees to assess recreational and leisure values of an area.
4. Some of the other methods use include **Change in productivity method**, **Loss (or gain) of earnings methods**, **Opportunity cost approach**, and **Replacement cost approach**.

2.3 Assets identified in the CBA

The CBA collated information gathered through the *Coastal Assets and Community Values Report* as well as the *Risk Treatment Report* and identified the following asset types as being under threat:

- Roads
- Residential properties
- Commercial properties
- Public and Community
- Foreshore - Developed
- Foreshore - Undeveloped
- Environmental
- Agricultural / Rural
- Aboriginal Heritage

Based on the collated information, Water Technology estimated the damage that would arise for each type of asset that were impacted by either erosion or inundation – as set out in Table 2. The estimation of the rates applied by Water Technology are presented in detail in the Cost Benefit Analysis section of the Risk Treatment Chapter Report.

Table 2: Estimated damage arising from each asset type impacted by erosion or inundation

Asset type	Erosion rates $2020 (real)	Inundation rates $2020 (real)
Roads (per km)	$3,000,000	$50,000
Residential (per parcel)	$500,000	$100,000
Commercial (per parcel)	$375,000	$75,000
Public and Community (per parcel)	$375,000	$75,000
Foreshore - Developed (per ha)	$3,125,000	$6,000
Foreshore - Undeveloped (per ha)	$2,500,000	$2,000
Environmental (per item)	$250,000	$25,000
Agricultural / Rural (per parcel)	$90,000	$3,750
Aboriginal Heritage (per item)	$2,000,000	$400,000

Source: Water Technology, 2022

Applying the different types of values identified in the TEV framework, Table 3 sets out the various assets and their value type based on the TEV framework. Additionally, this table also sets out a potential valuation method for each of these assets and their beneficiaries.

Table 3: Asset values, valuation methods and potential beneficiaries

Asset type	Asset owner	TEV Value type	Valuation method	Beneficiaries
Roads	Likely to be a mix of Local Government and State Government	Direct use or opportunity value	Replacement cost	Some benefit to all WA residents Higher benefit to local residents accessing private and public assets. For this BDA we have assumed that the road network is an asset that provides direct or opportunity values to all WA residents
Residential	Private landowners	Direct use value	Market value	Private landowners of the properties that will be protected
Commercial	Private landowners	Direct use value	Market value	Private landowners of the properties that will be protected
Public and Community	Local or state Government	Direct use value	Non-Market	Community - probably a mix of local community and broader community
Foreshore - Developed	Local or state Government	Direct use value	Non-Market	Community - probably a mix of local community and broader community
Foreshore - Undeveloped	Local or state Government	Direct use value or opportunity value	Non-Market	Community - probably a mix of local community and broader community
Environmental	NA	Non-use value (existence value)	Existence	Broader WA community
Agricultural / Rural	Private landowners	Direct use value	Market value	Private landowners of the properties that will be protected
Aboriginal Heritage	NA	Non-use value (existence value)	Existence	Broader WA community

Comparing the different asset types, it can be seen that privately owned assets (such as residential, commercial or agricultural land) are easily apportioned to the private land holder.

It can also be seen that we have allocated foreshore (either developed or undeveloped) as "use values" – and it appears likely that the largest users will be the local community.

In contrast environment and aboriginal heritage assets are categorised as "non-use values" and so the whole WA community are identified as beneficiaries.

When the CBA is revised, it would be appropriate to review the value of the damage to each asset type from erosion and inundation as well as to test these assumptions on the use and value of these assets to both the local community and the broader WA public.

2.4 Approach for the BDA in this report

In this report, our approach to BDA is to focus on three MUs and a single option within these areas. The reasoning behind this is set out in Section 1.3. Following this, it was decided to focus on one option for each of the units. The options considered are:

- PR (Protect) 6 for MU 1 and 2 – Levy / Weir / Storm Surge Barrier – To address inundation only
- PR 2 for MU 3 and 5 – Groynes – To address erosion only

These options were chosen based on the recommendation from Water Technology and their analysis of the costs and benefits associated with each of the option.

The CBA identified that the biggest threats to each of the regions were either coastal erosion or inundation. The benefits were then calculated separately for inundation and erosion. The combined benefits were calculated up to the year 2120 and their present value was calculated using a rate of 4% and sensitivities were tested at rates of 7% and 2%.

The discounted benefits were then divided up proportionally amongst the key beneficiary groups for each of the Management Units. Detailed BDA results are found in Section 4.

2.5 Approach to identifying the funding mechanism

The Water Technology analysis considered four assessment periods of 2020, 2035, 2050, 2120. The analysis identifies assets that are at risk for each of these periods and the assets that would benefit from the proposed interventions.

- Assets identified to be at risk in 2020, essentially require immediate action, whilst assets identified to be at risk in 2035, 2050 or 2120 do not require immediate action.
- For this project identified three broad groups of funding sources:
  - Private property owners (residential, commercial or agricultural)
  - WA State government (representing the broader WA community) and
  - Local community

- We identify the funding required could be collected as either a lump sum, or as an annuity over a number of years. We have assumed that funding through an annuity would be collected over a 15-year period.

Payment form

For each of the stakeholders that are identified as a key beneficiary, we identify the financial contribution that would be required as a singular payment as well as the annuity payment that would be required if the funds were collected over a 15-year period and at 7% discount rate.

15 years is an arbitrary period – but aligns with the duration between the first three assessment periods (2020, 2035, 2050).

If funds started to be collected now, the projects would be largely funded ahead of the 2035 timeframe for implementation. Ahead of 2035, the risks and work required for 2050 could be reviewed, and then annuity payments could be required for 15 years to ensure any activities undertaken at that time were also funded ahead of work commencing.

3. Discussion of cost benefit analysis

For this project the cost benefit analysis was undertaken by Water Tech and Marsden Jacob have been commissioned to undertake the benefit distribution analysis.

The CBA focussed on 11 Management Units and 6 treatment options for each of the Management Units for protection against coastal erosion and/or inundation. The list of options considered are provided in Section 1.2.

To some extent the benefit distribution analysis set out here is limited in its detail by the cost benefit analysis. For this reason, key recommendations of the report are:

- The design and cost estimation of the preferred interventions should be refined to a preliminary or functional design level; and
- A further detailed cost benefit analysis should be undertaken for the preferred option - seeking to expand the range of benefits considered and also refine the estimation of the value of these benefits.
- Once these steps are undertaken the benefit distribution analysis can be revised or updated to reflect the new costs and benefits.

