MARSDEN JACOB ASSOCIATES

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Princess Royal Harbour Coastal Protection Options – Revised Report

Benefit Distribution Analysis

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A Marsden Jacob Report

Prepared for the City of Albany

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Acronyms and abbreviations

CoA	City of Albany
CBA	Cost-Benefit Analysis
BDA	Benefit Distribution Analysis
TEV	Total Economic Valuation
MU	Management Unit

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 (WA), the governing policy is the State Planning Policy No. 2.6 (SPP 2.6).[1]

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

1.1.1 Coastal Hazard Risk Management and Adaptation Plan

WA guidelines for a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) are 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 Benefit Distribution Analysis (BDA) fits within Stage 6 (implementation plan), following the cost-benefit analysis (CBA) undertaken as part of Stage 5 (risk treatment). The BDA forms the basis for a 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] Available at: https://www.wa.gov.au/government/document-collections/coastal-hazard-risk-management-and-adaptation-planning-guidelines

1.1.2 Study area

The City of Albany has recognised the land surrounding Princess Royal Harbour as being potentially exposed to coastal hazards and climate change. A CHRMAP[3] was produced to investigate the nature and severity of any coastal hazards that could affect this area. The BDA has been undertaken for Management Units (MUs) 1 – 5 around the Princess Royal Harbour identified in the CHRMAP (Figure 1).

Figure 1 Study area and management units

Source: Water Technology, Princess Royal Harbour CHRMAP. (City of Albany, August 2024)

[3] Water Technology, *Princess Royal Harbour CHRMAP*. (City of Albany, August 2024).

2. Framework and approach

2.1 Benefit distribution analysis

As mentioned in the earlier section, a BDA fits within Stage 6 (implementation plan), following the cost-benefit analysis undertaken as part of Stage 5 (risk treatment). The BDA forms the basis for a funding proposal for the identified risk management measures. The output(s) of the CBA identifies the preferred risk management measures while the BDA is the basis for the funding proposal for the risk management measures – often this includes infrastructure option for mitigation against the identified hazard.

For Princess Royal Harbour, a CBA was undertaken by Water Technology. The CBA methodology and results are presented in the 'Assessment of Risk Treatment Options' report. The following section provides a brief overview of the CBA.

2.2 CBA overview

An overview of the key features of the CBA undertaken by Water Technology is summarised in this section.

- For each of the MU, a range of adaptation options were assessed against a 'Do nothing' scenario.
- The 'Do nothing' scenario involves implementing no adaptation option over the timeframe of the study.
- The range of adaptation options for each of the MUs were selected based on the result of the Multi Criteria Analysis study as part of the CHRMAP.
- The basis for selecting the preferred option is set out in Table 1 (for erosion) and Table 2 (for inundation) in Section 2.6.1.
- For MU 1, no options were considered suitable for assessment to protect against inundation. This was due to the result of the previous multi-criteria analysis. As a result, no rapid CBA and BDA was undertaken.
- FOR MU 4, the preferred option to protect against erosion is voluntary acquisition. This involves the City buying back the land in danger from the respective owners. Since, this option is not an infrastructure option, a BDA is not suitable.

2.3 Cost sharing principles

Within Government projects, cost allocation is typically done on a User pays / Impactor pays / Beneficiary pays approach for environmental projects with high infrastructure costs. Coastal

adaptation principles and Stage 6 of the CHRMAP process stipulate that risk management plans should be implemented using a 'beneficiary pays' approach. Applying this approach to coastal management actions will minimise the burden on taxpayers and ratepayers and avoid subsidies.

Under a beneficiary pays approach, the cost of coastal works is recovered from identified beneficiaries of those works. Beneficiaries generally include those who directly and indirectly benefit from the proposed works. A direct beneficiary of the proposed works will typically be a land/property owner who is situated in an identified threatened coastal area, with the level of threat being mitigated due to the works. An indirect beneficiary will be a group or individual who derives value from knowing that the otherwise threatened coastal area is being protected. Indirect beneficiaries are usually from the wider community.

Key beneficiaries are likely to include:

- State Government (e.g. utilities such as roads, water, electricity that are being protected)
- Business and industry (e.g. cafés and other businesses that are being protected)
- Private land holders (e.g. residential property that is being protected)
- Local community (e.g. local users of public assets such as beaches, parks, estuaries etc that are being protected - provided proposed works enhance rather detract from the value of those assets)
- Broader community (e.g. users of public assets who reside outside of the local area and community members who value the assets for altruistic reasons).

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 lower order indirect effects. These beneficiaries include, for example, users of a café that is being protected or people who might indirectly benefit from the productivity of lands that are preserved. Inability to identify these beneficiaries may become 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 intervention is paid for. The BDA will provide an indication of 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 a 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?
- Step 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 who will benefit from implementing a risk treatment measure, such as coastal protection works, and the distribution of benefits between the different stakeholders.

2.4 Total economic valuation (TEV) framework

2.4.1 Overview

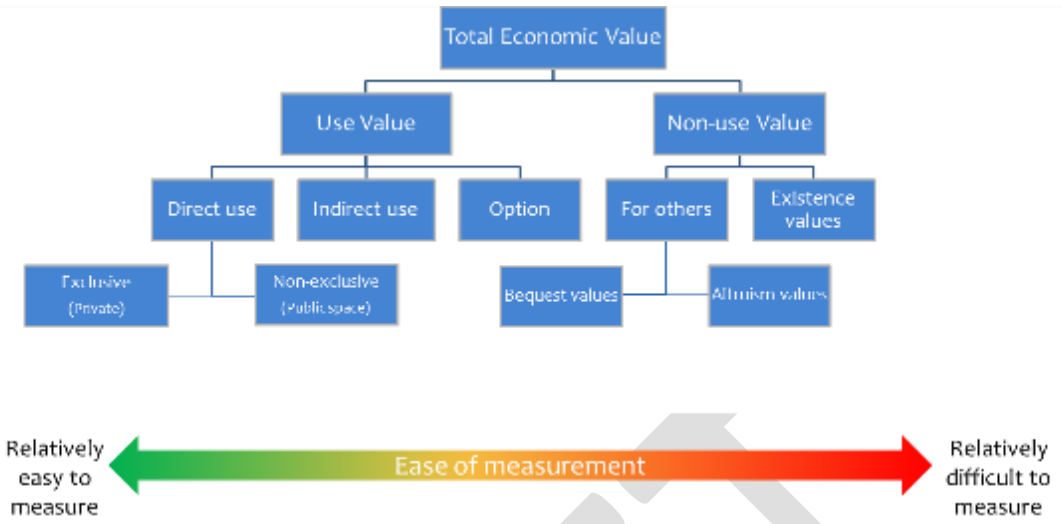
Identifying all the benefits and beneficiaries of climate interventions in coastal areas, requires the full range of uses and values of those areas to be identified. This is particularly important for public assets, which may have multiple values and uses.

The concept of total economic value (TEV) is a well-established and useful framework for identifying the full range of values associated with both public and private assets.[4] The framework 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 economic values and is shown in Figure 2. The basic premise of the framework is that the total economic value of an area is a function of all its use and non-use values, both direct and indirect, market and non-market. Use values measure the value of using an area, either directly (e.g. for housing or recreation) or indirectly (e.g. goods or services derived from other people using the area). Use values also include the option of being able to use the area in the future (option values). Non-use values 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. Non-use values typically include bequest and existence values.

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

Figure 2 Total economic value framework



Source: Adapted from Phillips (1998)

2.4.2 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**.

2.5 Assets identified in the CBA

Section 4 in the draft CHRMAP outlines the identification process for coastal assets and community values. These are reported in the Risk Identification and Vulnerability Analysis Chapter Reports (Appendix C and Appendix D). Assets have been classified as follows:

- Residential property
  - Private houses and apartments and supporting structures such as sheds and garages, and rural properties.
  - Corresponding Local Planning Scheme zones are: Regional Centre, Residential, Rural Small Holdings, Rural Residential, Rural Enterprise, Rural townsite, Private community purposes.
- Commercial property
  - This includes shops, businesses, offices etc.
  - Corresponding Local Planning Scheme zones are, Light Industry, General Industry, Tourism, Urban & Industrial Development, Commercial, mixed use, service commercial.
- Developed Foreshore reserve
  - Reserve containing public assets, e.g., car parks, public ablutions, playgrounds, walkway, access structures.
  - Corresponding Local Planning Scheme zones are Car Park, Public Open Space, Public Purpose, Public Purposes; Recreational.
- Public and Community
  - This item mainly relates land that is publicly owned, and includes public infrastructure, the marine facility and its structures, the port and public parks.
  - Corresponding Local Planning Scheme zones are Cemetery, Civic and Community, Cultural Facilities, Drainage/Waterway; Education, Emergency Services; Government Services; Infrastructure; Medical Services, Neighbourhood Centre; Railways, Social Care Facilities, Special Purpose; Strategic Industry and Infrastructure, Special Use.
  - Special Purpose Areas within this category include public drinking water sources; special control areas such as the Albany port special control area.
- Roads
  - Corresponding Local Planning Scheme zones are Distribution, Local, Major and Priority Roads.
- Environmental
  - This category covers all undeveloped foreshore.
  - A large area of the foreshore is classified as Environmental Conservation within the Local Planning Scheme.
- Heritage
  - This includes any Historical sites within the City and Aboriginal Heritage.
  - Specific Aboriginal Heritage sites are obtained from the Aboriginal Heritage Inquiry System, hosted by the Department of Planning, Lands and 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. The unit rates for damages applied by Water Technology are presented in detail in the Cost Benefit Analysis Report.

2.6 Approach for the rapid CBA and the BDA

As shown in Figure 1, the CHRMAP considered the Albany harbour in 5 Management Units (MUs).

In this report, our approach to BDA is to focus on the five MUs and the preferred option as identified in previous reports[5] within these areas. The preferred options are set out in Section 2.6.1.

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 2122 and their present value was calculated using a rate of 4% and sensitivities were tested at rates of 7% and 2%.

Based on tenure data and GIS information provided by the City of Albany, vulnerable properties and assets for each timeframe in each of the MU were identified and it was assumed than each intervention would be 100% effective in removing the risk of inundation or erosion.

Following a workshop with the City of Albany, it was decided to undertake a rapid CBA on the preferred options against a 'do nothing' scenario with updated unit rates for key elements.

Where the preferred option is predicted to deliver a net benefit, a benefit distribution analysis (BDA) was then considered. The BDA identified the proportion of the total benefits that falls to each stakeholder group and uses this proportion to allocate the costs of the intervention to that group. The results of the rapid CBA and BDA are presented for each MUs in Section 4.

2.6.1 Preferred options

The preferred options for all MUs are shown in Table 1 and Table 2 below. Table 1 shows the preferred options to mitigate erosion impacts. Table 2 shows the preferred options to mitigate inundation impacts. The preferred options were determined following the CBA when a range of options were assessed against a 'Do nothing' scenario. The basis for selecting the preferred option is provided in the notes.

[5] Previous CHRMAP reports produced by Water Technology for the City of Albany.

Table 1 Preferred options for erosion

Management Unit	Preferred option	Notes
MU 1	PR1 Beach Nourishment	PR1 is best value for all discount rates and has a positive benefit/cost ratio for all rates. PR3 Seawall is not recommended as it would mean the loss of the beach. Should the objectives of this MU change in the future PR3 Seawall may be suitable in the long-term. PR1 Beach nourishment could also later be transitioned to both PR2 Groynes or PR3 Seawall if required. PMR4 Retreat by voluntary acquisition is the worst value option for all discount rates.
MU 2	PR1 Beach Nourishment	PR1 is best value for all discount rates and has a positive benefit/cost ratio for all rates. PR3 Seawall is not recommended as it would mean the loss of the beach. Should the objectives of this MU change in the future PR3 Seawall may be suitable in the long-term. PMR4 Retreat by voluntary acquisition is the worst value option for all discount rates.
MU 3	PR1 Beach Nourishment	PR1 is best value for all discount rates and has a positive benefit/cost ratio for all rates. PR3 Seawall is not recommended as it would mean the loss of the beach. Should the objectives of this MU change in the future PR3 Seawall may be suitable in the long-term. PMR4 Retreat by voluntary acquisition is the worst value option for all discount rates.
MU 4	PMR4 Retreat by Voluntary Acquisition	PMR4 Retreat by Voluntary Acquisition is the best value option for one discount rate (7%) and has a positive benefit/cost ratio for this rate. PMR4 Retreat by Voluntary Acquisition does not have a positive benefit-cost ratio for the other two rates (4% and 2%) but no other options were deemed appropriate for CBA. Other non-CBA options will form part of the management approach and will be presented at the Stage 7 Implementation Report.
MU 5	PR1 Beach Nourishment	PR1 Beach Nourishment has a positive benefit-cost ratio for all rates.

Source: Water Technology for the City of Albany.

