

# **COASTAL MANAGEMENT STRATEGY - BENEFIT DISTRIBUTION ANALYSIS**

## **SHIRE OF COCOS (KEELING) ISLANDS**

**February 2024**



**FAR lane**

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## 1 RELIANCE AND DISCLAIMER

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## 2 EXECUTIVE SUMMARY

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### Background

This report provides a Benefit Distribution Analysis (BDA) for the Cocos Keeling Islands (CKI) Coastal Hazard Risk Management Adaptation Plan (CHRMAP) 2024.

The coastal hazards of erosion and inundation, combined with rising sea levels, are impacting the safety and existence of coastal communities around the globe. CKI consists of low-lying islands that are already being impacted by these coastal hazards. CKI's two populated islands, Home Island and West Island, are considered in detail in this report. CKI's unpopulated islands are also considered for loss of public amenity.

Where coastal hazards are deemed a risk to a community, a range of interventions may occur to mitigate this risk. These includes consideration of options to avoid impacts, retreat, accommodate or to protect.

When investment is made in interventions, different individuals, enterprises or groups may experience different levels of benefit. This report systematically estimates benefits to different parties as the result of interventions in CKI.

West Island's and Home Island's risk of inundation and erosion is so great that potential interventions other than relocation have been assessed as cost prohibitive and will likely be ineffective against the combination of erosion and inundation. As such, this report makes the assumption that the CKI communities will eventually be relocated.

For completeness, FAR Lane has estimated the value of benefits that would be affected by coastal hazards in CKI by 2068. These benefits are based on the estimated maximum costs of relocating and incorporating the entire CKI community into an alternative location in Western Australia (WA). The beneficiaries are agencies and community members who:

- Do not have to unsustainably invest in the home that is not economically feasible to sustain (the CKI).
- Can avoid the physical and economic costs of considerable trauma from ongoing disasters due to coastal hazards.
- Avoid the ongoing costs for defending the islands from coastal erosion and inundation.

The BDA in this report is therefore developed to:

- Elicit a shared understanding of which parties will benefit from coastal hazard interventions.
- Ensure a broad understanding is developed by capturing a range of benefits from different perspectives.
- Inform any future decision-making relating to funding contributions for interventions (noting that a cost distribution analysis is out of scope for this report).

## Methodology

The BDA quantifies the estimated proportional benefit accruing to relevant groups of asset holders against a do-nothing base case, thereby informing future structures for robust and fair cost allocations in the future. The BDA takes a broad view of the benefits resulting from coastal management interventions, including consideration of benefits to landowners, tenants, agencies, interest groups, and the community as a whole.

For this work, benefit is defined as “the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA”. A key assumption is that coastal management interventions will result in beneficiaries continuing to enjoy these benefits in perpetuity.

For the purposes of this BDA, essential services infrastructure is defined as infrastructure without which a settlement would not sustainably exist on CKI. Examples of essential services infrastructure includes infrastructure for water, wastewater, telecommunications, fuel, power and ports (particularly important given CKI imports most of its food and all fuel by sea).

Maintaining this infrastructure against coastal hazards is essential to maintaining the existence of the CKI community and adjacent activities. Given the essential nature of this infrastructure and the community’s reliance on it, this infrastructure is not included in the BDA as the benefit accrues equally to all community members. However, for completeness, it is estimated total value of essential services infrastructure on CKI is \$1.5 billion, noting this figure is provided by the Australian Government.

Non-essential infrastructure (distinct to essential services infrastructure) is considered within this BDA as a community on CKI could arguably continue to exist without it. Note that non-essential infrastructure is not considered with Net Present Value calculations, but instead is presented in current values of built form to represent indicative costs of relocating the infrastructure.

It is important to note that CKI is unusual in that there is very little privately held land. Instead, the islands comprise of Crown Land, and land held by the Cocos (Keeling) Islands Lands Trust (Trust) of which the Shire of CKI is the administrator and Trustee. The majority of residents are renters in houses owned by the Trust. Therefore, while much of the benefit is noted as preserved for private dwellings, most of this benefit ultimately flows to the Trust.

## Summary of findings

A summary of all owner and community benefit that will be impacted by coastal hazards at CKI is at Table 1. All calculations are based on the assumption that interventions to mitigate the impact of erosion and inundation would successfully protect the assets.

Table 1 - Summary of economic Net Present Value in CKI that will be impacted by erosion and inundation

Beneficiary / community benefit	Net Present Value	Percentage of total benefit
Private Dwellings	\$87,021,600	45.8%
Private Commercial Properties	\$37,185,729	19.6%
Environmental Amenity	\$9,355,068	4.9%
Public Sector Revenue - rates	\$5,773,262	3.0%
Economic Activity - wages	\$50,628,977	26.7%
<b>Total</b>	<b>\$189,964,636</b>	<b>100.0%</b>

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value of assets included in the BDA, that will potentially be impacted by coastal hazards in CKI by 2068 is approximately \$190 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 65.4% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust), with private dwellings (predominantly owned by the Trust) and lost economic activity from lost wages constituting the highest preserved values.

As noted above, non-essential infrastructure is not considered with Net Present Value calculations but instead is presented in current values of built form to represent indicative costs of relocating the infrastructure. Noting this, the approximate total value of replacement of non-essential infrastructure in CKI is \$78.9 million (2023 dollars). None of the value of the non-essential infrastructure would go to private beneficiaries.

The essential services infrastructure is \$1.5 billion for the entirety of CKI.

In summary, supporting economic Net Present Value of \$190 million in CKI is:

- \$78.9 million in non-essential infrastructure in CKI.
- \$1.5 billion of essential services infrastructure across all CKI.

Short term interventions are possible to extend the enjoyment of CKI's coastal lifestyle but are likely to be sacrificial in the long term, and any planning should be cognisant of this. Notwithstanding, should any protection be proposed to mitigate the risk of flooding, 65.4% of the economic Net Present Value of providing coastal hazard adaptation would be apportioned to private interests (including the Trust), who, under the beneficiary pays principal outlined in State Planning Policy 2.6, should be obliged to contribute to protection measures.

Given the extreme likelihood of erosion and inundation, the community of CKI will likely need to be relocated in the medium term. In the case of retreat, no intervention is being proposed that assures "the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA". Therefore, caution should be used in consideration of a BDA as sole means of considering the preserved benefits of CKI.

### 3 INTRODUCTION

This report is intended as an attachment to the Cocos Keeling Islands (CKI) Coastal Hazard Risk Management Adaptation Plan 2023 (Shape Urban, 2024). Some key background is included here for completeness. Please note this section draws heavily on Shape Urban, 2024.

#### 3.1 BACKGROUND AND PROJECT SCOPE

The coastal hazards of erosion and inundation, combined with rising sea levels, are impacting the safety and existence of coastal communities around the globe. Coastal flooding and long-term shoreline recession risk making parts of many coastal communities untenable in the longer term unless action is taken.

CKI comprises several islands which face unique challenges in managing coastal hazards and sea level rise, due to being low lying with sandy shorelines and narrow foreshore buffers and chronic erosion along the ocean-facing shores. The CHRMAP process considers how best to mitigate these effects and allow for informed decisions regarding land use and development in its coastal areas.

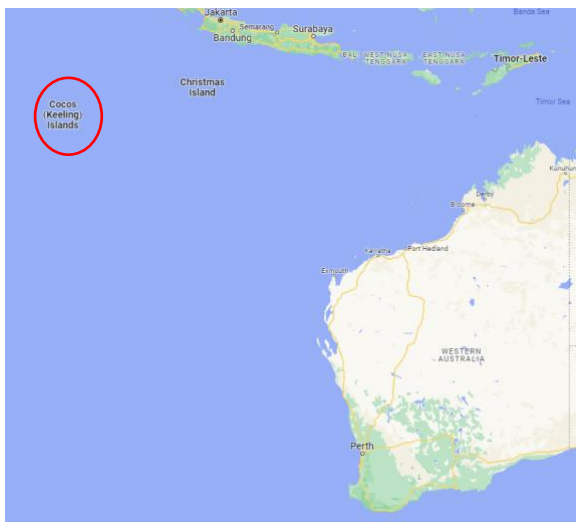
Where coastal hazards are deemed a risk to a given community, a range of interventions may be considered to mitigate this risk. These includes consideration of options to ‘avoid’ impact, ‘retreat’, ‘accommodate’ or to ‘protect’. CKI already has experience in this space, with the sandbags already installed to slow the coastal erosion process on West Island (protect).