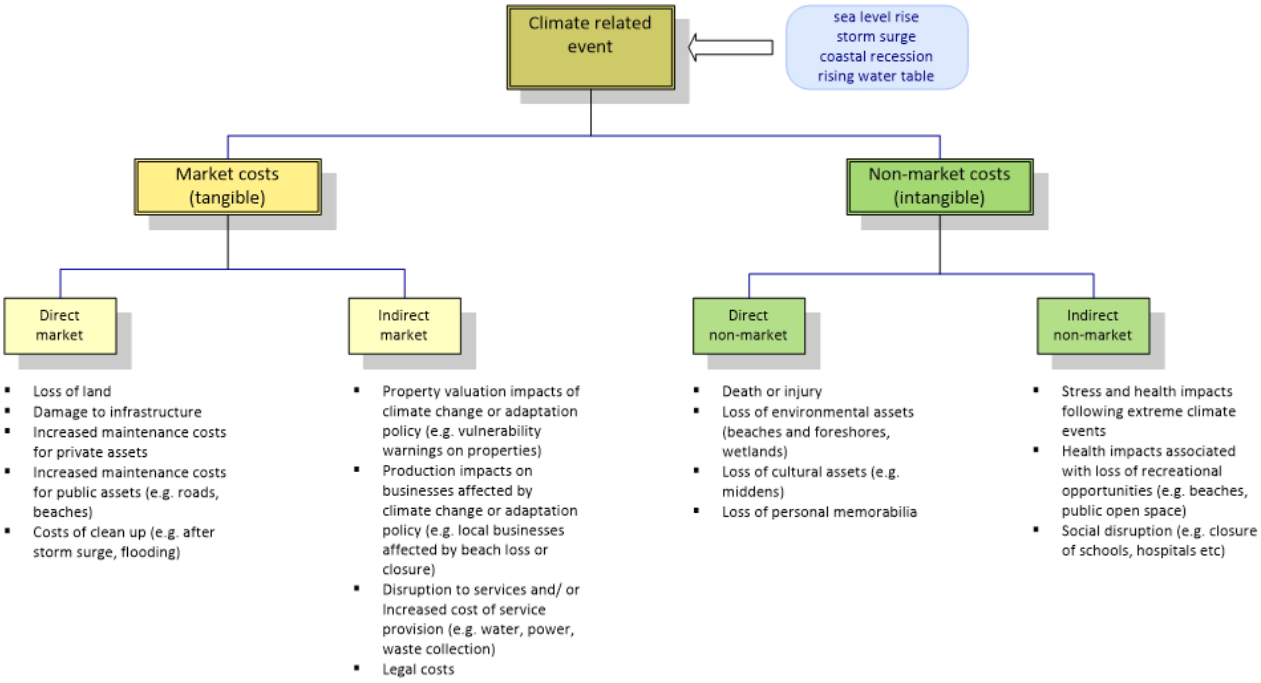
The following sections discuss some of the key aspects that are not included in the current CBA. Each of these elements should be included in the CBA and BDA before final decisions are made on whether to fund any interventions.

3.1 Benefits considered in the CBA

To include the cost benefit analysis within the project timeframe and budget, the analysis focusses on the largest and most easily valued benefits. In this manner, the CBA has similarities to a rapid CBA.[4] This has resulted in the analysis using readily available data which quantifies direct and market use values. However, this CBA does not fully capture or quantify indirect use on non-use values. Traditionally, these values have been difficult to quantify and allocate to a particular group in a CBA. Due to this, care must be taken when interpreting the results of the CBA or the BDA since some costs or benefits may have been missed. Figure 3 shows the TEV framework applied for valuing coastal adaptation. This gives a basic understanding of some non-market values which may not have been identified in the CBA.

[4] www.infrastructureaustralia.gov.au/sites/default/files/2021-07/Assessment%20Framework%202021%20Guide%20to%20economic%20appraisal.pdf

Figure 3 TEV framework applied for valuing coastal adaptation.



Source: Marsden Jacob analysis using the TEV framework

In addition to focussing on some key benefit types, the values used for CBA have been based on the estimated values of similar land uses in other locations. This approach is referred to as benefit transfer – but the value of the benefit should be reviewed through primary research undertaken at the specific location.

3.2 Probabilistic approach to identifying hazard lines and impacts

The CBA is based on the current coastal hazard assessment for the base case and appears to be based on the predicted most likely outcome for both inundation and erosion for 2035, 2050 and 2120.

The reality is that both erosion and inundation will occur during specific weather events (such as storms), and these could occur earlier or later than predicted and could be larger or smaller than predicted. For this reason, we consider the current approach used to be suitable to provide indicative values, but a probabilistic approach (which is not required under the SPP2.6 guidelines) would provide an improved understanding of changing risks of erosion and inundation over time.

Ideally the hazard lines and cost benefit analysis would use a probabilistic approach to identify climate change impacts and predicting the damage to the study area. This involves assigning probabilities of impacts to the assets at risk in the study area.

Figure 4 shows the application of a probabilistic approach to individual properties, which Marsden Jacob has previously used for Warilla beach. Each line represents an individual property and the table

on left shows the probability of impact under a range of storm impacts for 2016 – benign weather on the left side of the table and extreme storms on the right side of the table.

The table on the right shows the same property under a range of weather events for 2066.

Figure 4: Probabilistic analysis from Warilla beach coastal hazard assessment

2016		Probability of % of land area impacted: 2016											
Piled = 1	0%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	4%	0.9%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	4%	23.6%	46%	79%	97%	99%	99%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	0%	0%	12%	29%	60%	81%	99%	99%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	0%	0%	5%	19%	42%	62%	99%	100%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	8%	28%	43%	86%	100%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%	29%	68%	100%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	17%	48%	94%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	34%	75%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	22%	55%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	36%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	13%	35%	62%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	16%	49%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	100%	100%	100%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%	51%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%	45%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	34%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	16%	31%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	15%	28%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	16%	28%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	17%	29%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	5%	18%	29%
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100	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	9%	22%	34%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	23%	35%
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100	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	13%	26%	38%
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100	0%	0%	0%	0%	0%	0%	0%	0%	2%	12%	17%	32%	45%
100	0%	0%	0%	0%	0%	0%	0%	0%	3%	14%	20%	35%	49%
100	0%	0%	0%	0%	0%	0%	0%	0%	5%	16%	22%	39%	54%
1	0%	0%	0%	0%	0%	0%	0%	0%	6%	19%	25%	43%	63%
100	0%	0%	0%	0%	0%	0%	0%	0%	7%	20%	27%	47%	74%
100	0%	0%	0%	0%	0%	0%	0%	0%	8%	24%	32%	55%	92%
100	0%	0%	0%	0%	0%	0%	0%	0%	8%	25%	33%	61%	99%
100	0%	0%	0%	0%	0%	0%	0%	0%	8%	26%	35%	67%	100%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	0%	0%	0%	13%	30%	39%	75%	100%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	5%	17%	34%	45%	82%	100%
1	0%	0%	0%	0%	0%	0%	0%	11%	23%	41%	53%	90%	99%
100	0%	0%	0%	0%	0%	0%	4%	16%	28%	45%	60%	97%	99%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	0%	2%	9%	21%	33%	52%	68%	99%	99%
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	0%	0%	0%	0%	2%	6%	14%	25%	37%	58%	74%	99%	99%