Table 2 Preferred options for inundation

Management Unit	Recommended option (s)	Notes
MU 1	N/A	No options were considered appropriate for CBA. Other non-CBA options will form part of the management approach and will be presented at the Stage 7 Implementation Report.
MU 2	PR6 Levee	PR6 Levee has a positive benefit/cost ratio for all rates.
MU 3	PR6 Levee	PR6 Levee has a positive benefit/cost ratio for two discount rates (7% and 4%).
MU 4	PR6 Levee	PR6 Levee has a positive benefit/cost ratio for all rates.
MU 5	PR6 Levee	PR6 Levee has a positive benefit/cost ratio for all rates.

Source: Water Technology for the City of Albany.

2.6.2 Assumptions underpinning the BDA

The assumptions underpinning the development of the interventions are provided below.

Based on the workshop held with the City of Albany, it was discussed the key focus of the BDA should lie in MUs 2, 3, and 5. This was because these 3 MUs would get both sand nourishment and a levee for additional protection. Additionally, MUs 2 and 3 contain many assets and protection of MU5 is critical to ensure the usefulness of the harbour. As it was identified by modelling that should MU5 be unprotected it would have adverse impacts on the harbour due to wave energies being modified. Additionally, the BDA results are provided for all MUs where the preferred intervention is an infrastructure option and there are a mix of beneficiaries (such as private owners, the City of Albany, and the State).

At the workshop, it was decided to use updated costings for the preferred options. Updated unit rates were obtained for road development and sand nourishment. Road development was estimated to cost $450 per square meter[6] and sand nourishment was estimated to cost $10.50 per cubic meter.[7]

Levee

The design of the levee is based on the dimensions provided in the Princess Royal Harbour CHRMAP: Summary Document.[8] The dimensions used to develop the cross section of the levee are:

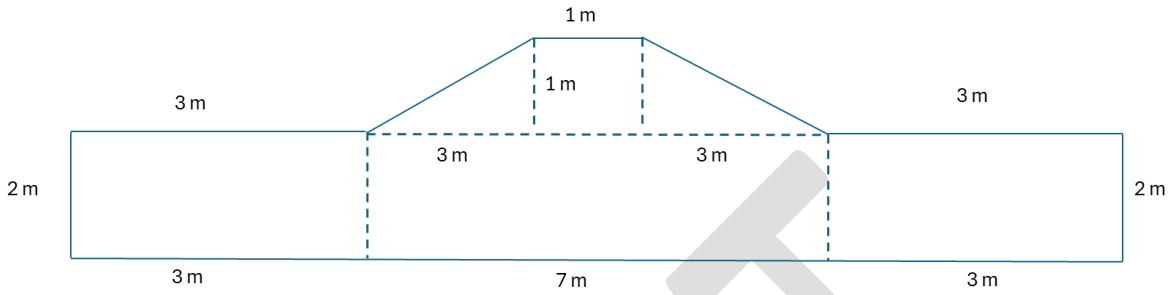
- Base width of 13 meters.
- Crest width of 1 meter.
- Height of 2 meters.

[6] Sourced from the City of Albany.
[7] Rough order of magnitude estimate sourced from contractors used by the City of Albany.
[8] Available at: https://www.albany.wa.gov.au/Profiles/albany/Assets/ClientData/22040008_PRH_CHRMAP_R07v02_untracked.pdf

- Slope at 1V:3H.
- Surfacing of grass/revegetation.

Based on this, the cross-section diagram of the levee was developed. This is shown below in Figure 3.

Figure 3 Levee cross-section diagram



Source: Marsden Jacob based on dimensions provided in the CHRMAP summary document.

Based on the diagram, the cross-section area of the levee was calculated to be 30 square meters.

Beach nourishment

In the CHRMAP summary document, it is assumed that beach nourishment follows the cross-sectional area as the levee at 30 square meters (shown in Figure 3). The summary document provides the relevant length of the beach nourishment where appropriate.

Assumptions specific to the interventions

Assumptions specific to each of the interventions are outlined below.

- MU 1
  - Beach nourishment is assumed to treat 1,000 meters of the shoreline west of Albany Waterfront Marina. Beach nourishment is expected to occur in 2072, and a useful life of 10-years is assumed. After which, beach nourishment would occur again.
- MU 2
  - Beach nourishment is assumed to treat 7,000 meters of the shoreline. Beach nourishment is expected to occur in 2026, and a useful life of 10-years is assumed. After which, beach nourishment would occur again.
  - Development of the levee is expected to occur in 2026 and replaced in 2072. Additionally, length of levee is 3,500 meters.
- MU 3
  - Beach nourishment in 2026 is assumed to treat 1,400 meters of the shoreline to the northwest of Princess Royal Sailing Club. Beach nourishment in 2047 is assumed to treat 3,850 meters of shoreline to the southeast of Princess Royal Sailing club. A useful life of 10-years is assumed. After which, beach nourishment would occur again.

- Development of the levee is expected to occur in 2072. Additionally, length of levee is 1,700 meters.

- MU 4
  - Development of the levee is expected to occur in 2047. Additionally, length of levee is 1,250 meters.
- MU 5
  - Beach nourishment is assumed to treat 750 meters of the beach and 150 meters of Camp Quaranup shoreline. Beach nourishment is expected to occur in 2047, and a useful life of 10-years is assumed. After which, beach nourishment would occur again.
  - Development of the levee is expected to occur in 2072. Additionally, total length of the levee is 350 meters. 300 meters of levee is required around Camp Quaranup and 50 meters of levee for the depression in the isthmus.

2.7 Approach to identifying the funding mechanism

The cost benefit analysis of each intervention measures the predicted cost of the intervention over the 100-year analysis period against the inundation or erosion impacts the intervention will mitigate. As such, a net benefit predicts that the intervention will provide benefits (as avoided costs) that are greater than the cost of the intervention.

The Water Technology analysis considered four assessment periods of 2022, 2047, 2072, 2122. 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 2022, essentially require immediate action, whilst assets identified to be at risk in 2047, 2072, 2122 do not require immediate action.
- For this project identified three broad groups of beneficiaries:
  - Private property owners (residential, commercial or agricultural)
  - WA State government (representing the broader WA community) and
  - Local community.

The cost of each intervention can then be allocated proportionally to each of the groups that would benefit from its implementation.

We identify the cost allocated to each group could be collected as either a lump sum, or as an annuity - annual payment spread over a number of years.

3. Discussion of the cost benefit analysis

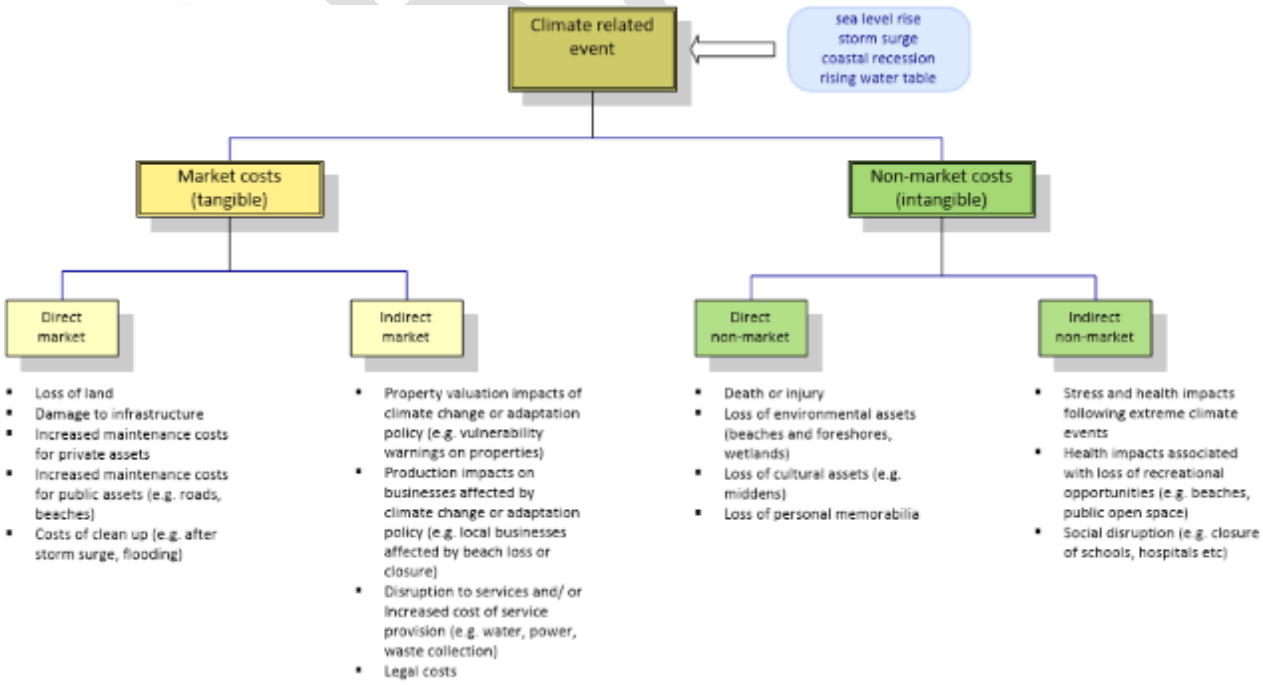
3.1 Benefits considered

While Water Tech had undertaken a CBA, the City of Albany requested that Marsden Jacob undertake a rapid CBA to confirm the results for the preferred interventions and provide full transparency of the calculation.

A rapid CBA focusses on the largest and most easily valued benefits. This has resulted in the analysis using readily available data which quantifies direct and market use values. However, this rapid 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 4 shows the TEV framework applied for valuing coastal adaptation of climate related events. This diagram assists by giving identifying the full range of direct and indirect impacts that would arise, but it should be noted that some of the non-market values may not have been identified in the CBA.

While a rapid CBA may not include some intangible costs and benefits from the consideration it provides a strong indication of whether an intervention provide a net benefit to the community or not.

Figure 4 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 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.

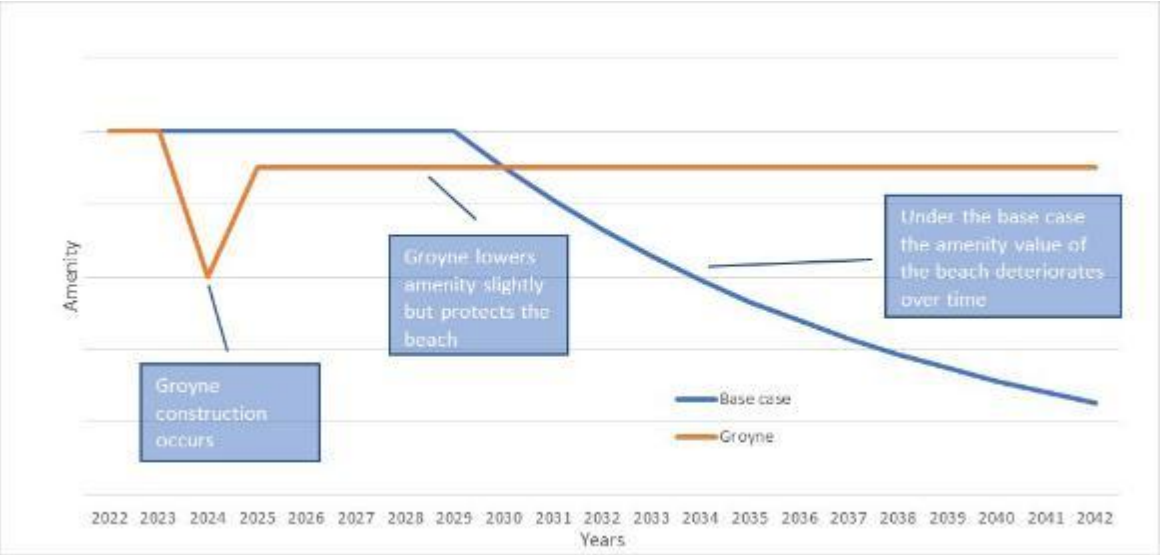
Since the Do-Nothing option does not immediately impact the beach amenity (in terms of visual amenity and use of the area), it may be perceived as a more attractive option by the public in the short term. However, in the long term this scenario will inevitably lead to coastal erosion or inundation and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

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) will often provide 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 no loss of amenity in the short term – but does consider the benefits that are expected to arise in the longer term.

4. Rapid CBA and BDA results

The results of the rapid CBA along with the BDA for the 5 MUs are presented below which sets out the base case costs (which are avoided under the intervention) as well as the intervention costs for the preferred option. The base case results are the same as those presented in the Princess Royal Harbour CHRMAP: Summary Document. The Intervention costs were estimated based on the updated costings as shown in Section 2.6.2. The results are shown for 7%, 4%, and 2% discount rate.[9] All values shown are present values. Furthermore, the assumptions around the interventions are the same as those outlined in Section 2.6.2. The analysis assumes each intervention is completely effective in avoiding the base case costs.

4.1 Management Unit 1 – Point King to Melville Point

MU 1 extends from Point King to Melville Point and is almost entirely hardened shoreline, due to naturally occurring rock or the installation of coastal rock protection. A natural rocky coastline is present from the edge of the study area at King Point to the edge of the Port of Albany at Spit Head.