When investment is made in interventions, different people or groups may experience different levels of benefit. This report develops a Benefit Distribution Analysis (BDA) to systematically estimate benefits to different parties as the result of interventions.

#### 3.2 STUDY AREA – COCOS (KEELING) ISLANDS

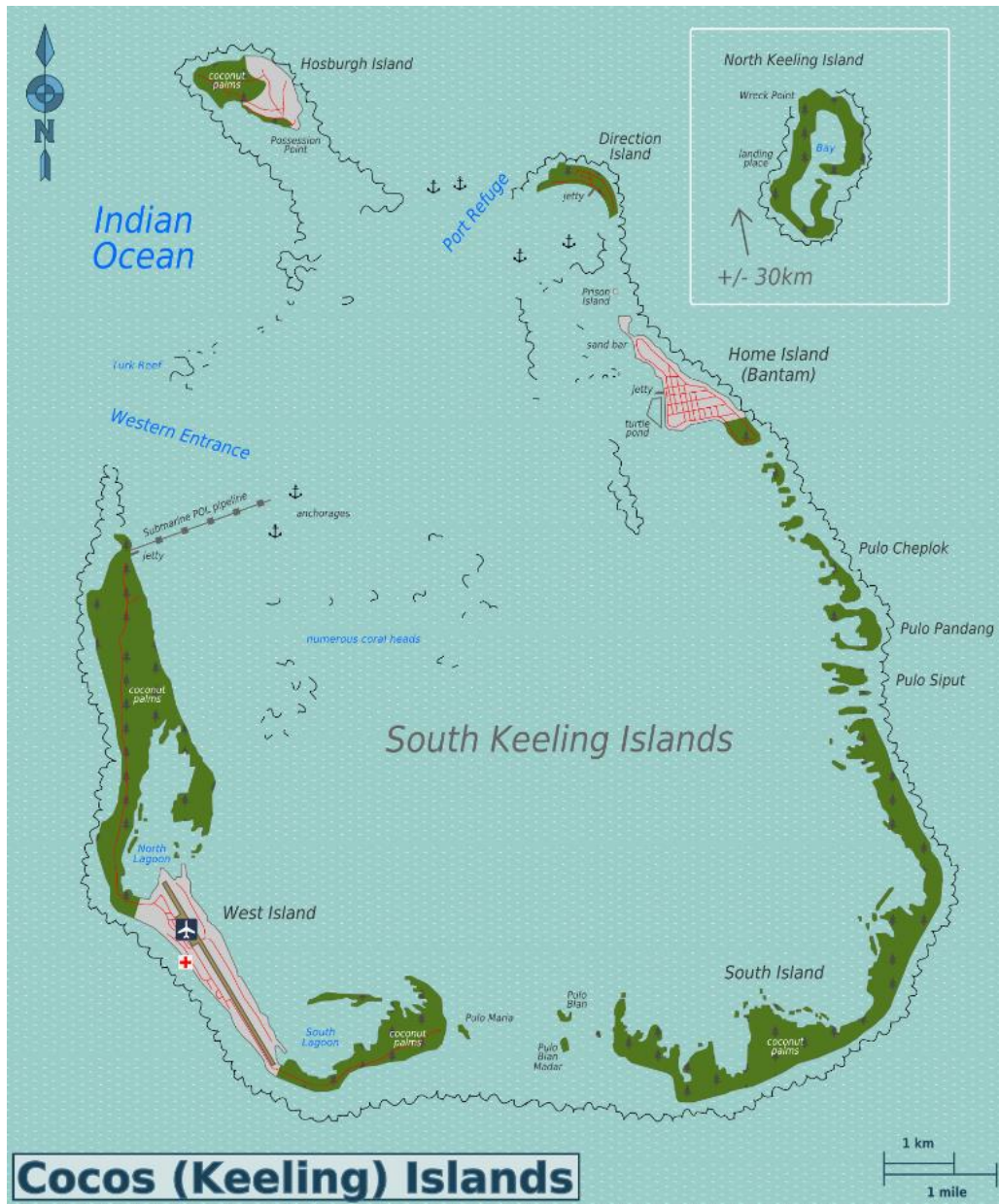
CKI are located in the Indian Ocean to the north west of Western Australia, and south west of Java (Figure 1). CKI consists of many islands surrounding a lagoon, all of which are low lying with a maximum height above mean sea level of eight metres. The only populated islands are Home Island and West Islands, which are the subject of this CHRMAP. A map of CKI is at Figure 2, with maps of West Island and Home Island respectively at Figure 3 and Figure 4.

Figure 1 - Map of Cocos (Keeling) Islands and Western Australia



Source: Google Maps, 2023.

Figure 2 - Map of Cocos (Keeling) Islands



Source: Wikimedia Commons, 2023.

West Island is the largest island in the CKI group (Figure 3). Development is primarily concentrated around the airport and West Island Settlement located in the southern region of the island. The island has a history of persistent erosion along its western ocean-facing shore, prompting the construction of coastal protection structures since the 1970s to address ongoing concerns regarding beach erosion. Over the past decade, instances of erosion and coastal flooding have been recorded during storm events, including two significant storm events occurring in 2013/2014 that threatened the island's already limited road infrastructure.

Home Island, which hosts the main population settlement, is situated on the eastern side of CKI (Figure 4). Home Island is also prone to coastal flooding, but from the lagoon-side rather

than open ocean. As a result, over the past decade three seawalls have been constructed along the lagoon-facing beaches. Infrastructure is reasonably well set back in most areas, and most shorelines have remained stable.

Figure 3 - Map of West Island



Source: Australian Government and Department of Primary Industries and Regional Development, 2019.

Figure 4 - Map of Home Island



Source: Australian Government and Department of Primary Industries and Regional Development, 2019.

South Island, Direction Island, Pulu Laur (Horsburgh Island) and some other smaller islands are all uninhabited and contain limited infrastructure, noting that numerous pondoks (traditional fishing huts) are scattered throughout the islands.

### 3.3 POLICY CONTEXT

CKI is a Territory of Australia that falls under jurisdiction of the Australian Government. However, legislative powers are applied as Western Australian laws as per *The Cocos (Keeling) Islands Act 1955*. The Government of Western Australia provides a range of services to CKI under formal agreements with the Australian Government. The Shire of CKI (Shire) operates under the same legislation as all local governments on mainland Australia.

The Western Australian Planning Commission (WAPC) has carriage of Western Australia's (and therefore CKI's) governing policy for coastal management via State Planning Policy No. 2.6 - State Coastal Planning Policy (SPP 2.6; 2013a). To guide land use and development decision making in coastal zones, SPP 2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan in accordance with WAPC's Coastal Hazard Risk Management and Adaptation Planning Guidelines (2019).

SPP 2.6 includes aims to establish coastal foreshore reserves that provide allowance for the protection, conservation and enhancement of coastal values across the state. This process includes identifying existential or intolerable risks to communities and other stakeholders, and developing suitable mitigation approaches that align with SPP 2.6.

### 3.4 PREVIOUS STUDIES

In 2019 the Australian Government, DPLH and the Shire commenced a CHRMAP for CKI, with the Cocos (Keeling) Islands Coastal Vulnerability Study - Coastal Vulnerability Assessment Report (the CVA Report) (RHDHV, March 2021) developed for Home Island and West Island.