2066Piled =		Probability of % of land area impacted: 2066											
Piled = 1	0%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	4%	0.9%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
1	0%	32%	54%	65%	75%	86%	97%	#####	100%	100%	100%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	13%	44%	95%
1	0%	23%	43%	53%	63%	73%	83%	93%	100%	100%	100%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	28%	77%
1	0%	14%	33%	42%	52%	61%	71%	80%	90%	100%	100%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	12%	58%
1	0%	3%	21%	30%	39%	48%	58%	67%	76%	92%	100%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	41%
1	0%	0%	10%	19%	28%	37%	46%	55%	64%	79%	94%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	26%
1	0%	0%	1%	8%	16%	25%	34%	43%	52%	67%	82%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	12%
1	0%	0%	0%	0%	6%	14%	23%	32%	41%	55%	70%	93%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
1	0%	0%	0%	0%	0%	3%	12%	20%	29%	43%	57%	80%	100%
1	0%	0%	0%	0%	0%	0%	2%	8%	17%	31%	45%	68%	100%
76	0%	0%	0%	6%	13%	20%	27%	34%	41%	53%	64%	83%	100%
1	0%	0%	0%	0%	0%	0%	5%	14%	23%	38%	53%	77%	100%
1	0%	0%	0%	0%	0%	9%	91%	100%	100%	100%	100%	100%	100%
1	0%	0%	0%	0%	0%	0%	8%	17%	26%	40%	54%	77%	100%
1	0%	0%	0%	0%	0%	1%	9%	17%	25%	38%	52%	73%	100%
1	0%	0%	0%	0%	0%	3%	9%	15%	22%	33%	43%	61%	89%
1	0%	0%	0%	0%	0%	4%	9%	15%	20%	29%	38%	53%	76%
1	0%	0%	0%	0%	1%	5%	10%	14%	19%	27%	34%	47%	67%
1	0%	0%	0%	0%	2%	7%	11%	15%	19%	26%	34%	45%	64%
1	0%	0%	0%	0%	4%	8%	12%	17%	21%	28%	35%	46%	64%
1	0%	0%	0%	1%	5%	9%	13%	17%	21%	28%	35%	45%	63%
1	0%	0%	0%	3%	7%	11%	16%	20%	24%	31%	38%	49%	66%
1	0%	0%	0%	5%	9%	13%	17%	21%	26%	33%	39%	51%	68%
4	0%	0%	2%	6%	10%	14%	18%	22%	27%	33%	40%	52%	70%
1	0%	0%	3%	8%	12%	16%	21%	25%	29%	36%	43%	55%	73%
1	0%	0%	5%	9%	13%	17%	21%	26%	30%	37%	44%	55%	74%
1	0%	0%	6%	11%	15%	19%	24%	28%	33%	40%	47%	59%	77%
1	0%	0%	8%	13%	17%	22%	26%	31%	36%	43%	51%	63%	83%
1	0%	0%	10%	15%	20%	25%	29%	34%	39%	47%	56%	69%	90%
1	0%	1%	12%	17%	22%	27%	33%	38%	43%	52%	61%	75%	97%
1	0%	2%	14%	19%	25%	31%	37%	42%	48%	58%	67%	82%	100%
1	0%	3%	15%	21%	27%	33%	40%	46%	52%	62%	73%	90%	100%
5	0%	3%	18%	25%	32%	39%	46%	53%	60%	72%	84%	100%	100%
76	0%	3%	18%	26%	33%	41%	48%	56%	63%	75%	88%	100%	100%
76	0%	3%	19%	27%	35%	43%	50%	58%	66%	79%	92%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	0%	8%	24%	32%	40%	48%	55%	63%	71%	84%	98%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%
1	0%	13%	29%	37%	45%	53%	60%	68%	76%	90%	100%	100%	100%
1	0%	20%	35%	43%	51%	59%	67%	74%	82%	95%	100%	100%	100%
1	0%	25%	40%	48%	56%	64%	71%	79%	87%	100%	100%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	34%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	24%
1	0%	30%	46%	54%	61%	69%	77%	84%	92%	100%	100%	100%	100%
76	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	15%
1	0%	35%	50%	58%	66%	73%	81%	89%	97%	100%	100%	100%	100%

Source: Adapted from Marsden Jacob (2020)

While we advocate for the use of probabilistic analysis, we note that this approach is not recommended in SPP 2.6 and care must be taken when using this approach. The following points need to be considered when undertaking this:

- Probabilities rely on the knowledge of climate scenarios as well as hydrologic and geological data
- probabilities are not constant over time (with different impacts and different likelihood of occurrences)
- over time properties may be redeveloped with new foundation considerations
- the potential for "edge effects" and other impacts that are difficult to model.

For the reasons outlined above, it is important to place a certain caution when attempting to assign probabilities of potential impacts to assets.

3.3 Beach amenity is a dynamic consideration

The CBA compares each option against the base case – which is considered to be a 'Do Nothing' option – where no action has been taken to protect the coastal assets from erosion or inundation.

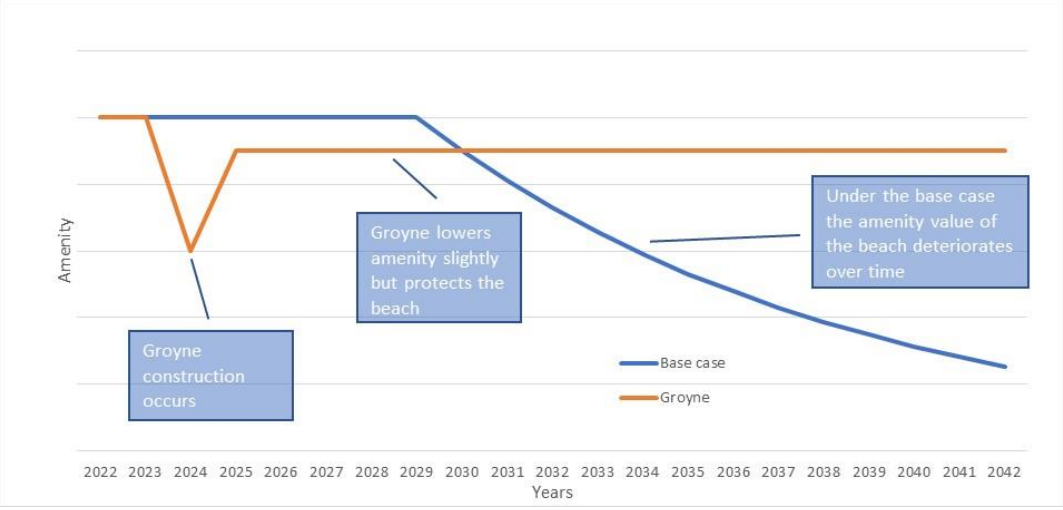
Since the Do Nothing option does not immediately impact the beach amenity (in terms of visual amenity and use of the area), it may be perceived as a more attractive option by the public in the short term. However, in the long term this scenario will inevitably lead to coastal erosion or inundation.