MU1 is characterised by unique and high value uses that may not be accurately captured using a rapid CBA, these include:

- Port of Albany – which is operated by Southern Ports, a Government Trading Enterprise.[10]
- Albany waterfront marina and Albany town jetty
- Entertainment centre precinct

In addition, the only intervention costed in the rapid CBA is for beach nourishment. This intervention may not be suitable for key parts of this management unit – as sea walls are already in place for much of the area and boat access is required for some areas.

MU 1 and the area impacted by erosion during the analysis period are shown in Figure 6, below. As shown in the image, the port area is not anticipated to be impacted by erosion.

[9] Discount rates – The discount rate is interest rate used to determine the present value of future cash flows (costs and benefits) in a discounted cash flow (DCF) or cost benefit analysis (CBA). This helps determine if the future benefits from a project will be worth more than the capital costs needed to implement the project in the present.

[10] Source: https://www.southernports.com.au/annual-reports, https://www.southernports.com.au/albany/poa-mpp

Figure 6 MU 1 showing impacted areas over the analysis period with property ownership and the Port of Albany

Source: *Marsden Jacob analysis*

Note: Image not to scale

4.1.1 Erosion

Table 3 shows the area vulnerable to erosion in MU 1 across the 4 modelled years. It should be noted that the values are not cumulative. The table shows that minimal impact is expected to arise before 2072.

Table 3 Area vulnerable to erosion in square meter

Category	2022	2047	2072	2122
Roads	-	-	-	131,835
Residential property	-	-	-	51,842
Commercial property	-	-	-	1,739
Public and Community	353	-	-	153,394
Developed Foreshore	-	-	-	43,518
Environmental	-	-	-	42,352
Heritage	-	-	-	24,169

Source: Water Technology

Table 4 Private (residential and commercial) properties vulnerable to erosion

Owner	2022	2047	2072	2122
Private	1	-	-	29

Source: Marsden Jacob analysis of tenure data provided by City of Albany

Table 4 shows the number of private (both residential and commercial) properties vulnerable to erosion in MU 1. Almost all the private properties in MU 1 are projected to be vulnerable to erosion in 2122.[11]

Table 5 shows the present value of the total costs of the base case and the intervention option over the analysis period. As most damage is expected to arise after 2072, the total cost estimates are impacted significantly by the discount rate applied. We have assumed that the intervention is entirely effective – reducing the damage costs to $0.

Note that while the CBA has been updated, the results follow the format used by Water Technology in their analysis. This presents the total present value of the costs for each option including damage

[11] The one property projected to be vulnerable in 2022 is only projected to have a very small part of the property traversing the hazard line. As a result, this can be safely ignored citing uncertainties with the modelling.

and intervention costs. As such the preferred option is the one with the lowest present value of the costs. This approach differs from many CBAs that present the results as the marginal costs and benefits compared to the base case.

Under the intervention the damage costs are reduced and both the initial and ongoing costs of the intervention are included in the analysis.

Table 5 CBA results for erosion intervention in MU1 shown as total costs incurred

Discount rate	Present value of the base case	Present value of PR1: Beach Nourishment
7%	$428,000	$21,000
4%	$4,488,000	$124,000
2%	$30,233,000	$453,000

Source: Marsden Jacob analysis

Table 6 shows the allocation of benefits to different stakeholders in dollars and in percentages. Note that the percentages may not add up to 100% due to rounding.

Table 6 BDA for MU1 – Erosion

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$1,175,000	24%
Residential property	$1,026,000	21%
Commercial property	$26,000	1%
Public and Community	$1,695,000	35%
Developed Foreshore	$269,000	6%
Environmental	$210,000	4%
Heritage	$479,000	10%

Source: Marsden Jacob analysis

The present value of the total intervention cost is $124,000. The benefits for this area largely fall to the public and community (35%), roads (24%) and residential properties (21%). It should be noted that the costings for the intervention are based on concept design and so should be considered to have high error margins.

4.1.2 Inundation

Table 7 shows the area vulnerable to inundation in MU 1 across the 4 modelled years. It should be noted that the values are not cumulative.

Table 7 Area vulnerable to inundation in square meter

Category	2022	2047	2072	2122
Roads	1,505	664	1,085	51,025
Residential property	-	-	-	-
Commercial property	7	26	73	752
Public and Community	3,480	1,657	2,515	24,506
Developed Foreshore	354	381	903	16,962
Environmental	2,481	469	664	34,059
Heritage	438	164	243	6,244

Source: Water Technology

The costs arising under the base case are shown in Table 8. The values vary significantly under different discount rates due to the extended time until significant areas of inundation (in 2122).

Table 8 CBA results for inundation shown as total costs incurred (present value)

Discount rate	Base case
7%	$724,000
4%	$979,000
2%	$2,151,000

Source: Marsden Jacob analysis

No intervention option was considered suitable for protection against inundation.[12] As a result, other non-infrastructure options will form the management of this MU. As a result, no BDA was undertaken for protection against inundation.

[12] As mentioned in the CBA report.

4.2 Management Unit 2 – Melville Point to Rushy Point

MU 2 extends from Melville Point to Rushy Point. The area is a gentle-sloping, sandy coastline. The shoreline is vegetated up to the water's edge and includes intertidal flats.

4.2.1 Erosion

Table 9 shows the area vulnerable to erosion in MU 2 across the 4 modelled years. It should be noted that the values are not cumulative.

Table 9 Area vulnerable to erosion in square meters

Category	2022	2047	2072	2122
Roads	12,484	25,694	25,192	74,195
Residential property	-	2,071	11,344	117,380
Commercial property	138	3,266	76,667	332,474
Public and Community	1,393	5,778	14,855	62,662
Developed Foreshore	-	-	-	-
Environmental	9,891	44,293	47,726	73,688
Heritage	681	207	5	4

Source: Water Technology

Table 10 shows the number of individual private properties vulnerable to erosion in MU 2. It is important to note that the numbers are not cumulative.

Table 10 Private (residential and commercial) properties vulnerable to erosion

Owner	2022	2047	2072	2122
Private	15	29	59	179

Source: Marsden Jacob analysis of tenure data provided by City of Albany

Table 11 shows the present value of the total costs of the base case and the intervention option over the analysis period. We have assumed that the intervention is entirely effective – removing the damage costs entirely.

Under the intervention the damage costs are reduced (to $0) and both the initial and ongoing costs of the intervention are included in the analysis.

Table 11 CBA results for erosion shown as total costs incurred

Discount rate	Base case	PR1: Beach Nourishment

Discount rate	Base case	PR1: Beach Nourishment
7%	$16,319,000	$3,418,000
4%	$39,764,000	$5,695,000
2%	$119,932,000	$9,774,000

Source: Marsden Jacob analysis

Table 12 shows the allocation of benefits to different stakeholders in dollars and in percentages.

Table 12 Benefit distribution for MU2 – Erosion intervention

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$12,211,000	28%
Residential property	$4,697,000	11%
Commercial property	$14,051,000	32%
Public and Community	$3,446,000	8%
Developed Foreshore	$0	0%
Environmental	$8,670,000	20%
Heritage	$759,000	2%

Source: Marsden Jacob analysis

The present value of the total intervention cost is $5,695,000. The benefits for this area largely fall to the commercial property owners (32%), roads (28%) and to the environment (20%). It should be noted that the costings for the intervention are based on concept design and so should be considered to have high error margins.

4.2.2 Inundation

Table 13 shows the area vulnerable to inundation in MU 2 across the 4 modelled years. It should be noted that the values are not cumulative.

Table 13 Area vulnerable to inundation in square meters

Category	2022	2047	2072	2122
Roads	11,097	8,397	38,882	67,435
Residential property	18,727	37,081	27,281	670,085
Commercial property	29,335	27,737	75,971	255,425
Public and Community	3,069	2,086	4,389	357,220
Developed Foreshore	-	-	-	-
Environmental	60,455	26,031	23,623	34,123
Heritage	136	90	181	543

Source: Water Technology

Table 14 shows the number of individual private properties vulnerable to inundation in MU 2. It is important to note that the numbers are not cumulative.

Table 14 Private (residential and commercial) properties vulnerable to inundation

Owner	2022	2047	2072	2122
Private	35	22	40	89

Source: Marsden Jacob analysis of tenure data provided by City of Albany

Table 15 shows the present value of the total costs of the base case and the intervention option over the analysis period. We have assumed that the intervention is entirely effective – reducing the damage costs to $0. Under the intervention the damage costs are reduced and both the initial and ongoing costs of the intervention are included in the analysis.

Table 15 CBA results for inundation shown as total costs incurred (present value)

Discount rate	Base case	PR6: Levee
7%	$15,630,000	$879,000
4%	$24,441,000	$1,098,000
2%	$57,733,000	$1,428,000

Source: Marsden Jacob analysis

Table 16 shows the allocation of benefits to different stakeholders in dollars and in percentages.

Table 16 BDA for MU2 – Inundation

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$1,263,000	5%
Residential property	$9,949,000	41%
Commercial property	$8,323,000	34%
Public and Community	$1,154,000	5%
Developed Foreshore	$0	0%
Environmental	$3,711,000	15%
Heritage	$41,000	0%

Source: Marsden Jacob analysis

The present value of the total intervention cost is $1,098,000. The benefits for this area largely fall to the residential property owners (41%), commercial property owners (34%) and to the environment (15%). It should be noted that the costings for the intervention are based on concept design and so should be considered to have high error margins.

4.3 Management Unit 3 – Rushy Point to Limekilns Point

MU 3 extends from Rushy Point to Limekilns Point and contains both rocks and sandy coastlines. Majority of the coastline in this is MU is fronted by private property.

4.3.1 Erosion

Table 17 shows the area vulnerable to erosion in MU 3 across the 4 modelled years. It should be noted that the values are not cumulative.

Table 17 Area vulnerable to erosion in square meter

Category	2022	2047	2072	2122
Roads	3,794	12,232	17,219	48,655
Residential property	2,042	6,740	23,368	148,270
Commercial property	-	207	21,954	173,671
Public and Community	-	-	-	385
Developed Foreshore	2,469	18,078	21,954	99,158
Environmental	10,657	44,912	46,841	64,403
Heritage	1,629	3,239	5,347	18,720

Source: Water Technology

Table 18 shows the individual private properties vulnerable to erosion in MU 3. It is important to note that the numbers are not cumulative.

Table 18 Private (residential and commercial) properties vulnerable to erosion

Owner	2022	2047	2072	2122
Private	7	4	60	87

Source: Marsden Jacob analysis of tenure data provided by City of Albany

Table 19 shows the present value of the total costs of the base case and the intervention option over the analysis period. We have assumed that the intervention is entirely effective – reducing the damage costs to $0. Under the intervention the damage costs are reduced and both the initial and ongoing costs of the intervention are included in the analysis.

Table 19 CBA results for erosion shown as total costs incurred

Discount rate	Present value of the base case costs	Present value of PR1: Beach Nourishment costs
7%	$16,652,000	$1,136,000
4%	$36,563,000	$2,480,000
2%	$102,122,000	$5,225,000

Source: Marsden Jacob analysis

Table 20 shows the allocation of benefits to different stakeholders in dollars and in percentages.

Table 20 Benefit distribution for MU3 – Erosion intervention

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$5,296,000	14%
Residential property	$10,794,000	28%
Commercial property	$4,954,000	13%
Public and Community	$4,000	0%
Developed Foreshore	$4,470,000	12%
Environmental	$8,843,000	23%
Heritage	$3,967,050	10%

Source: Marsden Jacob analysis

The present value of the total intervention cost is $2,480,000. The benefits for this area largely fall to the residential property owners (28%), the environment (23%), the roads (14%), the commercial property owners (13%) and to the developed foreshore (12%). Additionally, heritage properties also benefit from the development of the intervention option. It should be noted that the costings for the intervention are based on concept design and so should be considered to have high error margins.

4.3.2 Inundation

Table 21 shows the area vulnerable to inundation in MU 3 across the 4 modelled years. It should be noted that the values are not cumulative.

Table 21 Area vulnerable to inundation in square meter

Category	2022	2047	2072	2122
Roads	2,368	1,819	3,416	28,097
Residential property	551	409	583	6,021
Commercial property	-	10	2,421	18,148
Public and Community	-	-	-	-
Developed Foreshore	8,488	6,075	5,014	9,918
Environmental	8,380	9,686	16,831	44,188
Heritage	169	163	349	631

Source: Water Technology

Table 22 shows the individual private properties vulnerable to inundation in MU 3. It is important to note that the numbers are not cumulative.

Table 22 Private (residential and commercial) properties vulnerable to inundation

Owner	2022	2047	2072	2122
Private	7	2	6	37

Source: Marsden Jacob analysis of tenure data provided by City of Albany

Table 23 shows the present value of the total costs of the base case and the intervention option over the analysis period. We have assumed that the intervention is entirely effective – reducing the damage costs to $0. Under the intervention the damage costs are reduced and both the initial and ongoing costs of the intervention are included in the analysis. Since the intervention is only required to be implemented in 2072, the costs are significantly impacted by the discount rate applied.