As per of SPP 2.6 and CHRMAP guidelines, the CVA identified coastal hazard risks, and the vulnerability of built and natural assets. The CVA found that CKI's coastline is exposed and vulnerable to erosion and inundation. This situation is likely to worsen over time as sea levels rise, potentially impacting critical infrastructure including housing, roads, and tourism assets.

## 4 OVERVIEW OF POTENTIAL COASTAL HAZARD IMPACT ON CKI

This section contains a high-level summary of CKI's potential vulnerability from erosion and inundation. As stated in the CHRMAP (Shape Urban, 2023), these vulnerabilities are measured against the following benchmarks:

- Vertical sea level rise of 0.4m for 50-year planning timeframes (2068)
- Vertical sea level rise of 0.9m for 100-year planning timeframes (2118).

Detailed assessments can be found in Shape Urban 2023.

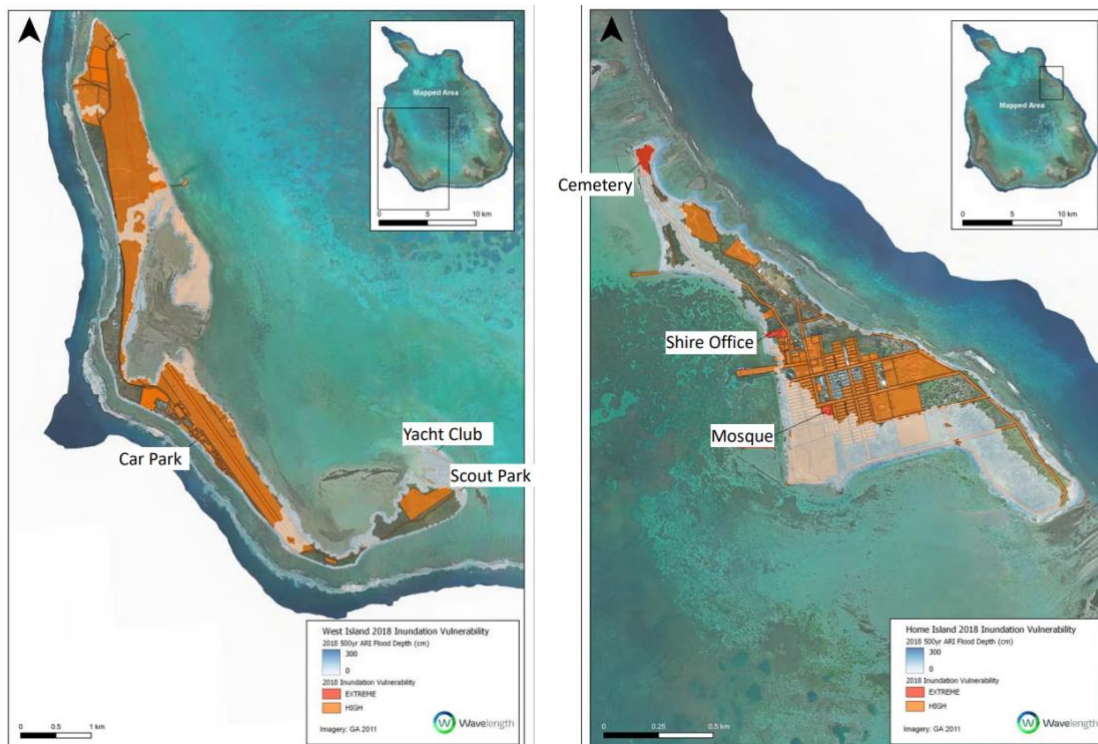
The considered impacts are:

- **Inundation** - Storm surges and increased mean sea levels will create flooding in areas adjacent to shorelines. The risk zone is measured based on 500-year average return interval (ARI) storms, combined with 100 years of sea level rise.
- **Erosion** – Coastlines composed primarily of loose sediment (such as beaches) recede until a new equilibrium shoreline is found further inland. This report considers predicted erosion levels at 2068.

Inundation vulnerability is shown at Figure 5 for 2018, and Figure 6 for 2068. Erosion risk is shown for 2068 at Figure 7 and

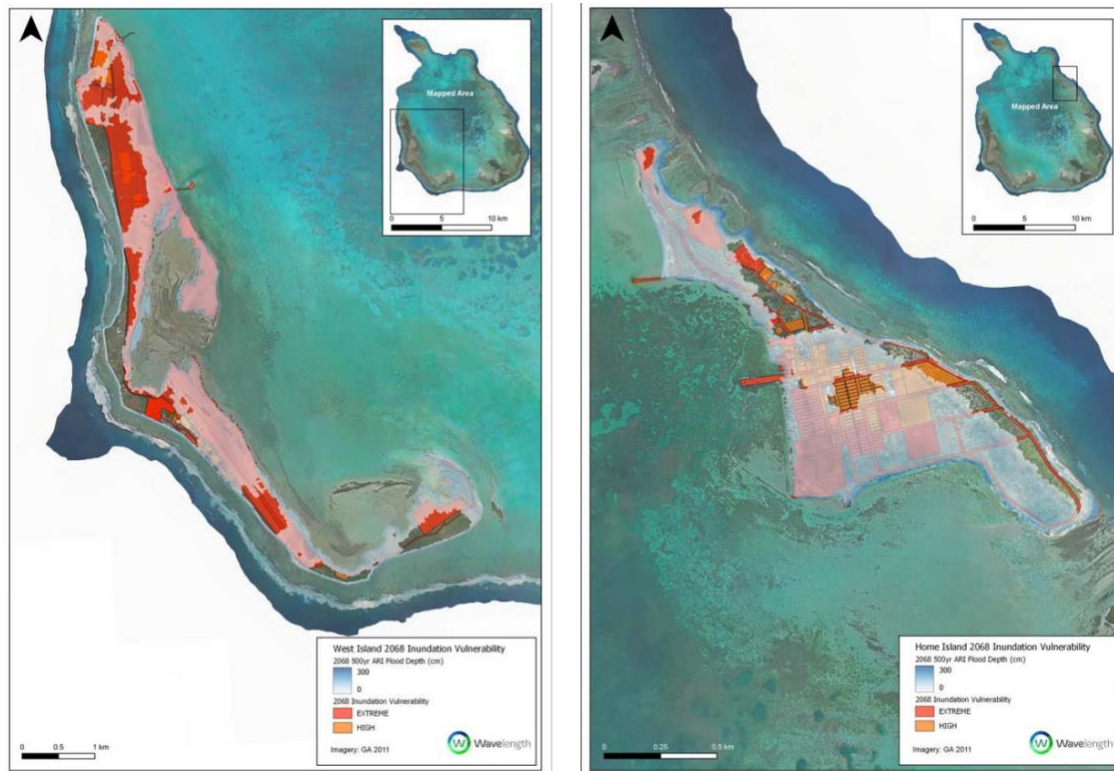
Figure 8.