Some actions to protect (such as the installation of groynes) may reduce the amenity of certain coastal assets, such as beaches, below the base case in the short term - but will protect the beach and so improve the amenity, in the longer term.

Because the exact timing of the improvement of the amenity can be hard to pinpoint and quantify, there is a degree of uncertainty as to the occurrence of benefits and their value. However, it is known that protection measures (such as the installation of groynes) may end up providing benefits over a case where there is no action done to protect coastal assets. These points are illustrated graphically in Figure 5, below. It is important to note that amenity is strongly linked to perception. Some beach users may dislike groynes and feel they reduce the beaty of the beach. However, other users may see that the groynes are beneficial, as they will protect the beach in the longer term.

In the figure the amenity of the beach dips when the groyne is constructed (orange line) and the amenity of the beach with groynes may be initially lower than the base case (giving a net cost to the treatment). However, it is expected that the beach would deteriorate under the base case and so the amenity of the beach with a groyne will be greater than it would be under the base case (giving a net benefit to the treatment).

Figure 5: Illustration of the impact of groynes on beach amenity



Source: Marsden Jacob analysis

Currently the CBA assumes there is not any loss of amenity in the short term – but does consider the benefits that are expected to arise in the longer term.

4. Benefit Distribution Analysis

4.1 BDA for Peppermint Grove beach and Capel Coast (MU1 & MU2)

BDA for this MU is only considered for benefits that arise from inundation protection. Residential properties are predicted to be impacted by floods or inundation by 2120 and many unacceptably close by 2050. In 2120, the land depression behind the area will be under constant risk of inundation. The majority of residential properties are not predicted to be affected by inundation. The existing sand dune acts as a natural barrier for coastal inundation. The inundation model assumes ocean water enters the land depression through Capel River and culvert openings, rather than by breaching of the dunes along the open coast.

At Capel Coast, most of the assets at risk of erosion are environmental and undeveloped foreshore. Agricultural / rural lots are predicted to be impacted by both erosion and inundation.[5] The area of inundation extends across the land depression adjacent to Capel River. In the north of the management unit, inundation is minimal. The dominant land use of rural / agricultural and regional open space is reflected in the assets-at-risk totals.

- MU 1 and 2 - PR6 - Levies along the banks of the Capel River to minimise inundation. This option shall also consider inundation protection at Higgins Cut and the mouth of the Minninup Drain outlet near Tatton Place in Stratham .

Key features of this option for Peppermint Grove beach are:

- To address inundation of Stirling Wetland.
  - Assumes two levies either side of river, each 2km long.
  - 2035 implementation.
  - Less volume per day, as likely to be slower than beach nourishment.
  - Higher contingency (50%) to cover any treatment, revegetation, local drainage challenges.

Key feature of this option for Capel Coast are:

- Levies to address inundation of Stirling Wetland.
  - Assumes new culverts with one-way valves installed at Higgins Cut with some associated earthworks.
  - Higher contingency than usual (50%) to cover any treatment, revegetation, local drainage challenges.
  - 2035 implementation.
- To address inundation at the Minninup Drain outlet near Tatton Place in Stratham , north of

[5] Water Technology's vulnerability analysis identified 55 agricultural/rural parcels are expected to have an unacceptable vulnerability at 2120

Peppermint Grove beach, from flowing to connect with Stirling Wetlands:

- Assumes levy at 300m long.
- Assume 2035 implementation.
- Less volume per day as likely to be slower than beach nourishment.
- Higher contingency than usual (50%) to cover any treatment, revegetation, local drainage challenges.

As discussed in Section 2.3, the CBA identified nine categories of assets (roads, residential etc) that may be protected by coastal interventions. The value of the damage that would arise from inundation or erosion is also drawn from Table 2, in that section.

Table 4 outlines the assets that are at risk from inundation in the identified Management Units.[6] An important point to note here is that the values are not cumulative. In this instance all the assets identified would be protected under the proposed coastal intervention. The avoided damage represents the benefits of the intervention.

Table 4: Assets at risk from inundation in MU1 and MU2

Assets at risk	2020	2035	2050	2120
Roads (km)	24.6	1.3	1.3	12
Residential (parcels)	6	0	0	27
Commercial (parcels)	2	0	0	0
Public and Community (parcels)	8	0	1	4
Foreshore - Developed (ha)	0	0	0	0
Foreshore - Undeveloped (ha)	6	0.3	0.3	2.1
Environmental (item)	537	5	14	72
Agricultural / Rural (parcels)	262	2	2	11
Aboriginal Heritage (item)	7	0	0	0

Table 5 sets out the value of the avoided damage (i.e., the benefit) of each asset type over the 100-year assessment period.

[6] These align with the Hazard Chapter Report describes assets at risk and the associated mapping.

Table 5: Total benefits of the option over the base case combined for MU1 and MU2

Assets	2020	2035	2050	2120	Total
Roads	$1,230,000	$23,559	$8,539	$691	$1,262,789
Residential	$600,000	$0	$0	$3,112	$603,112
Commercial	$150,000	$0	$0	$0	$150,000
Public and Community	$600,000	$0	$9,853	$346	$610,198
Foreshore - Developed	$0	$0	$0	$0	$0
Foreshore - Undeveloped	$12,000	$217	$79	$5	$12,301
Environmental	$13,425,000	$45,306	$45,978	$2,074	$13,518,359
Agricultural / Rural	$982,500	$2,718	$985	$48	$986,251
Aboriginal Heritage	$2,800,000	$0	$0	$0	$2,800,000
Total	**$19,799,500**	**$71,801**	**$65,434**	**$6,276**	**$19,943,010**

Analysis of Table 4 indicates that 99% of the benefit arises from areas that are protected in 2020 – so are already under threat.