Table 23 CBA results for inundation shown as total costs incurred

Discount rate	Present value of the base case costs	Present value of PR6: Levee costs
7%	$905,000	$18,000
4%	$1,360,000	$75,000
2%	$2,837,000	$199,000

Source: Marsden Jacob analysis

Table 24 shows the allocation of benefits to different stakeholders in dollars and in percentages.

Table 24 Benefit distribution for MU3 – Inundation intervention

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$245,00	18%
Residential property	$181,000	13%
Commercial property	$106,000	8%
Public and Community	$0	0%
Developed Foreshore	$7,000	1%
Environmental	$763,000	56%
Heritage	$58,000	4%

Source: Marsden Jacob analysis

The present value of the total intervention cost is $75,000. The benefits for this area largely fall to the environment (56%), roads (18%) and to the residential property owners (13%). It should be noted that the costings for the intervention are based on concept design and so should be considered to have high error margins.

4.4 Management Unit 4 – Limekilns Point to Geake Point

MU 4 extends from Limekilns Point to Geake Point and contains distinct sections of sandy and rocky coastline. This MU includes a major portion of the Vancouver Peninsula, which forms the shallow waters of Shoal Bay. The coastline is rocky from Limekilns Point to Jessica's Beach (half of the MU), then sandy for a continuous stretch along Vancouver Beach, before becoming rocky again at Quarantine Hill.

4.4.1 Erosion

Table 25 shows the area vulnerable to erosion in MU 4 across the 4 modelled years. It should be noted that the values are not cumulative.

Table 25 Area vulnerable to erosion in square meters

Category	2022	2047	2072	2122

Category	2022	2047	2072	2122
Roads	690	12,908	20,837	15,575
Residential property	-	16	15,168	112,270
Commercial property	-	-	-	-
Public and Community	-	138	1,270	3,625
Developed Foreshore	-	-	-	1,800
Environmental	23,305	102,254	118,033	373,309
Heritage	1,571	8,571	11,863	38,800

Source: Water Technology

Table 26 shows the present value of the total costs of the base case and the intervention option over the analysis period. We have assumed that the intervention is entirely effective – reducing the damage costs to $0. Under the intervention the damage costs are reduced and both the initial and ongoing costs of the intervention are included in the analysis.

Table 26 CBA results for erosion shown as total costs incurred

Discount rate	Present value of base case costs	Present value of PMR4: voluntary acquisition costs
7%	$17,066,000	$16,982,000
4%	$35,797,000	$38,427,000
2%	$89,095,000	$106,230,000

Source: Marsden Jacob analysis

Table 27 shows the allocation of benefits to different stakeholders in dollars and in percentages.

Table 27 BDA for MU4 – Erosion intervention

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$3,948,000	11%
Residential property	$4,363,000	12%
Commercial property	$0	0%
Public and Community	$151,000	0%
Developed Foreshore	$11,000	0%
Environmental	$21,416,000	58%
Heritage	$7,224,000	19%

Source: Marsden Jacob analysis

For this area, the preferred option for protection against erosion is voluntary acquisition of the vulnerable area. Since this is not an infrastructure option, BDA was not undertaken for this hazard in this MU.

4.4.2 Inundation

Table 28 shows the area vulnerable to inundation in MU 4 across the 4 modelled years. It should be noted that the values are not cumulative.

Table 28 Area vulnerable to inundation in square meters

Category	2022	2047	2072	2122
Roads	-	767	7,060	26,605
Residential property	-	-	-	15,627
Commercial property	-	-	-	-
Public and Community	-	-	-	10,915
Developed Foreshore	223	85	254	1,648
Environmental	11,887	8,133	134,700	538,124
Heritage	2,038	1,582	2,078	75,677

Source: Water Technology

Table 29 shows the number of individual private properties vulnerable to inundation in MU 4.

Table 29 Private (residential and commercial) properties vulnerable to inundation

Owner	2022	2047	2072	2122
Private	-	-	-	8

Source: Marsden Jacob analysis of tenure data provided by City of Albany

Table 30 shows the present value of the total costs of the base case and the intervention option over the analysis period. We have assumed that the intervention is entirely effective – reducing the damage costs to $0. Under the intervention the damage costs are reduced and both the initial and ongoing costs of the intervention are included in the analysis.

Table 30 CBA results for inundation shown as total costs incurred

Discount rate	Present value of base case costs	Present value of PR6: levee costs
7%	$1,456,000	$73,000
4%	$3,304,000	$148,000
2%	$10,891,000	$240,000

Source: Marsden Jacob analysis

Table 31 shows the allocation of benefits to different stakeholders in dollars and in percentages.

Table 31 Benefit distribution for MU4 – Inundation intervention

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$108,000	3%
Residential property	$62,000	2%
Commercial property	$0	0%
Public and Community	$22,000	1%
Developed Foreshore	$190	0%
Environmental	$2,227,000	67%
Heritage	$884,000	27%

Source: Marsden Jacob analysis

The present value of the total intervention cost is $148,000. The benefits for this area largely fall to the environment (67%) and to heritage sites (27%). It should be noted that the costings for the intervention are based on concept design and so should be considered to have high error margins. The intervention is required to be implemented in 2047. Hence, the total costs are impacted by discounting.

4.5 Management Unit 5 – Geake Point to Point Possession/Uredale Point

MU 5 extends from Geake Point to Point Possession/Uredale Point. The MU contains distinct sections of rocky coastline. The sandy coastline is an isthmus extending between the rocky outcrops of Quarantine Hill and Bramble Point and is also likely to be underlain by rock at some level, given its stability. During the workshop held with the City of Albany, it was raised that there are possible impacts from erosion and inundation on MU 5 also has the potential to impact on the Princess Royal Harbour and Port of Albany – which are in MU 1. The rapid CBA and the BDA analysis shown below do not take into account the potential impacts to the Port of Albany from inundation and/or erosion of MU 5, as these impacts have not been modelled. Therefore, these results must be interpreted with this in mind.

Additionally, in MU 5, all the properties that are projected to be impacted by erosion or inundation are owned by the State of WA. As such, there are no private property owners in the MU.

4.5.1 Erosion

Table 32 shows the area vulnerable to erosion in MU 5 across the 4 modelled years. It should be noted that the values are not cumulative. In MU 5, the only asset categories in danger are developed foreshore, environmental, and heritage. Developed foreshore is only projected to be impacted by erosion in the year 2122.

Table 32 Area vulnerable to erosion in square meters

Category	2022	2047	2072	2122
Roads	-	-	-	-
Residential property	-	-	-	-
Commercial property	-	-	-	-
Public and Community	-	-	-	-
Developed Foreshore	-	-	-	5,284
Environmental	28,182	49,341	33,114	694
Heritage	28,323	49,354	33,114	5,982

Source: Water Technology

Table 33 shows the present value of the total costs of the base case and the intervention option over the analysis period. We have assumed that the intervention is entirely effective – reducing the damage costs to $0. Under the intervention the damage costs are reduced and both the initial and ongoing costs of the intervention are included in the analysis.

Table 33 CBA results for erosion shown as total costs incurred

Discount rate	Base case	PR1: Beach Nourishment
7%	$48,149,000	$106,000
4%	$64,488,000	$314,000
2%	$89,426,000	$765,000

Source: Marsden Jacob analysis

Table 34 shows the allocation of benefits to different stakeholders in dollars and in percentages.

Table 34 Benefit distribution for MU5 – Erosion intervention

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$0	0%
Residential property	$0	0%
Commercial property	$0	0%
Public and Community	$0	0%
Developed Foreshore	$16,000	0%
Environmental	$6,420,000	20%
Heritage	$25,807,000	80%

Source: Marsden Jacob analysis

The present value of the total intervention cost is $314,000. The benefits for this area largely fall to heritage sites (80%) and to the environment (20%). It should be noted that the costings for the intervention are based on concept design and so should be considered to have high error margins. Beach nourishment to protect against erosion is expected to be implemented in 2047. As a result, the present value of the total costs is impacted by the discount rate applied.

4.5.2 Inundation

Table 35 shows the area vulnerable to inundation in MU 5 across the 4 modelled years. It should be noted that the values are not cumulative. In MU 5, the only asset categories in danger from inundation are developed foreshore, environmental, and heritage.

Table 35 Area vulnerable to inundation in square meters

Category	2022	2047	2072	2122
Roads	-	-	-	-
Residential property	-	-	-	-
Commercial property	-	-	-	-
Public and Community	-	-	-	-
Developed Foreshore	498	375	1,377	4,895
Environmental	4,723	1,201	1,879	7,394
Heritage	6,915	1,662	3,351	12,485

Source: Water Technology

Table 36 shows the present value of the total costs of the base case and the intervention option over the analysis period. We have assumed that the intervention is entirely effective – reducing the damage costs to $0. Under the intervention the damage costs are reduced and both the initial and ongoing costs of the intervention are included in the analysis.

Table 36 CBA results for inundation shown as total costs incurred

Discount rate	Base case	PR6: Levee
7%	$1,721,000	$3,700
4%	$1,931,000	$16,000
2%	$2,539,000	$41,000

Source: Marsden Jacob analysis

Table 37 shows the allocation of benefits to different stakeholders in dollars and in percentages.

Table 37 Benefit distribution for MU5 – Inundation intervention

Category	Present value of benefits	Percentage distribution of the benefits
Roads	$0	0%
Residential property	$0	0%
Commercial property	$0	0%
Public and Community	$0	0%
Developed Foreshore	$560	0%
Environmental	$279,000	14%
Heritage	$1,651,000	86%

Source: Marsden Jacob analysis

The present value of the total intervention cost is $16,000 (at a 4% discount rate). The benefits for this area largely fall to heritage sites (80%) and to the environment (20%). It should be noted that the costings for the intervention are based on concept design and so should be considered to have high error margins.

Development of the levee to protect against inundation is expected to be implemented in 2072. As a result, the present value of the total costs is significantly impacted by the applied discount rate.

4.6 Discussion of results

MU 1

For MU 1, almost all the damage occurs at 2122. Therefore, the present value of the intervention costs appears relatively small when discounted. Additionally, beach nourishment is expected to occur in 2072. As a result, no immediate action is required.

MU 2

For MU 2, immediate action (proposed to be beach nourishment) is required to protect against erosion. The present value estimates of the cost of the beach nourishment are much less than the expected damage costs with no intervention. This area also requires several actions over a large timeframe. Beach nourishment for part of the area is required immediately with ongoing replenishment. For protection against inundation, the levee is expected to be developed immediately and then replaced around 2072. As with erosion, the cost estimates of the intervention are much less than the expected damage costs with no intervention.

MU 3

For MU 3, immediate action is required to address risks from erosion to the coastline northwest of the Princess Royal Sailing Club. Action is required from 2047 to address risks from erosion to the

coastline southeast of the Princess Royal Sailing Club. For protection against inundation, development of levee is required to occur in 2072. As the interventions are proposed to be implemented in over 20 years (2047 and 2072 respectively), the present value of the costs is significantly impacted by the discount rate applied.

MU 4

For MU 4, the preferred option against erosion is voluntary acquisition. For voluntary acquisition, CBA and BDA are of less use as the costs are transferred from one party (the owners) to another (the City). To ensure that acquisition costs are not overblown, it is important to have constant monitoring of vulnerable areas and ensure that property owners are aware of the potential dangers. The City must also ensure that expensive development does not occur in areas that will be subject to acquisition. This is to ensure the acquisition costs are not overblown and that costs are sufficiently shared by the owner, the City, and the taxpayer. Development of the levee to protect against inundation is expected to occur in 2047. As a result, present value of the total costs shown previously are impacted by the discount rate applied.

MU 5

The rapid CBA and the BDA analysis shown above do not consider the potential costs to the Port of Albany that result from the erosion of MU 5. As such, there are possible additional benefits that arise from protecting MU 5 that have not been analysed fully in this analysis. Therefore, these results must be interpreted with this in mind. Beach nourishment is required to be implemented in 2047 as existing protection measures are modelled to be sufficient until that time. For protection against inundation, levee is expected to be implemented in 2072 as no protection against inundation is required in the short term.

Since, both interventions are required to implemented at a later stage, the present value of the total costs shown previously are significantly impacted by the discount rate applied.

5. Funding assessment

5.1 Funding models

Any suitable option chosen to mitigate the identified risks will not proceed further until satisfactory funding arrangements have been identified. As discussed in section 2.3 the purpose of undertaking an BDA is to allocate costs on a beneficiary pays basis. However, this is only one part of the funding assessment – which generally involves the following steps:

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?

The most common funding model for a project of this kind is 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 few 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 Council's ability to levy fees and charges

The three broad beneficiary groups that stand to benefit from the implementation of the interventions are:

- Private property owners
- State and local government
- Local community

Table 38 below provides possible funding sources and collection methods.

Table 38 Funding sources and collection methods

Assets	Funding source	Collection method
Roads	WA Taxpayers and local rate payers (depending on the road)	State Government grant, added to all rate payers in Albany (depending on the road)
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
Developed foreshore	Direct users	Added to all rate payers
Environmental	WA Taxpayers	State Government grant
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*.[13] 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)

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.