Figure 5 - Inundation vulnerability for West Island (left) and Home Island, 2018



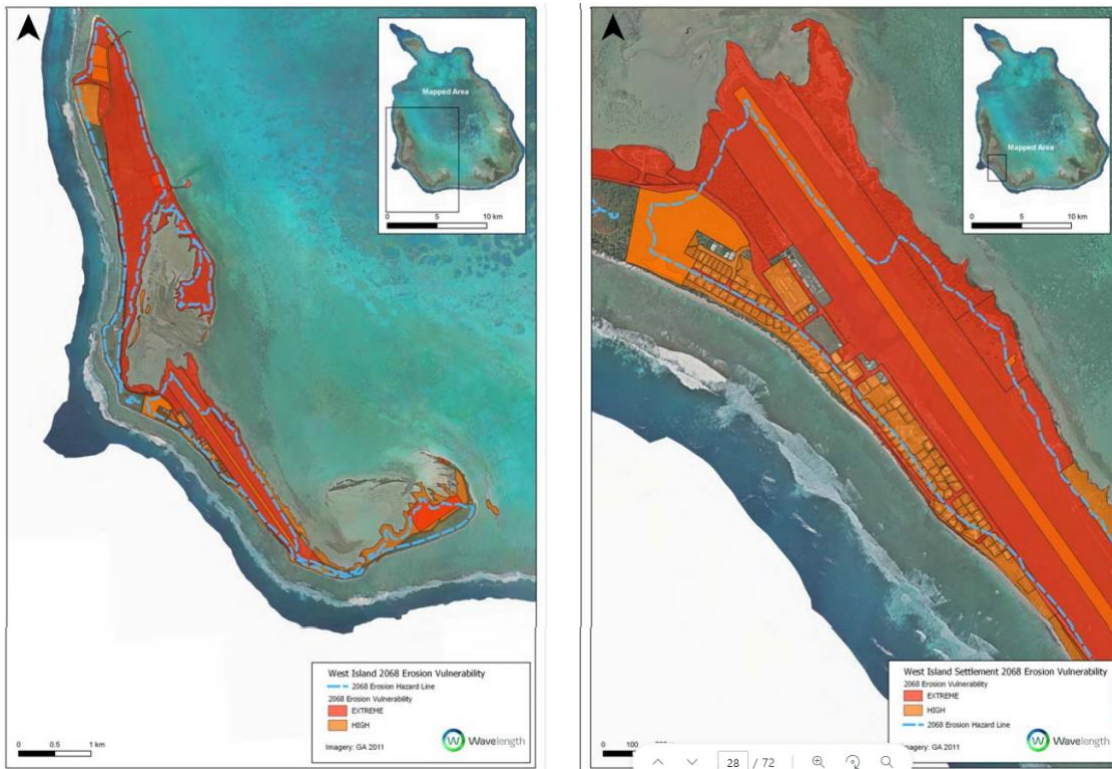
Source: Shape Urban, 2024.

Figure 6 - Inundation risk for West Island (left) and Home Island, 2068



Source: Shape Urban, 2024.

Figure 7 – Erosion risk for West Island, and West Island settlement, 2068



Source: Shape Urban, 2024.

Figure 8 - Erosion risk for Home Island, 2068



Source: Shape Urban, 2024.

The analysis indicates:

- Both West Island and Home Island are already at high risk of inundation.
- By 2068, almost all of West Island will be at extreme risk of inundation, and almost all of Home Island will be at either high or extreme risk of inundation.
- By 2068, all of West Island will be at high or extreme risk of erosion (including the settlement), while significant parts of Home Island will be at high or extreme risk of erosion.

These findings are summarised at Table 2.

Table 2 - Summary of CKI inundation and erosion risk

Island	Inundation risk - 2018	Inundation risk - 2068	Erosion risk – 2018	Erosion risk- 2068
West Island	High	Extreme	n/a	Extreme/High
Home Island	High	Extreme/High	n/a	Extreme/High

Source: Shape Urban, 2023.

## 5 METHODOLOGY OVERVIEW

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As noted in Section 4, both West Island's and Home Island's risk of inundation and erosion is so great that potential interventions other than relocation will be cost prohibitive and will likely be ineffective against the combination of erosion and inundation. Given this, this report makes the assumption that the community will eventually be relocated.

Notwithstanding this, for completeness FAR Lane has estimated the value of benefits that would be impacted by coastal hazards in CKI by 2068 (see Section 6). These benefits are based on the maximum costs of relocating and incorporating the entire CKI community into an alternative location in WA that is safe from coastal hazards. The beneficiaries are community members who:

- Do not have to unsustainably invest in a location that is not economically feasible to sustain (i.e. the CKI).
- Can avoid considerable trauma from ongoing disasters due to coastal hazards.
- Avoid the ongoing costs for defending the islands from coastal erosion and inundation.

Assumptions include:

- Preserved benefits include costs for property value, infrastructure (services and built form), and community benefits.
- Costs do not include land, or efficiencies gained from moving the CKI community to a better serviced location.
- Environmental amenity is captured on the assumption that the community will be provided with the same level of amenity when relocated.

Methodology for these calculations is below. All calculations assume that interventions to mitigate the impact of erosion and inundation successfully protect the assets.

### **Background to Benefit Distribution Analysis (BDA)**

Typically, a BDA is developed to:

- Develop a shared understanding of who will benefit from coastal hazard interventions (existing and future).
- Ensure a broad understanding is developed by capturing a range of benefits from different perspectives.
- Inform future decision-making relating to funding contributions for interventions.

The report breaks down the communities into "management units" which allows for the required level of detail for assessment under the BDA (see section 8.2). The BDA captures and, where possible, quantifies relevant proportional benefits associated with existing and proposed protection works identified in the CHRMAP at the management unit level. This includes objective and/or subjective capture of benefits related to, but not limited to:

- Avoided loss of assets and/or asset value.

- Retention of opportunities for business activities and earning of wages.
- Retention for options for alternative asset utilisation in the future.
- Retention of critical infrastructure.
- Avoided travel costs.
- Avoided clean-up costs.
- Retention of amenity.

The BDA quantifies the estimated proportional benefit accruing to relevant groups of asset holders against a do-nothing base case, informing future structures for robust and fair cost allocations in the future. Cost distribution modelling is out of scope for this report and is therefore not considered.

The BDA takes a broad view of the benefits resulting from CMS interventions, including consideration of benefits to landowners, tenants, agencies, interest groups, and the community as a whole.

For this work, benefit is defined as “the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA”. A key assumption is that beneficiaries will continue to enjoy these benefits in perpetuity.

### **Essential services infrastructure**

Essential services infrastructure is infrastructure without which a settlement could not sustainably exist on CKI. Examples of essential services infrastructure includes infrastructure for water, wastewater, power, fuel, telecommunications, and ports services (particularly important given CKI imports most of its food and all fuel by sea).

Maintaining this infrastructure against coastal hazards is critical to maintaining the existence of the CKI community and adjacent activities. Given the critical nature of this infrastructure and the community’s reliance on it, this infrastructure is not included in the BDA as the benefit accrues equally to all community members.

For completeness, aggregated asset values for Home Island and West Island are included in this report based on figures provided by the Australian Government.

It should also be noted that maintaining this infrastructure will be required well in advance of 2068, and is likely to require short term intervention as well as longer term maintenance.

### **Apportioning benefit**

The methodology for apportioning benefit is:

1. Profile relevant benefits against the CHRMAPs for:
  - Owner benefits
  - Community benefits.

2. Calculate total benefit retention/realisation for all owners and users, including public and private landowners; service/utility providers; commercial operators; community groups; and local, state and federal governments.
3. Allocate overall benefit at the unit management level.

It is important to note that CKI is unusual in that there is very little privately held land. Instead, the islands comprise of Crown Land, and land held by the Cocos (Keeling) Islands Lands Trust of which the Shire is the administrator and Trustee. The majority of residents are renters in houses owned by the Trust. Therefore, while much of the benefit is noted as preserved for private dwellings, most of this benefit ultimately flows to the Trust.

Methodology for calculating the value of benefit for each type of beneficiary is at Table 3. Please note that a glossary of definitions can be found at section 10.

Table 3 - Methodology summary table for calculating value of benefit

Benefit type	Value of benefit – calculation methodology
Private dwellings	Net Present Value of annual Gross Rental Value
Private commercial assets	Net Present Value of annual Gross Rental Value
Environmental amenity	Net Present Value of foregone amenity
Public sector revenue - rates	Net Present Value of foregone Shire rates
Economic activity	Net Present Value of indirect and induced economic impact of foregone wages on CKI
Infrastructure value	Cost of replacement based on current values

Source: FAR Lane, 2023.

A discount rate of four percent was used for Net Present Value calculations for private dwellings, private commercial assets, and community amenity. This social discount rate was selected to reflect the multigenerational nature of interventions and impacts being considered.