The present value cost of interventions is **$2,536,034**. This value is based on the capital expenditure expected to arise in 2035 and the operating and maintenance costs that would occur from 2035 to 2120. It should be noted that while we show this value to the nearest dollar the cost estimates are based on concept design estimate so should be considered to have ± 50% margin.

The allocation of the present value cost of the intervention to each beneficiary is set out in Table 6.

Table 6: BDA for MU1 and MU2

Assets	Percentage of total benefits	Benefits (A$)
Roads	6%	$163,542
Residential	3%	$78,108
Commercial	1%	$19,426
Public and Community	3%	$79,026
Foreshore – Developed	0%	$0
Foreshore – Undeveloped	0%	$1,593
Environmental	68%	$1,750,742
Agricultural / Rural	5%	$127,728
Aboriginal Heritage	14%	$362,624

Source: Marsden Jacob analysis

4.1.1 Private beneficiaries

Private benefits arise for owners of Residential, Commercial and Agricultural / Rural properties. As shown in Table 4, the vast majority of the benefits arise from work done to protect properties that are impacted in 2020.

Also, to note is that there are a high number of agricultural properties are impacted in 2020 compared to later years, and for residential properties there is an extreme delay before further parcels are impacted – as shown in Table 7.

Table 7: Assets benefitting from proposed works (total number of properties for each timeframe) (MUs 1 and 2)

Assets at risk	2020	2035	2050	2120
Residential (parcels)	6	0	0	27
Commercial (parcels)	2	0	0	0
Agricultural / Rural (parcels)	262	2	2	11

Source: Marsden Jacob analysis

Note: Values are not cumulative

For the private properties impacted, the total funds to be collected per property are set out in Table 8.

The table should be interpreted in the following way.

- For the properties under threat in 2020, it is expected that works will commence as soon as possible, with the government allocating funds for the project immediately.
- The beneficiaries of the proposed works will then pay off the annuity for a period of 15 years starting from 2020. It can be seen that the six residential properties that would benefit from the 2020 works would be required to contribute an annual levy of $1,396 for a period of 15 years. In contrast the two commercial properties that would benefit from the 2020 works would be required to contribute an annual levy of $1,047 and rural properties would contribute $52 per year for 15 years. The differing contributions reflect the different benefits that each property is expected to gain from the planned works.
- For properties affected later in the timeframe i.e., 2035, 2050 and 2120, the beneficiaries could be charged the shown annuity from 2020 to a period of 15 years. It can be seen that no residential or commercial properties are expected to benefit from the 2035 or 2050 works but the two rural parcels benefiting from the 2035 works would be required to contribute an annual levy of $19 (for a period of 15 years).
- For works predicted to occur in 2050 or these funds could then be collected now, or the collection of funds could be delayed set aside for works to be done at a larger stage.
- Alternatively, the beneficiaries could be charged these at a later stage. However, the quantity to be charged may then change.

The funding mechanism is explained in detail in Section 2.5. The funds could be collected as a single lump sum, or as an annual payment (we have assumed 15 years).

Table 8: Annual funds to be collected per property that is saved for a period of 15 years

	2020	2035	2050	2120
Residential (parcels)	$1,396	-	-	$2
Commercial (parcels)	$1,047	-	-	-
Agricultural / Rural (parcels)	$52	$19	$7	$1

Source: Marsden Jacob analysis

Note: Annuity is calculated using 7% discount rate and values are rounded.

4.1.2 Local community beneficiaries

As set out in Table 3, the local community are likely to be a significant beneficiary of the following land uses:

- Public and Community land
- Foreshore - Developed
- Foreshore - Undeveloped

While these areas may be used by a mix of local community and the broader community (such as those travelling to or past the area) – the broader community would have a wide range of substitute locations they could use. Therefore, they would be expected to have a relatively low willingness to pay- to protect an area.

If all the funds are to be collected from the local community, then the total budget would be a relatively modest $80,000 as set out in Table 9. If these funds were collected as an annuity (such as from rates) then the annual impact for 15 years would be $8,852 per year for the whole Shire. Given that the Shire of Capel has forecast rates for 2023 of 14.2 million[7] the annual impost of less than $9,000 would require a negligible increase in rates for the local community.

Table 9: Local community assets (MUs 1 and 2)

Assets	Total funds to be collected	Annuity (15 years)
Public and Community	$79,026	$8,677
Foreshore - Undeveloped	$1,593	$175
Total	**$80,619**	**$8,852**

Source: Marsden Jacob analysis

Note: As shown in Table 6, Foreshore – Developed has no benefits attached and therefore is not included in this table and the values are rounded.

[7] https://shireofcapel.sharepoint.com/:b:/s/website/EbF-dXdA6hRIroymace3jGQBYaSWg0WfVeHdNTJSzZBbXw?e=BRLvj6 see Attachment 15.4.1 Financial Report 2208

4.1.3 Broader community beneficiaries

As set out in Section 2.3, some assets are likely to have a significant non-use value arising from existence, altruism or bequest values. These are particularly strong for environmental and heritage items. Similarly, the road network is likely to have a mix of use values (to the local community) and option values (to the broader community).

Based on the benefit distribution, the total contribution from the broader WA community would be $2.277 million dollars – as shown in Table 10. This adds up to 88% of the total funds required for the intervention.

Table 10: Broader community assets (MUs 1 and 2)

Assets	Total funds to be collected	Annuity (15 years)
Roads	$163,542	$17,956
Environmental	$1,750,742	$192,222
Aboriginal Heritage	$362,624	$39,814
Total	**$2,276,908**	**$249,992**

Source: Marsden Jacob analysis

Note: Annuity is calculated using 7% discount rate and values are rounded.

4.2 BDA for Dalyellup (MU3)

The main risk for this area is erosion, with residential and environmental categories the most affected. Inundation, however, is not a high risk. Although this option has not scored positively in the CBA, its analysis in the BDA will still be valuable and provide further information about the selection of adaptation options.

MU3 – PR2 – Groynes to protect Dalyellup, the old landfill site and wastewater treatment plant to the north from erosion.

Key features for this option are as follows:

- Assumes 6 rock groynes 100 m long.
- 2035 implementation.

Table 11 outlines the assets at risk from erosion in the identified MU. It is important to note that the values are not cumulative.