[13] Source: www.legislation.wa.gov.au/legislation/statutes.nsf/law_a465.html

5.3.1 Roads

In WA, the road hierarchy mainly consists of six categories.[14] These are:

- Primary distributor; (built up and rural areas)
- Regional distributor; (rural areas)
- District distributor A; (built up areas)
- District distributor B; (built up and rural areas)
- Local distributor; (built up and rural areas)
- Access road. (built up and rural areas)

All primary roads in WA are managed directly by Main Roads WA. Regional distributors and local distributors are directly managed by the local government. District distributors are generally intended to carry traffic between industrial, commercial, and residential areas and generally connect to Primary Distributors.

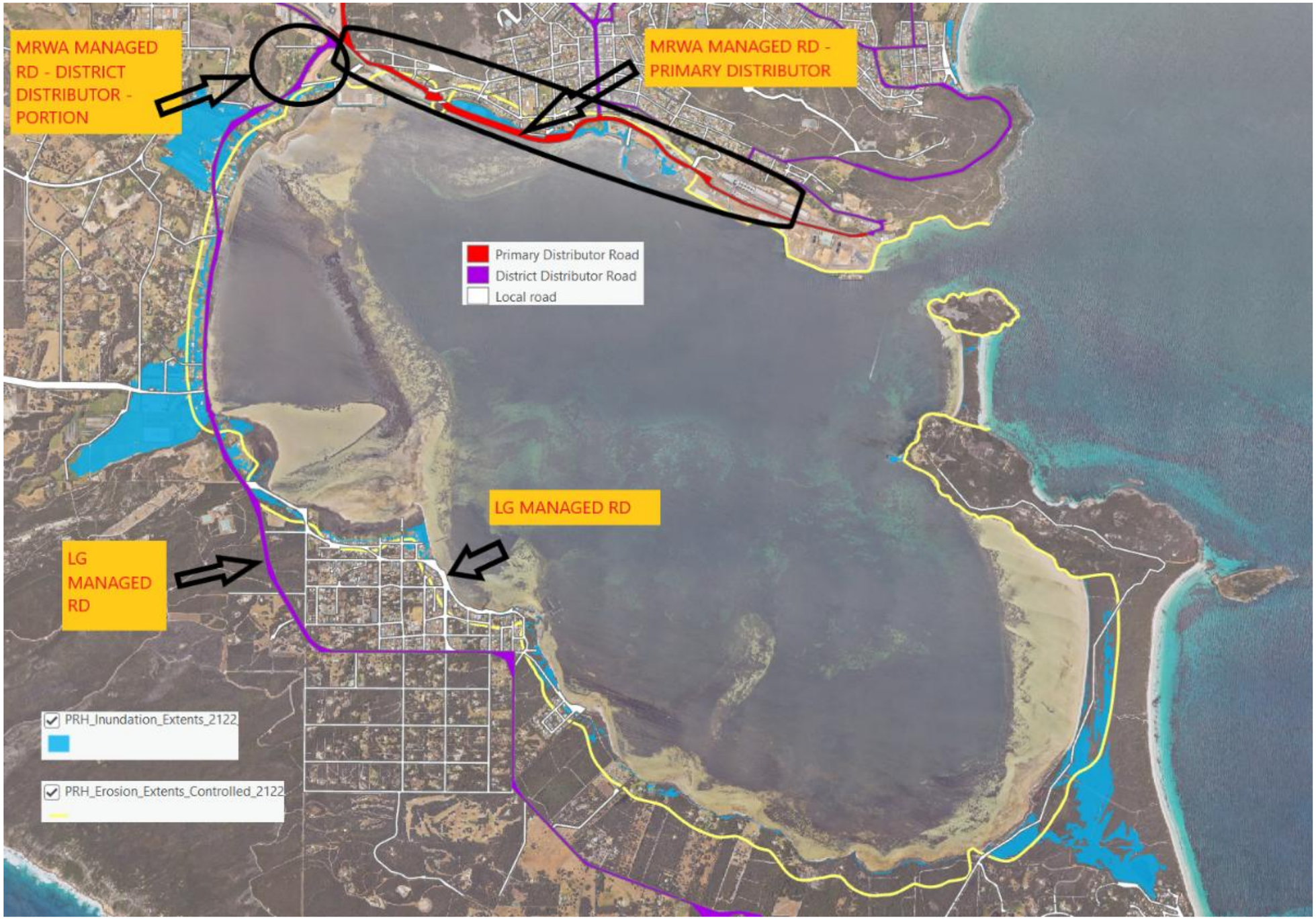
Figure 7, below, shows the road hierarchy within the City of Albany. As shown below, there are mainly three different types of roads that fall within the five MUs. These are:

- Primary distributor (in red);
- District distributor (in purple); and
- Local road (in white).

As per the road hierarchy, Primary Distributors (mainly in MU 1) are managed by Main Roads WA and the rest of the roads in MUs 2, 3, 4, and 5 are managed by the City of Albany. As a result, where roads are identified as being vulnerable to erosion or inundation depending on the road the beneficiary would be either the City or the State government of WA. As a result, funds can be shared between a State Government grant (for larger roads) and the relevant portion (relating to smaller roads) can be collected from all Albany rate payers.

[14] As per the WA Road hierarchy published by Main Roads WA. https://www.mainroads.wa.gov.au/4a1d6f/globalassets/technical-commercial/planning-development/about-the-western-australian-road-hierarchy-website.pdf

Figure 7 Road hierarchy within the study area in the City of Albany



Source: City of Albany

5.4 Capacity of beneficiaries to pay apportioned costs

Based on the estimates used to cost the interventions for the analysis in this report, it appears that most of the interventions cost significantly less than their proposed benefits. However, it should be noted that the costings are estimates and should be interpreted with very high error margins. Noting this, the sections below describe the capacity of beneficiaries to pay for the interventions.

5.4.1 Private beneficiaries

As set out in Table 38, funds from private beneficiaries could be collected by the local government through the rates processes (such as specified rates). The initial CBA analysis does not provide details on parcels and/or properties that would be affected during the various timeframes. The BDA utilised tenure data provided by the City to undertake further analysis on parcels and/or propertied that would be affected. These numbers are shown in the previous section and utilised in the following section to develop a possible funding model for collection of funds from private beneficiaries.

5.4.2 Local government beneficiaries

Local community benefits (which are distinct from private benefits) could be funded through Local Government rates. These would be applied to the whole area. Since, costing estimates are still at concept design, the estimates outlined in previous sections should be considered to have high error margins. When detailed costings are undertaken, if the estimates are shown to be able to be added to rate base without significant difficulty, they can be collected from the rate payers.

However, should any estimates appear likely to cause more difficulty (for example increasing rates by more than 10% of the current base), larger fund collection period should be considered. Alternatively, different funding mechanism may also be sought.

5.4.3 Broader community beneficiaries

Broader community benefits could 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

Further consultation and analysis are required to communicate these initial results and understand concerns from stakeholders (private, residential, commercial) that stand to be affected under the timeframes. Additionally, this consultation can be utilised to ascertain their willingness to pay for the interventions.

6. Recommended next steps

6.1 Background – design phases for large projects

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

- predicting erosion and inundation climate impacts
- predicting the effectiveness of engineering interventions
- 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. Table 39 shows the design stages and cost error margins associated with each stage.

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

Table 39 Order of magnitude design

Design stage	Cost error margins
Optioneering / order of magnitude study	Order of magnitude
Concept design	± 50%
Preliminary 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 Princess Royal Harbour 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 rapid CBA and BDA.
- Updated modelling of the properties/parcels that are affected under both the base case and the proposed intervention for each timeframe.
- A feasibility analysis of the proposed design.

6.3 Distribution of intervention costs between beneficiaries

This section identifies the distribution of development costs for interventions between beneficiaries for all the MUs. This section will also provide an indicative timeline for collection of funds and identify the beneficiaries and possible funding sources. The dollar values shown in this section are all real values (undiscounted) in 2025. The values shown here, therefore, are different to the values shown in Section 4. The tables below assume fund collection will occur over 25 years.

> Private property owners whose properties are projected to be vulnerable in 2047, 2072, and/or 2122 are assumed to begin payments 10 years in advance prior to the implementation of the intervention. This would allow the City to ensure that works can commence early should the need arise due to worsening climate change impacts.

This section provides the distribution of intervention costs between beneficiaries for MUs where the preferred option is an infrastructure option. The following list provides the MUs and the hazard where the preferred option is an infrastructure option.

- MU 1 – Erosion
- MU 2 – Erosion and Inundation
- MU 3 – Erosion and Inundation
- MU 4 – Inundation
- MU 5 – Erosion and Inundation

A key point to note in this section is that for MU 2 and MU 3, repayment calculations are further complicated due to the following factors:

- Nature of intervention against erosion and inundation (i.e. beach nourishment and levee requiring multiple iterations); and
- Progressive nature of damages to privately-owned properties in the MUs.

Hence, the approach taken to MU 2 and MU 3 for calculating repayments are different to MUs 1, 4, and 5.

Noting the above, this section proposes an approach to calculating repayment and suggests a repayment structure to fund the interventions. Additionally, the values provided here are not exact and are rounded figures. This is to reflect that this provides a starting point for the City to begin discussion with affected stakeholders and gain an understanding of their perspective prior to making an informed decision.

Finally, where there are private beneficiaries (specifically for MU 1, 2, 3, and 4), who are benefitting from the proposed intervention, the analysis provides their suggested repayment as a simple value without accounting for interests (or discount rate). This is because, the analysis has assumed that the fund collection will occur over 25 years with property owners beginning to pay 10 years prior to the suggested implementation date in the analysis. This effectively means that the City has enough cash

in hand to start work early if needed. There is a caveat to this, as this will not be the case where intervention is required immediately. Due to this complexity, the above approach is used to provide a starting point negotiation.

6.3.1 MU 1

Erosion

For MU 1, beach nourishment to protect against erosion is required in 2122. The analysis assumes that the beach nourishment would be implemented in 2072 and have a useful life of 10-years. As a result, total real value of the intervention (undiscounted and shown in current values) is expected to be $1,890,000.

Table 42 shows the distribution of intervention costs between beneficiaries.

Table 40 Distribution of intervention costs between beneficiaries, funding source, and possible collection method

Category	% distribution	Funding source	Collection method
Roads	24%	WA Taxpayers/ Direct users	State Government grant and added to all rate payers
Residential property	21%	Property owners	Special levy on relevant properties - collected through rates
Commercial property	1%	Property owners	Special levy on relevant properties - collected through rates
Public and Community	35%	Indirect users	Added to all rate payers
Developed Foreshore	6%	Direct users	Added to all rate payers
Environmental	4%	WA Taxpayers	State Government grant
Heritage	10%	WA Taxpayers	State Government grant

Source: Marsden Jacob analysis

Figure 8 shows the vulnerable properties to erosion across all time periods classified based on ownership (i.e. State-owned, City-owned or privately owned). In MU 1, majority of the area is owned by the State of WA. This is primarily the area in and around the Princess Royal Harbour. There are a number of privately owned properties that are projected to be vulnerable in 2122.

Figure 8 Map showing vulnerable properties to erosion classified by owners

Source: Marsden Jacob Associates based on tenure data provided by City of Albany

Note: Image not to scale

Given that intervention is only required to be implemented in 2072, no immediate action is required for this area. The city can progress the design phases for this intervention later when the high priority actions have occurred. Once detailed design is completed, the funds can start to be collected. We suggest that the funds begin to be collected at least 10-years prior to the intervention implementation. This would allow for some parts of the intervention be funded and the rest be recovered over a 25-year period. An important point to note is that, since the intervention is only required in 2072, there are several factors that will impact the total costs. This includes technology changes, inflation etc.

6.3.2 MU 2

MU 2 is projected be impacted by erosion from 2022 till the end of the analysis period in 2122. Beach nourishment is the preferred option for protection against erosion. As a result, beach nourishment requires refurbishment every 10 years or so. This creates a complex scenario where properties that are projected to be in immediate danger benefit from repeated beach nourishments longer than those properties that are projected to be vulnerable later. As a result, repayment calculations for properties taking into account refurbishments of beach nourishment and projected period of vulnerability becomes complex. Similarly, some parts of MU 2 are also immediately vulnerable to

inundation and, a levee is required to implemented immediately. The levee implementation is similar to beach nourishment as it also requires a reiteration in 2072. As a result, inundation repayments also take encounter similar complexity as erosion for MU 2.

The table below (Table 41), shows the number of iterations of beach nourishment that is expected to occur over the analysis period to protect vulnerable properties from erosion.