A discount rate of seven percent was used for Net Present Value calculations for public sector revenues and economic activity (the economic impact of indirect and induced wages). This rate was selected to reflect that wages and public sector revenues are not accruing in a multi-generational way but instead are accruing to given individuals/households at a given point in time.

The direct economic impact from wages is assumed to accrue to individuals/households, while indirect and induced accrues to the local economy. For this reason, only the impact from indirect and induced wages are considered in the BDA.

## Infrastructure

Infrastructure considered in this report (excluding essential services infrastructure) includes:

- Public assets - estimated value of built form for items such as roads, and amenities such as sports facilities, schools, and museums.

Infrastructure is not considered with Net Present Value calculations because:

- Infrastructure can, in many cases, generate revenues which are utilised in future infrastructure upgrades.
- The infrastructure is specifically provided to support other assets such as residential and commercial assets.

A full methodology can be found in section 8.

## 6 KEY FINDINGS – BENEFIT DISTRIBUTION ANALYSIS BASED ON PROPOSED INTERVENTIONS

As noted in section 4, CKI’s risks from coastal hazards include:

### Inundation risk:

- Both West Island and Home Island are already at high risk of inundation.
- By 2068, almost all of both West Island will be at extreme risk of inundation, and almost all of Home Island will be at either high or extreme risk of inundation.

### Erosion risk:

- By 2068, all of West Island will be at high or extreme risk of erosion (including the settlement), while significant parts of Home Island will be at high risk of erosion, with other parts at extreme risk.

Both West Island’s and Home Island’s risk of inundation and erosion is so great that potential interventions other than relocation will be cost prohibitive and will likely be ineffective against the combination of erosion and inundation. Given this, this report makes the assumption that the community will eventually be relocated.

Below is a breakdown of the BDA for CKI by management unit. Please note that detailed calculations and breakdowns of management units can be found at section 9.

### 6.1 REPLACEMENT OF ESSENTIAL SERVICES INFRASTRUCTURE

Aggregated asset values for essential services infrastructure for Home Island and West Island in this report have been provided by the Australian Government (noting that figures have only been provided as aggregated and not by management unit). These values indicate the approximate total value of replacement (in 2023 dollars) of essential services infrastructure is:

- \$0.5 billion for Home Island.
- \$1 billion for West Island.

### 6.2 HOME ISLAND OVERVIEW

A summary of all owner and community benefit that will be impacted by coastal hazards at Home Island is at Table 4. Note that Home Island contains only a single management unit, meaning the entire island is considered in this section.

Table 4 - Summary of economic NPV in Home Island impacted by coastal hazards by 2068

Beneficiary	Net PV of Benefit	% of Total Benefit
Private Dwellings	\$49,542,000	53.7%
Private Commercial	\$10,141,563	11.0%
Environmental Amenity	\$470,560	0.5%
Public Sector Revenue	\$3,286,758	3.6%
Economic Activity - Wages	\$28,830,874	31.2%
Total	\$92,271,754	100.0%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in Home Island by 2068 is approximately \$92.2 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 64.7% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in Home Island, representing indicative costs of relocating the infrastructure, is \$42.8 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the value of essential services infrastructure on Home Island is \$0.5 billion.

In summary, supporting economic Net Present Value of \$92.2 million in Home Island is:

- \$42.8 million of non-essential infrastructure.
- \$0.5 billion of essential services infrastructure.

### 6.3 WEST ISLAND SETTLEMENT OVERVIEW

A summary of all owner and community benefit that will be impacted by coastal hazards at West Island Settlement is at Table 5.

Table 5 – Summary of economic Net Present Value in West Island Settlement that will be impacted by coastal hazards by 2068

Beneficiary	PV of Benefit	% of Total Benefit
Private Dwellings	\$37,479,600	42%
Private Commercial	\$26,368,063	30%
Environmental Amenity	\$1,629,118	2%
Public Sector Revenue	\$2,486,504	3%
Economic Activity – Wages	\$21,357,737	24%
Total	\$89,321,021	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island Settlement by 2068 is approximately \$89.3 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 71.5% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island Settlement, representing indicative costs of relocating the infrastructure, is \$23.8 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island Settlement management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$89.3 million in West Island Settlement is:

- \$23.8 million in non-essential infrastructure in the West Island Settlement management unit.
- \$1 billion of essential services infrastructure across all of West Island.

#### 6.4 WEST ISLAND NORTH OVERVIEW

Summary of all owner and community benefit that will be impacted by coastal hazards at West Island North is at Table 6.

Table 6 - Summary of economic Net Present Value in West Island North that will be impacted by coastal hazards by 2068

Beneficiary	PV of Benefit	% of Total Benefit
Dwellings	\$0	0%
Private Commercial	\$676,104	27%
Environmental Amenity	\$1,404,989	56%
Public Sector Revenue	\$0	0%
Economic Activity - Wages	\$440,366	17%
Total	\$2,521,458	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island North by 2068 is approximately \$2.5 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 26.8% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island North, representing indicative costs of relocating the infrastructure, is \$7.3 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island North management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$2.5 million in West Island North is:

- \$7.3 million in non-essential infrastructure in the West Island North management unit.
- \$1 billion of essential services infrastructure across all of West Island.

### 6.5 WEST ISLAND SOUTH OVERVIEW

A summary of all owner and community benefit that will be impacted by coastal hazards at West Island South is at Table 7.

Table 7 – Summary of economic Present Value in West Island South that will be impacted by coastal hazards by 2068

Beneficiary	PV of Benefit	% of Total Benefit
Dwellings	\$0	0%
Private Commercial	\$0	0%
Environmental Amenity	\$780,549	100%
Public Sector Revenue	\$0	0%
Economic Activity – Wages	\$0	0%
Total	\$780,549	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island South by 2068 is approximately \$0.78 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, none of the Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island South, representing indicative costs of relocating the infrastructure, is \$5 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island South management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$0.78 million in West Island South is:

- \$5 million in non-essential infrastructure in the West Island Settlement management unit.
- \$1 billion of essential services infrastructure across all of West Island.

### 6.6 OTHER ISLANDS – OVERVIEW

This section examines CKI's unpopulated islands which are considered for loss of public amenity, as they contain many sites used for by CKI's residents for recreation, including fishing and sightseeing. Islands considered are South Island, Direction Island, and Pulu Laur (Other Islands).

Note that no other benefits are considered as these islands are unpopulated and do not contain infrastructure or properties, with the exception of numerous pondoks (traditional fishing huts) scattered throughout the islands which are assumed to have no determinable value.

A summary of community benefit that will be impacted by coastal hazards for Other Islands is described at Table 35.

Table 8 – Community benefit for Other Islands by 2068

Item	Net Present Value	% of Total Benefit
Environmental Amenity	\$5,069,853	100%

Source: FAR Lane, 2023.

The analysis indicates that the Net Present Value of the preserved community benefits on all other islands is approximately \$5 million, none of which would be apportioned to private interests.

## 6.7 SUMMARY

A summary of the NPV of all owner and community benefit that will be impacted by coastal hazards in CKI is at Table 9. All calculations assume that interventions to mitigate the impact of erosion and inundation successfully protect the assets.

Table 9 – Summary of economic Net Present Value in CKI that will be impacted by coastal hazards by 2068

Beneficiary / Community Benefit	Value of Benefit	Percentage of Total Benefit
Private Dwellings	\$87,021,600	45.8%
Private Commercial	\$37,185,729	19.6%
Environmental Amenity	\$9,355,068	4.9%
Public Sector Revenue – Rates	\$5,773,262	3.0%
Economic Activity – Wages	\$50,628,977	26.7%
Total	\$189,964,636	100.0%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in CKI by 2068 is approximately \$190 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 65.4% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust), with private dwellings (predominantly owned by the Trust) and lost economic activity from lost wages constituting the highest preserved values.

The approximate total value of replacement of non-essential infrastructure in CKI, representing indicative costs of relocating the infrastructure, is \$78.9 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

The essential services infrastructure is \$1.5 billion for the entirety of CKI.