Table 11: Assets at risk from erosion in MU3

Assets at risk	2020	2035	2050	2120
Roads (km)	0	0	0	0
Residential (parcels)	0	4	0	60
Commercial (parcels)	0	1	0	0
Public and Community (parcels)	0	3	0	0
Foreshore - Developed (ha)	0	0	0.1	0.5
Foreshore - Undeveloped (ha)	0.2	0.6	0.5	1.7
Environmental (item)	22	3	1	21
Agricultural / Rural (parcels)	0	0	0	0
Aboriginal Heritage (item)	0	0	0	0

Note: Values are not cumulative

Table 12 sets out the value of the avoided damage (i.e., the benefit) of each asset type over the 100-year assessment period.

Table 12: Total benefits of the option over the base case for MU3

Assets	2020	2035	2050	2120	Total
Roads	$0	$0	$0	$0	$0
Residential	$0	$724,892	$0	$34,574	$759,466
Commercial	$0	$135,917	$0	$0	$135,917
Public and Community	$0	$407,752	$0	$0	$407,752
Foreshore - Developed	$0	$0	$41,052	$1,801	$42,853
Foreshore - Undeveloped	$500,000	$543,669	$164,209	$4,898	$1,212,776
Environmental	$4,250,000	$271,835	$32,842	$6,050	$4,560,727
Agricultural / Rural	$0	$0	$0	$0	$0
Aboriginal Heritage	$0	$0	$0	$0	$0
Total	**$4,750,000**	**$2,084,065**	**$238,103**	**$47,322**	**$7,119,490**

The present value of interventions is **$11,136,564**. This value is based on the capital expenditure expected to arise in 2035 and the operating and maintenance costs that would occur from 2035 to 2120.

As noted in the CBA produced by Water Technology, this option does not deliver a net benefit and so is unlikely to be progressed.

It should be noted that while we show this value to the nearest dollar the cost estimates are based on concept design estimate so should be considered to have ± 50% margin.

The allocation of the present value cost of the intervention to each of the beneficiaries is set out in Table 13.

Table 13: BDA for MU3

Assets	Percentage of total benefits	Benefits (A$)
Roads	0%	$0
Residential	11%	$759,466
Commercial	2%	$135,917
Public and Community	6%	$407,752
Foreshore - Developed	1%	$42,853
Foreshore - Undeveloped	17%	$1,212,776
Environmental	64%	$4,560,727
Agricultural / Rural	0%	$0
Aboriginal Heritage	0%	$0

Source: Marsden Jacob analysis

4.2.1 Private beneficiaries

Private benefits arise for owners of Residential, Commercial and Agricultural / Rural properties. As shown in Table 14, 60 residential parcels are projected to be impacted in the year 2120.

Table 14: Assets at benefitting from proposed action (total number of properties for each timeframe) (MU3)

Assets at risk	2020	2035	2050	2120
Residential (parcels)	0	4	0	60
Commercial (parcels)	0	1	0	0
Agricultural / Rural (parcels)	0	0	0	0

Source: Marsden Jacob analysis

Note: Values are not cumulative

For the private properties impacted, the total funds to be collected per property are set out in Table 15. The funding mechanism is explained in detail in Section 2.5. This could be collected as a single

lump sum, or as an annual payment (we have assumed 15 years) – as a special levy attached to Local Government rates.

Table 15: Total funds to be collected per property saved for a period of 15 years

	2020	2035	2050	2120
Residential (parcels)	-	$31,124	-	$99
Commercial (parcels)	-	$23,343	-	-
Agricultural / Rural (parcels)	-	-	-	-

Source: Marsden Jacob analysis

Note: Agricultural parcels are not impacted and hence, are not included in the table. Annuity is calculated using 7% discount rate and values are rounded.

4.2.2 Local community beneficiaries

As set out in Table 3, the local community are likely to be a significant beneficiary of the following land uses:

- Public and Community land
- Foreshore - Developed
- Foreshore - Undeveloped

While these areas may be used by a mix of local community and the broader community (such as those travelling to or past the area) – the broader community would have a wide range of substitute locations they could use. Therefore, they would be expected to have a relatively low willingness to pay- to protect an area.

If all the funds are to be collected from the local community, then the total budget would be around $2.6 million as set out in Table 16. If these funds were collected as an annuity (such as from rates) then the annual impact for 15 years would be $290,124 for the whole Shire. Given that the Shire of Capel has forecast rates for 2023 of 14.2 million[8] the annual impost of around $300,000 would require a considerable increase in rates for the local community.

[8] https://shireofcapel.sharepoint.com/:b:/s/website/EbF-dXdA6hRIroymace3jGQBYaSWg0WfVeHdNTJSzZBbXw?e=BRLvj6 see Attachment 15.4.1 Financial Report 2208

Table 16: Local community assets (MU3)

Assets	Total funds to be collected	Annuity (15 years)
Public and Community	$647,749	$71,119
Foreshore - Undeveloped	$68,076	$7,474
Foreshore – Developed	$1,926,599	$211,530
Total	**$2,642,423**	**$290,124**

Source: Marsden Jacob analysis

Note: Annuity is calculated using a discount rate of 7% and the values are rounded.

4.2.3 Broader community beneficiaries

As set out in Section 2.2, some assets are likely to have a significant non-use value arising from existence, altruism or bequest values. These are particularly strong for environmental and heritage items. Similarly, the road network is likely to have a mix of use values (to the local community) and option values (to the broader community).

Based on the benefit distribution, the total contribution from the broader WA community would be around $7.2 million – as shown in Table 17. This adds up to 64% of the total funds required for the intervention.

Table 17: Broader community assets (MU 3)

Assets	Total funds to be collected	Annuity (15 years)
Environmental	$7,245,106	$795,473.73

Source: Marsden Jacob analysis

Note: As noted in Table 13, Aboriginal heritage and roads have no benefits attached and are not included in the table. Annuity is calculated using 7% discount rate and values are rounded.

4.3 BDA for Bunbury (MU5)

For this Management Unit (which includes Bunbury back beach and Koombana bay), erosion is a significant risk from the present day to both built and natural assets along the western coast of the City of Bunbury. Inundation is a significant risk across much of this MU. The inundation risk is predicted to increase from present day to 2120. By 2120, the 1-year ARI is predicted to inundate a significant residential commercial area. Environmental, public and community assets are also predicted to be significantly impacted by inundation.

MU5 – PR 2 – Groynes to protect Bunbury from coastal erosion.

Key features of this option are as follows:

- Implementation in 2020.
- Assumes 15 rock groynes 100 m long, 400 m apart.

- 13 groynes on ocean coast and 2 in Koombana bay.

Table 18 outlines the assets that are at risk from erosion in the identified MU. It is important to note that the values shown are not cumulative.