Table 41 Beach nourishment iterations benefitting private beneficiaries, and calculation of cost shares

Modelled year of impacts	Number of private properties impacted for the first time (A)	Number of beach nourishments benefitting these properties (B)	Year when beach nourishment occurs									
			2026	2036	2046	2056	2066	2076	2086	2096	2106	2116
2022	15	10	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2047	29	8			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2072	59	6					Yes	Yes	Yes	Yes	Yes	Yes
2122	179	1										Yes

Source: Marsden Jacob analysis

Table 41, above, shows the following:

- Beach nourishment is expected to occur in 2026 and then every 10 years thereafter
- Number of private properties impacted in each time-period (non-cumulative), it can be seen that there are 15 that are already vulnerable, and 29 additional properties are expected to be vulnerable to erosion in 2047 with a further 59 properties becoming vulnerable in 2072 and another 179 in 2122;
- Number of beach nourishments benefitting these properties shows the simple addition of the total number of iterations that occur from just before the properties become vulnerable till the end of the analysis period; and
- Cost shares. This is calculated by multiplying the number of affected private properties in each time-period and the number of beach nourishments benefitting these properties.

Erosion

For MU 2, beach nourishment to protect against erosion is required to be immediately implemented. As a result, the analysis assumes that the beach nourishment would be implemented in 2026 and have a useful life of 10-years. As a result, total real value of the intervention (undiscounted and shown in current values) is expected to be $22,050,000.

Table 42 shows the distribution of intervention costs between beneficiaries.

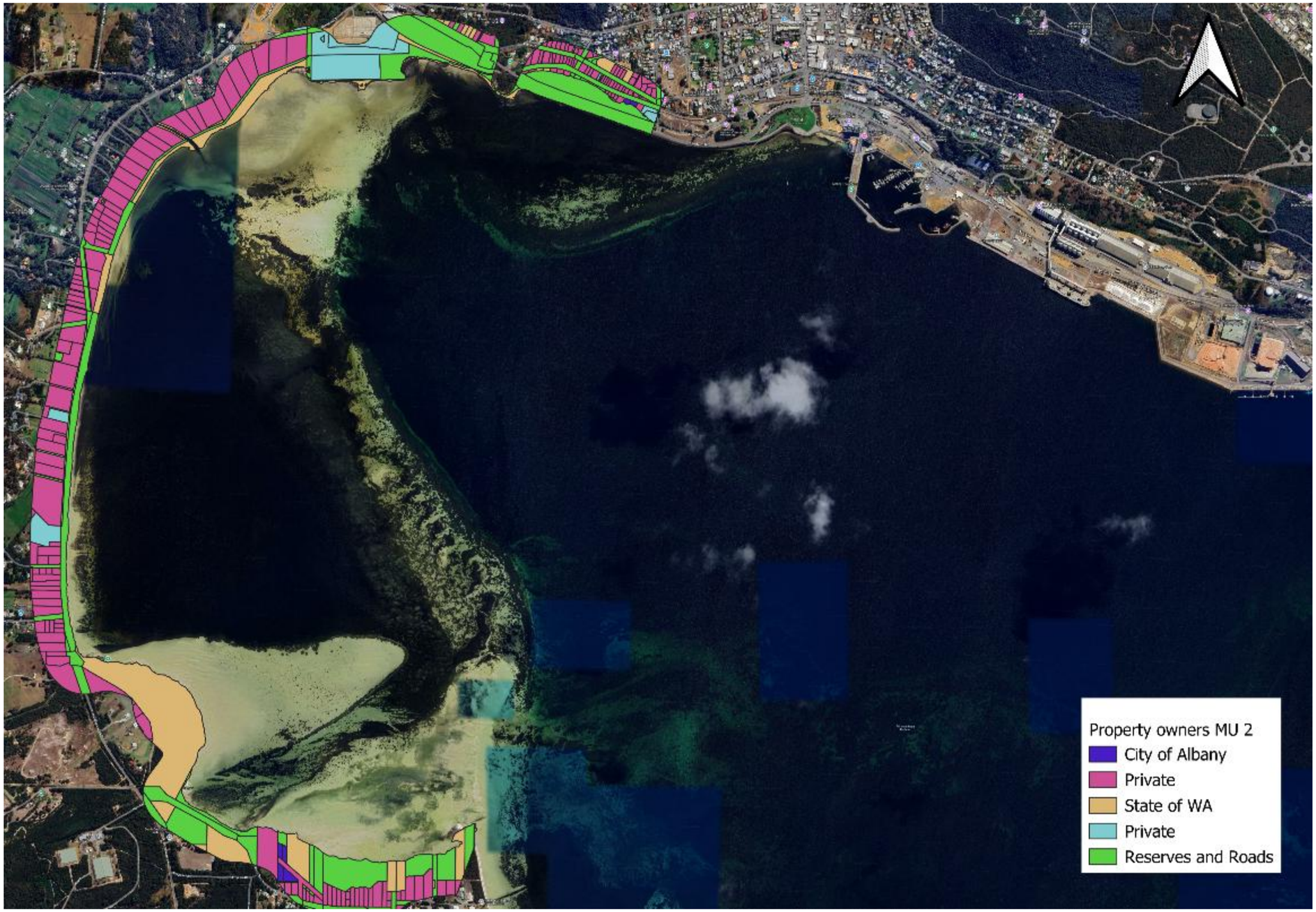
Table 42 Distribution of intervention costs between beneficiaries, funding source, and possible collection method

Category	% distribution	Funding source	Collection method
Roads	28%	WA Taxpayers/Direct users	State Government grant and added to all rate payers
Residential property	11%	Property owners	Special levy on relevant properties - collected through rates
Commercial property	32%	Property owners	Special levy on relevant properties - collected through rates
Public and Community	8%	Indirect users	Added to all rate payers
Developed Foreshore	0%	Direct users	Added to all rate payers
Environmental	20%	WA Taxpayers	State Government grant
Heritage	2%	WA Taxpayers	State Government grant

Source: Marsden Jacob analysis

Figure 9 shows the vulnerable properties to erosion across all time periods classified based on ownership (i.e. State-owned, City-owned or privately owned). In MU 2, majority of the properties are privately-owned. This includes both residential, commercial, and privately-owned land. Note, the map shows two different colours for privately-owned properties as empty-lots are recorded differently in the tenure data. But for purposes of the BDA, they are all treated the same.

Figure 9 Map showing vulnerable properties to erosion classified by owners



Source: Marsden Jacob Associates based on tenure data provided by City of Albany

Note: Image not to scale

This funding model was developed due to the nature of the properties (i.e. the same property being impacted across multiple periods), projected impacts from erosion, and the nature of the intervention (i.e. requiring multiple refurbishments). In brief, properties that are impacted in 2022 also benefit from refurbishing the intervention at regular intervals to maintain effectiveness. Additionally, some large properties in this area are projected to be impacted across multiple time periods. As a result, properties that get impacted across multiple time periods derive additional benefit from multiple refurbishments of the intervention. These additional benefits and the corresponding increase in willingness to pay have not been factored into the funding calculations. The benefit share approach accounts for these to an extent. The funding calculations are based on the number of unique properties that are impacted in the time period.

Given that beach nourishment is immediately required, we recommend that this option be progressed to detailed design stages and funds be collected as early as possible.

Inundation

As set out above in section 4.2.2, inundation risk is modelled at the four intervals (2022, 2047, 2072, and 2122) and a levee is proposed to be implemented immediately and then renewed in 2072.

While the levee is not expected to be expanded, the number of properties benefiting from the flood protection increases over the 100 years of analysis.

It is important to note that although a property may not be identified as benefiting from the levy until a later point (such as 2072) it would have some risk of inundation currently and will breach the 1 in 500 year Average Recurrence Interval threshold used by Water Technology in their report at some point ahead of that timeframe.

Figure 10 below illustrates the risk of inundation across the four time periods modelled in the analysis. Key points to note from the graph are:

- The blue dashed horizontal line shows the risk of an inundation event with a 1 in 500 years average recurrence interval.
- The three red dashed vertical lines indicate 2047, 2072, and 2122.
- The four solid lines (dark blue, red, blue, and green) indicate the cumulative risk of inundation over the analysis period to properties impacted in 2022, 2047, 2072, and 2122.

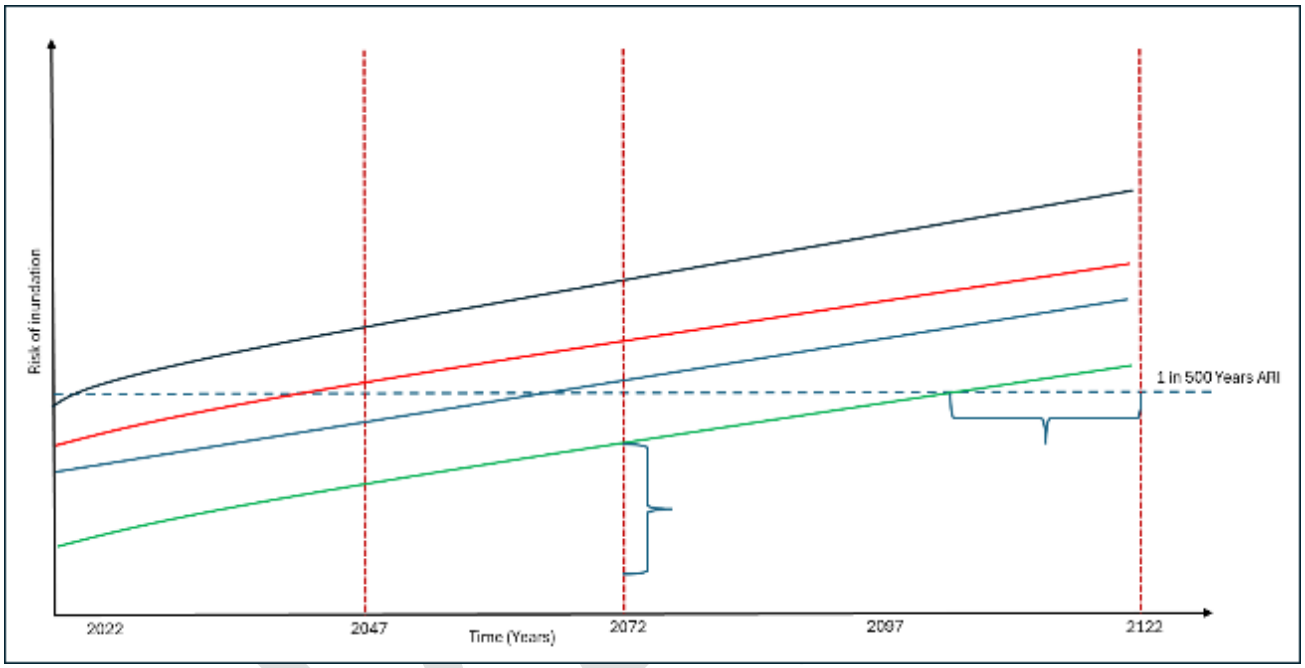
At the four time periods (2022, 2047, 2072, 2122), the modelling predicts that the risk of inundation to the properties will exceed the 1 in 500-year threshold and thus an intervention would become necessary.

Modelling undertaken to date has not provided specific time when the threshold will be crossed (the horizontal line identified under '{' in the figure below) and how much greater the risk would be (the vertical line identified under '{' in the figure below).

The first iteration of the levee has immediate benefit to the properties modelled to be vulnerable in 2022. These properties also benefit from the second implementation of the levee in 2072. Thus,

groups vulnerable in 2022 do benefit proportionally more than the others by implementing the levee twice. Similarly, properties vulnerable in 2047 benefit somewhat from the first levee being built in 2022 as it slightly reduces their risk of inundation. Therefore, these must be accounted for in the benefit shares calculation as part of calculating their annuity. The cost shares calculations are explores in further detail later in this section.

Figure 10 Illustrative graph highlighting the risk of inundation and effectiveness of installing interventions



Source: Marsden Jacob analysis

For MU 2, a levee to protect against inundation is required to be immediately implemented. As a result, the analysis assumes that the levee would be implemented in 2026 and then be replaced in 2072. The total real value of the intervention (undiscounted and shown in current values) is expected to be $2,205,000. Table 43 shows the distribution of intervention costs between beneficiaries.