In summary, supporting economic Net Present Value of \$190 million in CKI is:

- \$78.9 million in non-essential infrastructure in CKI.

- \$1.5 billion of essential services infrastructure across CKI.

As noted above, CKI is unusual in that there is very little privately held land. Instead, the islands comprise of Crown Land, and land held by the Cocos (Keeling) Islands Lands Trust of which the Shire is the administrator and Trustee. The majority of residents are renters in houses owned by the Trust. Therefore, while much of the benefit is noted as preserved for private dwellings, most of this benefit ultimately flows to the Trust.

Short term interventions are possible to extend the enjoyment of CKI's coastal lifestyle but are likely to be sacrificial in the long term, and any planning should be cognisant of this. Notwithstanding, should any protection be proposed to mitigate the risk of flooding, 65.4% of the economic Net Present Value of providing coastal hazard adaptation would be apportioned to private interests (including the Trust), who, under the beneficiary pays principal outlined in State Planning Policy 2.6, should be obliged to contribute to protection measures.

Given the extreme likelihood of erosion and inundation, the community of CKI will likely need to be relocated in the medium term. In the case of retreat, no intervention is being proposed that assures "the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA". Therefore caution should be used in consideration of a BDA as sole means of considering the preserved benefits of CKI.

## 7 CONCLUSION

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This report provides a Benefit Distribution Analysis (BDA) for the Cocos Keeling Islands (CKI) Coastal Hazard Risk Management Adaptation Plan 2023.

Both West Island's and Home Island's risk of inundation and erosion is so great that potential interventions over the long term other than relocation will be cost prohibitive and will likely be ineffective against the combination of erosion and inundation. Notwithstanding this, for completeness FAR Lane has estimated the value of benefits that would be impacted by coastal hazards in CKI by 2068.

The BDA quantifies the estimated proportional benefit accruing to relevant groups of asset holders against a do-nothing base case, thereby informing potential future structures for robust and fair cost allocations in the future. The BDA takes a broad view of the benefits resulting from coastal management interventions, including consideration of benefits to landowners, tenants, agencies, interest groups, and the community as a whole.

The analysis indicates supporting economic Net Present Value of \$190 million in CKI is:

- \$78.9 million in non-essential infrastructure in CKI.
- \$1.5 billion of essential services infrastructure across all CKI.

## 8 DETAILED METHODOLOGY

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### 8.1 METHODOLOGY OVERVIEW

#### Background to benefit distribution analysis

The benefit distribution analysis (BDA) in this report is developed to:

- Develop a shared understanding of who will benefit from coastal hazard interventions (existing and future).
- Ensure a broad understanding is developed by capturing a range of benefits from different perspectives.
- Inform future decision-making relating to funding contributions for interventions.

The BDA quantifies the estimated proportional benefit accruing to relevant groups of asset holders against a do-nothing base case, informing future structures for robust and fair cost allocations in the future. Cost distribution modelling is out of scope for this report and is therefore not considered.

The BDA takes a broad view of the benefits resulting from CMS interventions, including consideration of benefits to landowners, tenants, agencies, interest groups, and the community as a whole.

For this work, benefit is defined as “the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA”. A key assumption is that, for the purposes of the analysis, beneficiaries will continue to enjoy these benefits in perpetuity.

#### Essential services infrastructure

Essential services infrastructure is infrastructure without which a settlement could not sustainably exist on CKI. Examples of essential services infrastructure includes infrastructure for water, wastewater, power, fuel, telecommunications, and ports services (particularly important given CKI imports most of its food and all fuel by sea).

Maintaining this infrastructure against coastal hazards is critical to maintaining the existence of the CKI community and adjacent activities. Given the critical nature of this infrastructure and the community’s reliance on it, this infrastructure is not included in the BDA as the benefit accrues equally to all community members.

For completeness, aggregated asset values for Home Island and West Island are included in this report. These values are based on aggregated insurance values provided by the Australian Government.

It should also be noted that maintaining this infrastructure will be required well in advance of 2068, and is likely to require short term intervention as well as longer term maintenance.

#### Apportioning benefit

Methodology for apportioning benefit is:

1. Profile logical groupings of management units based on logical groupings of adjoining residential/commercial sites.
2. Profile relevant benefits against the CHRMAPs for:
  - Owner benefits
  - Community benefits.
3. Calculate total benefit retention/realisation for all owner users, including landowners; service/utility providers; commercial operators; local, state and federal governments; and the community.
4. Allocate overall benefit at the unit management level.

Methodology for calculating the value of benefit for each type of beneficiary is at Table 10, and is detailed below. Please note that a glossary of definitions can be found at Section 10.

Table 10 – Methodology summary table for calculating value of benefit

Benefit Type	Value of Benefit – Calculation Methodology
Private Dwellings	Net Present Value of Gross Rental Value
Private Commercial Assets	Net Present Value of Gross Rental Value
Environmental Amenity	Net Present Value of foregone amenity
Public Sector Revenue - Rates	Net Present Value of foregone Shire rates
Economic Activity - Wages	Net Present Value of indirect and induced economic impact of foregone wages on CKI
Infrastructure Value	Cost of replacement based on current values

Source: FAR Lane, 2023.

Net Present Value considers the lifetime of streams of costs and benefits expressed in constant real dollars. The below equation displays how to calculate the net present value of a cash flow existing in perpetuity:<sup>1</sup>

$$\text{Net Present Value} = \frac{\text{Net Annual Cash Flow}}{\text{Discount Rate}}$$

A discount rate of four percent was used for Net Present Value calculations for private dwellings, private commercial assets, and community amenity<sup>2</sup>. This social discount rate was selected to reflect the multigenerational nature of interventions and impacts being considered.

A discount rate of seven percent was used for Net Present Value calculations for public sector revenues and economic activity. This rate was selected to reflect that wages and public

<sup>1</sup> Assumption: Constant discount rate and cash flows hold in perpetuity.

<sup>2</sup> CSIRO, Estimating Coastal Values using multi-criteria and valuation methods, 2018, p.59.

sector revenues are not accruing in a multi-generational way but instead are accruing to given individuals/households at a given point in time.

The direct economic impact from wages is assumed to accrue to individuals/households, while indirect and induced accrues to the local economy. For this reason, only the impact from indirect and induced wages are considered in the BDA.