Table 18: Assets at risk from erosion in MU5

Assets at risk	2020	2035	2050	2120
Roads (km)	9.7	3.7	3.5	10.5
Residential (parcels)	0	4	29	234
Commercial (parcels)	3	0	1	4
Public and Community (parcels)	5	0	9	36
Foreshore - Developed (ha)	20	2.7	1.9	1.6
Foreshore - Undeveloped (ha)	9.8	0.7	0.4	2.5
Environmental (item)	60	8	6	67
Agricultural / Rural (parcels)	0	0	0	0
Aboriginal Heritage (item)	0	0	0	1

Note: Values are not cumulative.

Table 19 sets out the value of the avoided damage (i.e., the benefit) of each asset type over the 100-year assessment period.

Table 19 Total benefits of the option over the base case for MU5.

Assets	2020	2035	2050	2120	Total
Roads	$29,100,000	$4,023,151	$1,379,355	$36,302	**$34,538,808**
Residential	$0	$724,892	$1,904,823	$134,837	**$2,764,552**
Commercial	$1,125,000	$0	$49,263	$1,729	**$1,175,991**
Public and Community	$1,875,000	$0	$443,364	$15,558	**$2,333,922**
Foreshore - Developed	$62,500,000	$3,058,138	$779,992	$5,762	**$66,343,893**
Foreshore - Undeveloped	$24,500,000	$634,281	$131,367	$7,203	**$25,272,850**
Environmental	$15,000,000	$724,892	$197,051	$19,304	**$15,941,246**
Agricultural / Rural	$0	$0	$0	$0	**$0**
Aboriginal Heritage	$0	$0	$0	$2,305	**$2,305**
Total	**$134,100,000**	**$9,165,354**	**$4,885,215**	**$222,999**	**$148,373,568**

The present value of interventions is **$72,027,835.**

Table 20: BDA for MU5

Assets	Percentage of total benefits	Benefits (A$)
Roads	23%	**$34,538,808**
Residential	2%	**$2,764,552**
Commercial	1%	**$1,175,991**
Public and Community	2%	**$2,333,922**
Foreshore - Developed	45%	**$66,343,893**
Foreshore - Undeveloped	17%	**$25,272,850**
Environmental	11%	**$15,941,246**
Agricultural / Rural	0%	**$0**
Aboriginal Heritage	0%	**$2,305**

4.3.1 Private beneficiaries

Private benefits arise for owners of Residential, Commercial and Agricultural / Rural properties. As shown in Table 21, the number of properties expected to benefit from the groynes is lower than the total number of properties at risk. This is because groynes offer protection from erosion and not inundation. The annual funds to be collected per property saved are set out in Table 22.

Table 21: Assets benefitting from the proposed works (total number of properties for each timeframe) (MU5)

Assets at risk	2020	2035	2050	2120
Residential (parcels)	0	4	29	234
Commercial (parcels)	3	0	1	4

Note: Agricultural parcels are not impacted and hence, are not included in the table. Values are not cumulative

Table 22: Funds to be collected per property saved for a period of 15 years

	2020	2035	2050	2120
Residential (parcels)	-	$9,659	$3,501	$31
Commercial (parcels)	$19,987	-	$2,626	$23

Source: Marsden Jacob analysis

Note: Agricultural parcels are not impacted and hence, are not included in the table. Annuity is calculated using 7% discount rate and values are rounded.

4.3.2 Local community beneficiaries

As set out in Table 3, the local community are likely to be a significant beneficiary of the following land uses:

- Public and Community land
- Foreshore - Developed
- Foreshore - Undeveloped

While these areas may be used by a mix of local community and the broader community (such as those travelling to or past the area) – the broader community would have a wide range of substitute locations they could use. Therefore, they would be expected to have a relatively low willingness to pay – to protect an area.

Table 23: Local community assets (MU5)

Assets	Total funds to be collected	Annuity (15 years)
Public and Community	$1,133,001	$124,397
Foreshore - Undeveloped	$32,206,592	$3,536,111
Foreshore – Developed	$12,268,686	$1,347,036
Total	**$45,608,279**	**$5,007,544**

Source: Marsden Jacob analysis

Note: Annuity is calculated using a discount rate of 7% and the values are rounded.

If all the funds are to be collected from the local community, then the total budget would be around $45.6 million as set out in Table 23. The local community's contribution adds up to 63% of the total funds required for the intervention.

4.3.3 Broader community beneficiaries

As set out in Section 2.2, some assets are likely to have a significant non-use value arising from existence, altruism or bequest values. These are particularly strong for environmental and heritage items. Similarly, the road network is likely to have a mix of use values (to the local community) and option values (to the broader community).

Based on the benefit distribution, the total contribution from the broader WA community would be $24.5 million dollars – as shown in Table 24. This adds up to 35% of the total funds required for the intervention.

Table 24: Broader community assets (MU 5)

Assets	Total funds to be collected	Annuity (15 years)
Roads	$16,766,838	$1,840,909
Environmental	$7,738,666	$849,664
Aboriginal Heritage	$1,119	$123
Total	**$24,506,622**	**$2,690,695**

Source: Marsden Jacob analysis

Note: Annuity is calculated using 7% discount rate and values are rounded.

5. Funding assessment

5.1 Funding models that would support development of the preferred management option(s)

Any suitable option chosen to mitigate the identified risks will not proceed further until satisfactory funding arrangements have been identified. Traditionally BDAs comprise of the following steps for funding assessments:

1. Step 1 – Current status of council resources for coastal management actions.
2. Step 2 – Are there any potential opportunities to align actions and leverage funding from neighbouring local, state or Commonwealth programs?
3. Steps 3 – Are there any relevant grant programs that could provide funding?
4. Step 4 – Potential for voluntary contributions from interested parties.
5. Step 5 – Considering the previous steps, what mechanisms could be used to equitable secure contributions?

There are three funding model options: **Impactor, Beneficiary, and Taxpayer**.

Traditionally, the preferred funding model for the proposed works identified will be a combination of **beneficiary pays and grant funding** from the state and Commonwealth government programs.

The preferred funding model for this project would also be a combination of beneficiary pays and grant funding. The funding sources and options are detailed in the following section.

5.2 Funding options and sources

The following groups are the three potential sources for funding for the identified options.

- Beneficiaries
- Grant funding
- Special rate mechanism

However, to identify the ability and capacity of beneficiaries to pay for the proposed works, a number of key things need to be taken into consideration.

- **Willingness to pay for the costs** - Since costs associated with the works are high, there may be reluctance amongst the beneficiaries to either pay upfront for the costs or bear high ongoing costs for a number of years. Thus, extensive consultation needs to be done to ascertain willingness, capacity and ability to pay.
- **Apportioning the environmental benefits to relevant groups** - There are large environmental benefits associated with the proposed works. Significant care must be taken to ensure these benefits are

apportioned accurately to relevant groups so that they can pay for these benefits.