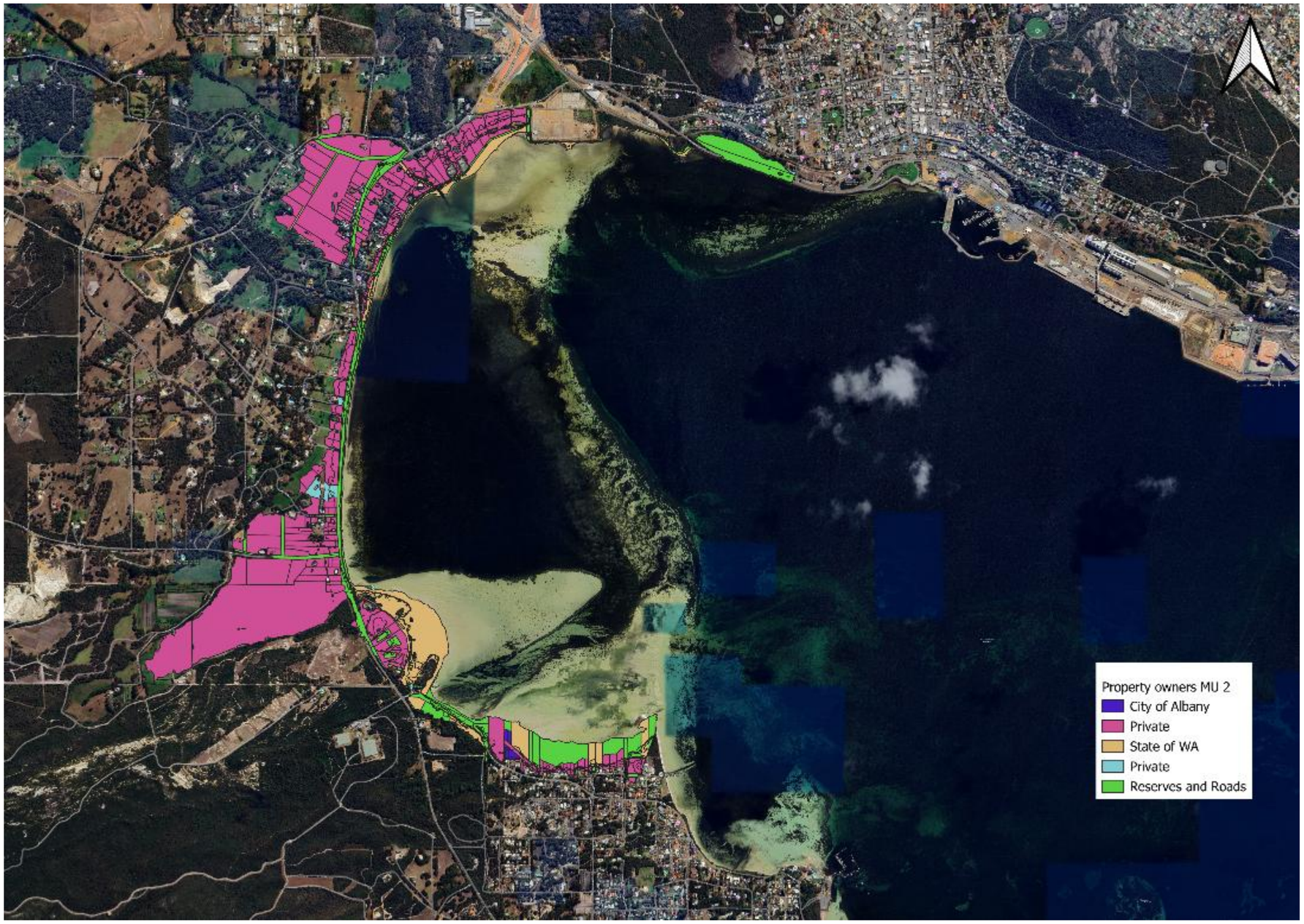
Table 43 Distribution of intervention costs between beneficiaries, funding source, and possible collection method

Category	% distribution	Funding source	Collection method
Roads	5%	WA Taxpayers/Direct users	State Government grant and added to all rate payers
Residential property	41%	Property owners	Special levy on relevant properties - collected through rates
Commercial property	34%	Property owners	Special levy on relevant properties - collected through rates
Public and Community	5%	Indirect users	Added to all rate payers
Developed Foreshore	0%	Direct users	Added to all rate payers
Environmental	15%	WA Taxpayers	State Government grant
Heritage	0%	WA Taxpayers	State Government grant

Source: Marsden Jacob analysis

Source: Marsden Jacob analysis

Figure 11 Map showing vulnerable properties to inundation classified by owners



Source: *Marsden Jacob Associates based on tenure data provided by City of Albany*

Note: Image not to scale

As explained earlier in the section, the benefit share approach for implementing a levee to protect against inundation is further complicated by the following the aspects:

- Properties vulnerable earlier in the analysis gain residual benefits from the levee being implanted a second time; and
- The first implementation of a levee does result in slightly lowering the risk of inundation to the group of properties that are projected to be vulnerable slightly later in the analysis.

As a result, the benefit shares were allocated as follows for each of the groups:

- Properties vulnerable in 2022 – 4.
- Properties vulnerable in 2047 – 3.2.
- Properties vulnerable in 2072 – 2.4.
- Properties vulnerable in 2122 – 1.6.

It is important to note that the above allocations are indicative at this stage. Further modelling would be required to understand exactly what the residual benefits are from implementing a levee. Regardless, this analysis utilises these values to put forward a proposed approach that can be then consulted upon.

Table 44 Annual payment required per property

Output	Value	Description
Total cost of intervention	$2,205,000	The total intervention cost (real and undiscounted) of the intervention based on cost estimates used as part of the Rapid CBA.
Percentage of benefit for private beneficiaries	75%	Proportion of benefits attributed to private beneficiaries (residential and commercial) as a stakeholder.
Total cost to be attributed	$1,648,400	Total cost of intervention * Percentage of benefits for private beneficiaries.

Source: Marsden Jacob analysis

Table 44, above, shows calculations for funds to be collected from private beneficiaries across the life of the intervention. This funding model was developed due to the nature of the properties (i.e. the same property being impacted across multiple periods), projected impacts from inundation, and the nature of the intervention (i.e. requiring multiple refurbishments). In brief, properties that are impacted in 2022 also benefit from refurbishing the intervention at regular intervals to maintain effectiveness. Additionally, some large properties in this area are projected to be impacted across multiple time periods. As a result, properties that get impacted across multiple time periods derive additional benefit from multiple refurbishments of the intervention. These additional benefits and the corresponding increase in willingness to pay have not been factored into the funding calculations. The benefit share approach accounts for these to an extent. The funding calculations

are based on the number of unique properties that are impacted in the time period. Properties that are vulnerable to inundation from 2022 onwards only get calculated once (i.e. in the 2022 column).

Given that a levee is required immediately, it is recommended that this option be progressed to detailed design stages and start collecting funds immediately for a period of 25-years to fund both the initial implementation (imminent) and the replacement around 2072.

6.3.3 MU 3

MU 3 is projected be impacted by erosion from 2022 till the end of the analysis period in 2122. Beach nourishment is the preferred option for protection against erosion. As a result, beach nourishment requires refurbishment every 10 years or so. This creates a complex scenario where properties that are projected to be in immediate danger benefit from repeated beach nourishments longer than those properties that are projected to be vulnerable later. As a result, repayment calculations for properties taking into account refurbishments of beach nourishment and projected period of vulnerability becomes complex.

MU 3 is projected to be vulnerable to inundation beyond 2072 and a levee is required to be implemented immediately. However, the levee is not projected to be refurbished within the timeframe of this analysis.

Erosion

For MU 3, beach nourishment to protect against erosion is required in stages. Beach nourishment to protect the beach northwest of the Princess Royal Sailing Club is required to be immediately implemented. Beach nourishment to protect the beach southeast of the Princess Royal Sailing Club is required from the year 2047.

As a result, the analysis assumes that the beach nourishment would be implemented in 2026 for the northwest area and beach nourishment for southeast area would occur from 2047. Both the nourishments are assumed to have a useful life of 10-years. As a result, total real value of the intervention (undiscounted and shown in current values) is expected to be $14,112,000.

Table 45 shows the distribution of intervention costs between beneficiaries.

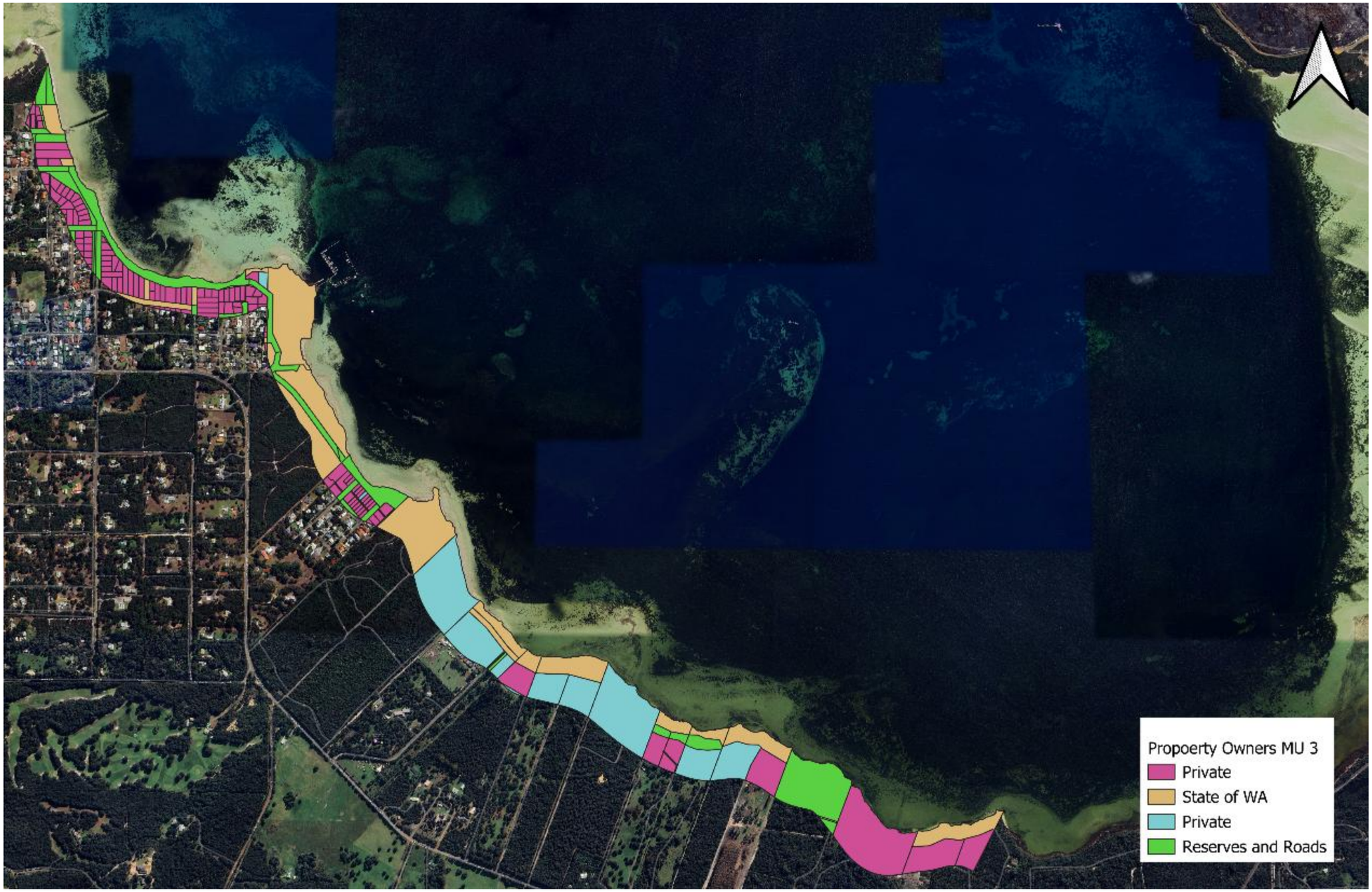
Table 45 Distribution of intervention costs between beneficiaries, funding source, and possible collection method

Category	% distribution	Funding source	Collection method
Roads	14%	WA Taxpayers/Direct users	State Government grant and added to all rate payers
Residential property	28%	Property owners	Special levy on relevant properties - collected through rates
Commercial property	13%	Property owners	Special levy on relevant properties - collected through rates
Public and Community	0%	Indirect users	Added to all rate payers
Developed Foreshore	12%	Direct users	Added to all rate payers
Environmental	23%	WA Taxpayers	State Government grant
Heritage	10%	WA Taxpayers	State Government grant

Source: Marsden Jacob analysis

Figure 12 shows the vulnerable properties to erosion across all time periods classified based on ownership (i.e. State-owned, City-owned or privately owned). In MU 3, majority of the properties are privately-owned. This includes both residential, commercial, and privately-owned land. Note, the map shows two different colours for privately-owned properties as empty-lots are recorded differently in the tenure data. But for purposes of the BDA, they are all treated the same.

Figure 12 Map showing vulnerable properties to erosion classified by owners



Source: Marsden Jacob Associates based on tenure data provided by City of Albany

Note: Image not to scale

Table 46 Annual payment required per property

Output	Value	Description
Total cost of intervention	$14,112,000	The total intervention cost (real and undiscounted) of the intervention based on cost estimates used as part of the Rapid CBA.
Percentage of benefit for private beneficiaries	41%	Proportion of benefits attributed to private beneficiaries (residential and commercial) as a stakeholder.
Total cost to be attributed	$5,798,500	Total cost of intervention * Percentage of benefits for private beneficiaries.

Source: Marsden Jacob analysis

Table 46, above, shows calculations for funds to be collected from private beneficiaries across the life of the intervention. This funding model was developed due to the nature of the properties (i.e. the same property being impacted across multiple periods), projected impacts from erosion, and the nature of the intervention (i.e. requiring multiple refurbishments). In brief, properties that are impacted in 2022 also benefit from refurbishing the intervention at regular intervals to maintain effectiveness. Additionally, some large properties in this area are projected to be impacted across multiple time periods. As a result, properties that get impacted across multiple time periods derive additional benefit from multiple refurbishments of the intervention. These additional benefits and the corresponding increase in willingness to pay have not been factored into the funding calculations. The benefit share approach accounts for these to an extent. The funding calculations are based on the number of unique properties that are impacted in the time period. Properties that are vulnerable to erosion from 2022 onwards only get calculated once.