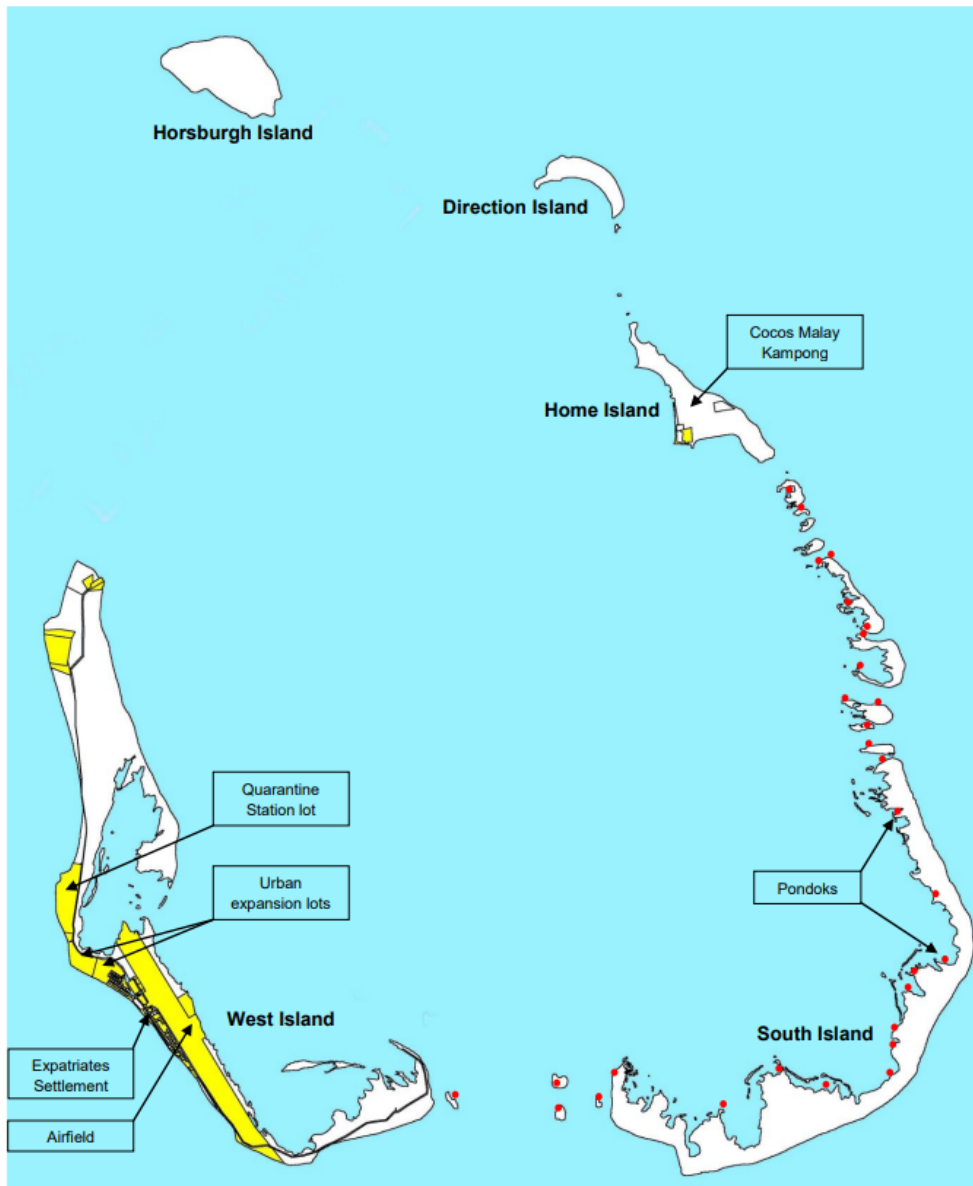
## 8.2 GEOGRAPHICAL DEFINITIONS – MANAGEMENT UNITS

The report breaks down CKI's coastal communities into "management units" which allows for the required level of detail for assessment under the BDA (see section 4). The BDA captures, and where possible, quantifies proportional benefits associated with existing and proposed protection works identified in the CHRMAP at the management unit level. This includes objective and/or subjective capture of benefits related to, but not limited to:

- Avoided loss of assets and/or asset value.
- Retention of opportunities for business activities and earning of wages.
- Retention for options for alternative asset utilisation in the future.
- Retention of critical infrastructure.
- Avoided travel costs.
- Avoided clean-up costs.
- Retention of amenity.

CKI is unusual in that there is very little privately held land. Instead, the islands comprise of Crown Land, and land held by the Cocos (Keeling) Islands Lands Trust of which the Shire is the administrator and Trustee (Figure 9). The majority of residents are renters in houses owned by the Trust.

Figure 9 – Map of land ownership on CKI



Source: Calmy Planning & Design, 2015.

#### Map Legend

- a) Crown land is shown in yellow.
- b) Freehold land held by the Land Trust since 1984 is shown in white.
- c) Freehold land held privately are residential lots all located within the Expatriates Settlement.
- d) The red dots shown depict the location of the Cocos Malay Pondoks.

Noting the breakdown into Crown land and Trust-owned land noted above, a list of management units is at Table 11.

Table 11 – Breakdown of CKI management units

Management unit	Area	Comment
Home Island	All of Home Island.	Treated as single units as any intervention (protect, retreat) impacts the settlement holistically and benefits everyone.
West Island Settlement	The main population centre on West Island located immediately west of the airport.	
West Island South	All land area south of airport runway.	For private commercial property (leased from the Trust), any preserved benefit will accrue solely to the owners.
West Island North	All land area north of Rumah Baru jetty. Includes Big Barge art gallery and Wild Coconut discovery centre.	Also considered for its environmental amenity benefits.
Other Islands	South Island, Direction Island, Pulau Laur.	Unpopulated islands, only environmental amenity benefits considered.

Source: FAR Lane, 2023.

### 8.3 CALCULATING BENEFITS FOR PRIVATE DWELLINGS AND PRIVATE COMMERCIAL ASSETS

Methodology for calculating the benefit value of preserving residential and commercial property in perpetuity is at Table 12.

Table 12 – Methodology for calculating benefit for residential and commercial property

Steps	Data source
1. Define value units based on median gross rental values for CKI	Shire of CKI statutory budget 2022/23
2. Calculate number of properties	ABS Census 2021
3. Calculate total gross rental value of value unit, as an annual cash flow	n/a
4. Convert into a PV at an assumed discount rate of 4%	Assumption – see section 8.1

Source: FAR Lane, 2023.

Assumptions:

- Continuation of usability (utility) of property and assets for the same uses.
- Cash flow exists in perpetuity.
- Cost of maintaining land asset at present value of GRV is nominal and therefore not accounted for in the model.

#### 8.4 CALCULATING COMMUNITY BENEFIT

Methodology for calculating the benefit value of preserving community benefit in perpetuity is at Table 13.

Table 13 – Methodology for calculating community benefit

Community benefit type	Analysis	Methodology
Environmental Amenity	Loss of access/use of islands' undeveloped landmass	Benchmarked amenity calculation based on areas of non-developed land, <sup>3</sup> at a discount rate of 4%
Public Sector Revenues – Rates	Foregone LGA rates revenue	Average Shire of CKI rate payment applied to each residential property <sup>4</sup> at a discount rate of 7%
Economic Activity – Wages	Total loss of indirect and induced economic impact from wages on CKI	The number of jobs, multiplied by the median household income, <sup>5</sup> minus direct impact <sup>6</sup> , at a discount rate of 7%.

Source: FAR Lane, 2023.

Assumptions:

- Continuation of community activities, access to services and amenity, rate revenues, jobs.

#### 8.5 CALCULATING BENEFITS TO INFRASTRUCTURE OWNERS

Infrastructure considered in this report includes:

- Road infrastructure.
- Estimated cost of replacement for built form of public infrastructure, such as schools and sporting facilities.

Methodology for calculating the benefit value of preserving service infrastructure is at Figure 10.

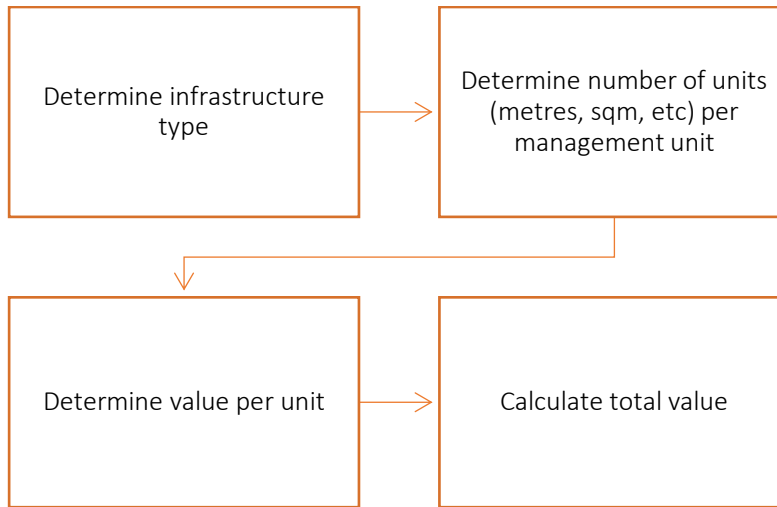
<sup>3</sup> CSIRO, Estimating Coastal Values using multi-criteria and valuation methods, 2018, p.59. Land areas calculated by FAR lane, 2023.

<sup>4</sup> Shire of CKI Adopted Budget 2022-23.