5.3 Councils' statutory ability to levy fees and charges under relevant state government legislation

As noted in Section 2.5, we identified three broad beneficiary groups that are likely

- Private property owners (residential, commercial or agricultural)
- WA State government (representing the broader WA community) and
- Local community

The following table details on beneficiaries, funding source and possible collection methods.

Table 25: Funding sources and collection methods.

Assets	Funding source	Collection method
Roads	WA Taxpayers	State Government grant
Residential	Property owners	Special levy on relevant properties - collected through rates
Commercial	Property owners	Special levy on relevant properties - collected through rates
Public and Community	Indirect users	Added to all rate payers
Foreshore - Developed	Direst users	Added to all rate payers
Foreshore - Undeveloped	Rate payers	Added to all rate payers
Environmental	WA Taxpayers	State Government grant
Agricultural / Rural	Property owners	Special levy on relevant properties - collected through rates
Aboriginal Heritage	WA Taxpayers	State Government grant

In Western Australia the power for Local Governments to collect rates is set out in the *Local Government Act, 1995*.[9] In particular Division 6 sets out types and conditions for rates and charges. In addition to the basic powers to set and collect rates outlined in section 6.32, relevant sections include:

- 6.33 (Differential general rates),
- 6.36 (Local government to give notice of certain rates) and
- 6.37 (Specified area rates)
- 6.38 (Service charges)

[9] www.legislation.wa.gov.au/legislation/statutes.nsf/law_a465.html Se

As noted above, Local Government have the power to collect specified area rates – which could be applied to areas that would benefit from climate adaptation projects.

5.4 Capacity of beneficiaries to pay apportioned costs

5.4.1 Private beneficiaries

As set out above it appears that the funds from private beneficiaries could be collected by the local government through the rates process (such as specified areas rates).

A review of the annuity funding required for each of the management areas (as set out in sections 4.1.1, 4.2.1, and 4.3.1) indicates a wide range of annuity fees are required.

The largest funds required are related to erosion benefits that would arise in 2020 or in 2035.

While these beneficiaries are contributing to projects that would save their property (estimated to be worth $500,000 for residential land), contributing an annuity of $31,000 (for MU3) may not be affordable for some beneficiaries.

5.4.2 Local Government beneficiaries

As set out in sections 2 and 4, it is proposed that local community benefits (which are not private benefits) would be funded through Local Government rates – which would be applied to the whole Local Government Area.[10]

MU 1, 2 and MU 3 are within the Shire of Capel, while MU5 is within the City of Bunbury. Table 26, sets out the funds to be collected for each project on an annuity basis (over 15 years at 7% discount rate), and compares this to the total expected rates for the current year.

The analysis shows that the proposed works for MU 1& 2 as well as MU3 are likely to be able to be added to the rate base – without significant difficulty to the council or rate payers. However, the proposed actions at MU5 (in the City of Bunbury) appear likely to cause some difficulty (to use more than 10% of current rates would not be feasible without a potential increased rate charge) and so may need to consider a longer fund collection period or alternative funding mechanism.

[10] We have assumed that grant funding would be available to support local government benefits.

Table 26: Comparison of required funds to LGA rate base

Management area	LGA	Annuity funds to be collected from local community	Total expected rates for 2022/23	Percentage of annual rates
MU1 & 2	Shire of Capel	$8,691	$14,179,504	0.06%
MU3	Shire of Capel	$285,677	$14,179,504	2.01%
MU5	City of Bunbury	$5,007,544	$42,800,000	11.70%

Source: *Capel Budget https://www.capel.wa.gov.au/about/council/meetings/agenda-minutes/*

Bunbury budget: https://cdn.bunbury.wa.gov.au/wp-content/uploads/2022/08/Budget-and-rates-2022-23.pdf

5.4.3 Broader community beneficiaries

As set out in sections 2 and 4, it is proposed that broader community benefits would be funded by a State Government grant. The quantity of funds sought for these projects appears well within the WA Government's capacity to pay. However, over time the WA Government may wish to create a fund – so that similar projects are compared and those delivering the highest benefits are given priority for funding. This is because many of WA's coastal settlements will have similar erosion/inundation issues over next 100 years. For this reason, State Government funds may need to be focussed on the highest priority areas rather than have each Local Government approach the State and their funding request be considered in isolation.

5.4.4 Further consultation

As set out above a number of the indicative funds required appear to be relatively small compared to the value delivered and the overall cost.

However, the proposed interventions for MU3 do pass significant costs (e.g. $31,000 as shown in section 4.2.1 on to a small number of private beneficiaries. The costs are well below the value of the benefit delivered, but may not be within the capacity of the property owners to pay.

In these instances, further consultation may be necessary to establish a suitable approach to apportioning and collecting these funds.

6. Recommended next steps

6.1 Background – design phases for large projects

Projects of this kind have a high level of uncertainty arising from:

- Difficulty in predicting erosion and inundation climate impacts
- Difficulty in predicting the effectiveness of engineering interventions
- Difficulty in costing engineering interventions given the relatively small level of industry expertise and the unique nature of each location and intervention.

The development of large or uncertain engineering projects are often subject to a "gateway process" – whereby the engineering design and costings are iteratively refined, and the viability of the project is reviewed after each design phase.

Standard engineering design stages are concept design, preliminary design, functional design, and detailed design.

Table 27: Order of magnitude design

Design stage	Cost error margins
Concept design	Indicative
Preliminary design	± 50%
Functional design	± 30%
Detailed design	± 10%

6.2 Benefit distribution analysis

The benefits and the distribution analysis provided here form a starting point toward the development of the coastal protection works in the identified areas in the Capel-Bunbury region. The recommended next steps for the coastal protection of the region are as follows:

- A preliminary design and costing of the proposed works analysed as part of the CBA.
- A detailed CBA and BDA, based on the inputs from the preliminary design as well as analysis of the full range of uses of environmental assets and refined value estimation.
- A feasibility analysis of the proposed design.

6.3 Recommendations

Based on the analysis set out in this report we recommend that:

1. the recommended options are progressed to a further level of design and costing (e.g., move towards Functional design)
2. the benefit values used in the CBA and the allocation of benefits to stakeholder groups should be tested for this location and these assets through specialised surveys of users (such as contingent valuation or choice modelling surveys) and analysis of asset use.
3. the funding approach in the BDA is consulted upon with stakeholders
4. the CBA and BDA should be revised and expanded to reflect updated costings, improved knowledge of risks (e.g., Probabilistic approach to identifying hazard lines and impacts) and the full range of benefits

References

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