Given that beach nourishment is immediately required to protect at least part of the MU, we recommend that this option be progressed to detailed design stages and funds be collected as early as possible. The annual payments in the table above show the payments required to fund the costs of nourishment for both the northwest and the southeast area. As a result, collecting funds over a 25-year period would allow for funds to be collected for all the works.

Inundation

For MU 3, a levee to protect against inundation is required to be implemented in 2072. As a result, the analysis assumes that the levee nourishment would be implemented in 2072. The total real value of the intervention (undiscounted and shown in current values) is expected to be $535,000.

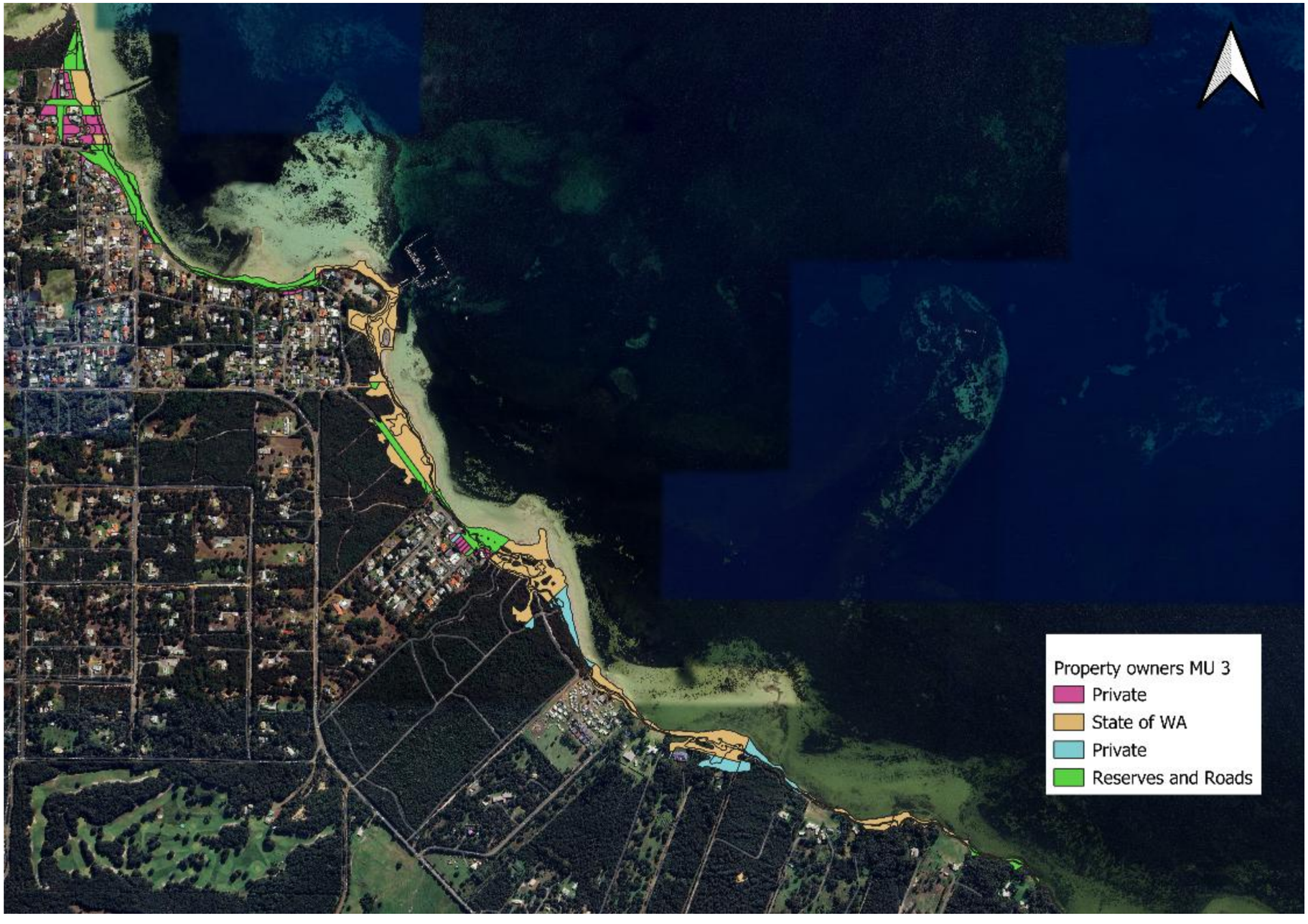
Table 47 shows the distribution of intervention costs between beneficiaries.

Table 47 Distribution of intervention costs between beneficiaries, funding source, and possible collection method

Category	% distribution	Funding source	Collection method
Roads	18%	WA Taxpayers/Direct users	State Government grant and added to all rate payers
Residential property	13%	Property owners	Special levy on relevant properties - collected through rates
Commercial property	18%	Property owners	Special levy on relevant properties - collected through rates
Public and Community	0%	Indirect users	Added to all rate payers
Developed Foreshore	0%	Direct users	Added to all rate payers
Environmental	47%	WA Taxpayers	State Government grant
Heritage	3%	WA Taxpayers	State Government grant

Source: Marsden Jacob analysis

Figure 13 Map showing vulnerable properties to inundation classified by owners



Source: Marsden Jacob Associates based on tenure data provided by City of Albany

Note: Image not to scale

Table 48 Annual payment required per property

Output	Value	Description
Total cost of intervention	$535,500	The total intervention cost (real and undiscounted) of the intervention based on cost estimates used as part of the Rapid CBA.
Percentage of benefit for private beneficiaries	21%	Proportion of benefits attributed to private beneficiaries (residential and commercial) as a stakeholder.
Total cost to be attributed	$112,900	Total cost of intervention * Percentage of benefits for private beneficiaries.

Source: Marsden Jacob analysis

Table 48 above, shows calculations for funds to be collected from private beneficiaries across the life of the intervention. Note that non-infrastructure-based interventions form part of the management for properties vulnerable to inundation in 2022 and 2047. This funding model was developed due to the nature of the properties (i.e. the same property being impacted across multiple periods), projected impacts from inundation, and the nature of the intervention (i.e. requiring multiple refurbishments). In brief, properties that are impacted in 2022 also benefit from refurbishing the intervention at regular intervals to maintain effectiveness. Additionally, some large properties in this area are projected to be impacted across multiple time periods. As a result, properties that get impacted across multiple time periods derive additional benefit from multiple refurbishments of the intervention. These additional benefits and the corresponding increase in willingness to pay have not been factored into the funding calculations. The benefit share approach accounts for these to an extent. The funding calculations are based on the number of unique properties that are impacted in the time period. Properties that are vulnerable to inundation from 2072 onwards only get calculated once.

Given that intervention is only required in 2072, no immediate action is required for this area. The city can progress the design phases for this intervention later when the high priority actions have occurred. Once detailed design is completed, the funds can start to be collected. We suggest that the funds begin to be collected at least 10-years prior to the intervention implementation. This would allow for some parts of the intervention be funded and the rest be recovered over a 25-year period. An important point to note is that, since the intervention is only required in 2072, there are several factors that will impact the total costs. This includes technology changes, inflation etc. As a result, the values shown here must be interpreted with a high error margin.

6.3.4 MU 4

Inundation

For MU 4, a levee to protect against inundation is required to be implemented in 2047. As a result, the analysis assumes that the levee nourishment would be implemented in 2047.The total real value of the intervention (undiscounted and shown in current values) is expected to be $393,750.

Table 49 shows the distribution of intervention costs between beneficiaries.

Table 49 Distribution of intervention costs between beneficiaries, funding source, and possible collection method

Category	% distribution	Funding source	Collection method
Roads	4%	WA Taxpayers/Direct users	State Government grant and added to all rate payers
Residential property	4%	Property owners	Special levy on relevant properties - collected through rates
Commercial property	0%	Property owners	Special levy on relevant properties - collected through rates
Public and Community	1%	Indirect users	Added to all rate payers
Developed Foreshore	0%	Direct users	Added to all rate payers
Environmental	65%	WA Taxpayers	State Government grant
Heritage	26%	WA Taxpayers	State Government grant

Source: Marsden Jacob analysis

Figure 14 Map showing vulnerable properties to inundation classified by owners

Source: *Marsden Jacob Associates based on tenure data provided by City of Albany*

Note: Image not to scale

Given that intervention is only required in 2072, no immediate action is required for this area. The city can progress the design phases for this intervention later when the other high priority actions have occurred. Once detailed design is completed, the funds can start to be collected. We suggest that the funds begin to be collected at least 10-years prior to the intervention implementation. This would allow for some parts of the intervention be funded and the rest be recovered over a 25-year period. An important point to note is that, since the intervention is only required in 2072, there are several factors that will impact the total costs. This includes technology changes, inflation etc. As a result, the values shown here must be interpreted with a high error margin.

6.3.5 MU 5

The distribution of intervention costs to beneficiaries that are shown below do not consider the potential costs to the Harbour from inundation and/or erosion of MU 5. Intervention to protect MU 5 from erosion and inundation also has potential benefits to the Princess Royal Harbour. The report from Water Technology[15] indicates that that the erosion of narrow spit of land leading to Uredale Point would result in increased currents impacting the harbour. However, the technical analysis has not quantified the impact to the Harbour. For this reason, the harbour is not listed as a potential beneficiary in the results shown below. Accordingly, these results must be interpreted with this in mind. Additionally, in MU 5 there are no privately-owned properties. Hence, collection of funds per property analysis was not required for this MU. The key beneficiary in MU 5 is the State of WA as the identified owner of key assets within the impacted areas of the MU.

Erosion

For MU 5, beach nourishment to protect against erosion is required in 2047. The analysis assumes that the beach nourishment would be implemented in 2047 and have a useful life of 10-years. As a result, total real value of the intervention (undiscounted and shown in current values) is expected to be $2,268,000.

Table 50 shows the distribution of intervention costs between beneficiaries.

[15] Available at: https://www.albany.wa.gov.au/Profiles/albany/Assets/ClientData/22040008_PRH_CHRMAP_R07v02_untracked.pdf

Table 50 Distribution of intervention costs between beneficiaries, funding source, and possible collection method

Category	In 2025 values	% distribution	Funding source	Collection method
Roads	$0	0%	WA Taxpayers/ Direct users	State Government grant and added to all rate payers
Residential property	$0	0%	Property owners	Special levy on relevant properties - collected through rates
Commercial property	$0	0%	Property owners	Special levy on relevant properties - collected through rates
Public and Community	$0	0%	Indirect users	Added to all rate payers
Developed Foreshore	$1,100	0%	Direct users	Added to all rate payers
Environmental	$451,600	20%	WA Taxpayers	State Government grant
Heritage	$1,815,200	80%	WA Taxpayers	State Government grant

Source: Marsden Jacob analysis

Given that intervention is only required in 2047, no immediate action is required for this area. The city can progress the design phases for this intervention later when the high priority actions have occurred. Once detailed design is completed, the funds can start to be collected. We suggest that the funds begin to be collected at least 10-years prior to the intervention implementation. This would allow for some parts of the intervention be funded and the rest be recovered over a 25-year period. An important point to note is that, since the intervention is only required in 2047, there are several factors that will impact the total costs. This includes technology changes, inflation etc. As a result, the values shown here must be interpreted with a high error margin.

Inundation

For MU 5, a levee to protect against inundation is required to be implemented in 2072. As a result, the analysis assumes that the levee nourishment would be implemented in 2072. As a result, total real value of the intervention (undiscounted and shown in current values) is expected to be $110,250.

Table 51 shows the distribution of intervention costs between beneficiaries.

Table 51 Distribution of intervention costs between beneficiaries, funding source, and possible collection method

Category	In 2025 values	% distribution	Funding source	Collection method
Roads	$0	0%	WA Taxpayers/ Direct users	State Government grant and added to all rate payers
Residential property	$0	0%	Property owners	Special levy on relevant properties - collected through rates
Commercial property	$0	0%	Property owners	Special levy on relevant properties - collected through rates
Public and Community	$0	0%	Indirect users	Added to all rate payers
Developed Foreshore	$30	0%	Direct users	Added to all rate payers
Environmental	$15,900	14%	WA Taxpayers	State Government grant
Heritage	$94,300	86%	WA Taxpayers	State Government grant

Source: Marsden Jacob analysis

Given that intervention is only required in 2072, no immediate action is required for this area. The city can progress the design phases for this intervention later when the high priority actions have occurred. Once detailed design is completed, the funds can start to be collected. We suggest that the funds begin to be collected at least 10-years prior to the intervention implementation. This would allow for some parts of the intervention be funded and the rest be recovered over a 25-year period. An important point to note is that, since the intervention is only required in 2072, there are several factors that will impact the total costs. This includes technology changes, inflation etc. As a result, the values shown here must be interpreted with a high error margin.

6.4 Recommendations

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

- the recommended options are progressed to a further level of design and costing (e.g., move towards Functional design).
- 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.
- the funding approach in the BDA is consulted upon with stakeholders.
- 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.

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