<sup>5</sup> ABS Census 2021.

<sup>6</sup> A multiplier of 1.4 was used to determine total impact, leaving a multiplier of 0.4 for indirect and induced impact. Source: NSW Department of Treasury, Aus Input-Output Employment Multipliers, February 2022.

Figure 10 – Methodology for calculating service infrastructure benefit



Source: FAR Lane, 2022.

The value per unit of service infrastructure types is described at Table 14. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 14 – Value per unit of road infrastructure

Infrastructure type	Value/unit <sup>7</sup>
Road - Sealed	\$2,200 per sqm
Road – Gravel (sqm)	\$1,406 per sqm

Source: FAR Lane, 2022.

Benefit value of preserving built form for infrastructure is calculated by area using the estimated values described at Table 15. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 15 – Value per unit of built form infrastructure

Infrastructure type	Value/unit <sup>8</sup>
Individual House, brick veneer	\$1,750 per sqm
Group Practice Surgery	\$2,125 per sqm

Source: FAR Lane, 2022.

Infrastructure is not considered with Net Present Value calculations because:

- Infrastructure can, in many cases, generate revenues which are utilised in future infrastructure upgrades.
- The infrastructure is specifically provided to support other assets such as residential and commercial assets.

<sup>7</sup> Wavelength, Cocos (Keeling) Islands CHRMAP, 2023.

<sup>8</sup> All per unit infrastructure values obtained from Rawlinsons Construction Cost Guide, 2022. All values are indexed at the highest listed rate for regional WA (160%) to reflect the additional expense for constructing infrastructure on CKI.

Assumptions:

- Continued operations/ performance of infrastructure.

### 8.6 LIMITATIONS OF APPROACH

Limitations of the above approach are at Table 16.

Table 16 – Limitations of approach

Assumption/limitation	Comment
Assumes status quo in perpetuity is desirable/beneficial.	Consideration of appropriate nature of the status quo is out of scope of this report.
Assumes protection in perpetuity.	Assumes interventions will be replaced when required to ensure assets remain protected.
Assumes equivalent benefit across all assets within a defined management unit.	Value units have been specifically selected based on similarity of gross rental value and/or community usage type.
Does not account for comparative sunk cost incurred by different stakeholders.	Due to the long timeframes involved calculating the BDA (50+ years), there is no mechanism available to determine the nature of any development costs that may improve the land value for each block over such a period.
Does not account for comparative opportunities for due diligence by different stakeholders i.e. recent lessees of landholdings should be more aware of risks than those purchasing 30-years ago.	Due to the long timeframes involved calculating the BDA (50+ years), and the current interventions already in place, it is a reasonable assumption that any new lessees will be aware of the effects of rising sea level on the Shire.
Does not dictate cost distributions – further processes need to be developed.	Out of scope of this report.

Source: FAR Lane, 2023.

## 9 DETAILED BENEFICIARY ANALYSIS BY MANAGEMENT UNIT

As noted in section 4, CKI's risks from coastal hazards include:

### Inundation risk:

- Both West Island and Home Island are already at high risk of inundation.
- By 2068, almost all of both West Island will be at extreme risk of inundation, and almost all of Home Island will be at either high or extreme risk of inundation.

### Erosion risk:

- By 2068, all of West Island will be at high or extreme risk of erosion (including the settlement), while significant parts of Home Island will be at high risk of erosion, with other parts at extreme risk.

Both West Island's and Home Island's risk of inundation and erosion is so great that potential interventions other than relocation will be cost prohibitive and will likely be ineffective against the combination of erosion and inundation. Given this, this report makes the assumption that the community will eventually be relocated.

Notwithstanding this, FAR Lane has estimated below the value that would be impacted. All calculations are based on the assumption that interventions to mitigate the impact of erosion and inundation successfully protect the assets. Full methodology and data sources can be found from sections 8.3 to 8.5

As noted in section 5, aggregated asset values for essential services infrastructure for Home Island and West Island in this report have been provided by the Australian Government based on insurance values (noting that values have only been provided as aggregated and not by management unit). These values indicate the approximate total value of replacement (in 2024 dollars) of essential services infrastructure is:

- \$500 million for Home Island.
- \$1 billion for West Island.

### 9.1 DETAILED BENEFICIARY ANALYSIS – HOME ISLAND

Economic value for property on Home Island has been considered based on the mean GRV within the Shire of CKI. Property benefits for Home Island are described at Table 17.

Table 17 – Property benefits for Home Island that will be impacted by coastal hazards

Type	Total Properties	Per unit value	Total (Annual)	NPV (4% discount rate)
Dwellings	115	\$17,232	\$1,981,680	\$49,542,000
Commercial	15	\$27,044	\$405,663	\$10,141,563
Total			\$2,387,343	\$59,683,563

Source: FAR Lane, 2023.

The analysis indicates that NPV of the preserved benefits for properties on Home Island is approximately \$59.6 million.

Community benefits for Home Island are described at Table 18.

Table 18 – Community benefit in Home Island

Item	Units	Total CKI Households	Per unit value	Annual Value	NPV	NPV discount rate
Wages	131	-	\$38,532	\$2,018,161	\$28,830,874	7%
Environmental Amenity	63	202	\$36.80	-	\$470,560	4%
Public Sector Revenue	-	115	\$2,001	\$230,073	\$3,286,758	7%
<b>Total</b>					\$32,588,192	

Source: FAR Lane, 2023.

The analysis indicates that the NPV of the preserved community benefits on Home Island is approximately \$32.6 million.

### Infrastructure

Cost of replacement for road infrastructure on Home Island is described at Table 19.

Table 19 – Cost of replacement for road infrastructure on Home Island that will be impacted by coastal hazards

Utility Type	Area Impacted (sqm)	Per unit value (\$)	Replacement Value (\$2023)
Road – Sealed	4,400	2,200	\$9,680,000
Road – Gravel	15,330	1,406	\$21,553,980
<b>Totals</b>			\$31,233,980

Source: FAR Lane, 2023.

The analysis indicates the estimated cost of replacement for road infrastructure on Home Island at approximately \$31.2 million.

Indicative cost of replacement for built form public infrastructure on Home Island is described at Table 20. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 20 – Cost of replacement for built form public infrastructure on Home Island that will be impacted by coastal hazards

Infrastructure Item – Built Form	Estimated Value of Built Form (\$2023)
Mosque	\$612,500
Doctor's centre	\$1,104,469
Museum	\$693,000
Police station	\$577,500
School	\$5,250,000
Oval	\$1,732,500
Tennis Courts	\$123,420
Yacht Club	\$70,455

Boat Yard	\$1,398,705
Total	\$11,562,549

Source: FAR Lane, 2023.

The analysis indicates the cost of replacement for built form public infrastructure on Home Island is approximately \$11.6 million.

Aggregating costs of replacement for road infrastructure and public infrastructure on Home Island gives a total of \$42.8 million (\$2023).

Please also note that values for the following built form infrastructure has been captured separately in calculations for private commercial properties:

- Shire office.
- Supermarket.

### Summary – Home Island

Summary of all owner and community benefit that will be impacted by coastal hazards at Home Island is at Table 21.

Table 21 - Summary of economic NPV in Home Island that will be impacted by coastal hazards

Beneficiary	NPV of Benefit	% of Total Benefit
Dwellings	\$49,542,000	53.7%
Private Commercial	\$10,141,563	11.0%
Environmental Amenity	\$470,560	0.5%
Public Sector Revenue	\$3,286,758	3.6%
Economic Activity – wages	\$28,830,874	31.2%
Total	\$92,271,754	100.0%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in Home Island by 2068 is approximately \$92.2 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 64.7% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in Home Island Settlement, representing indicative costs of relocating the infrastructure, is \$42.8 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the value of essential services infrastructure on Home Island is \$0.5 billion.

In summary, supporting economic Net Present Value of \$92.2 million in Home Island is:

- \$42.8 million of non-essential infrastructure.
- \$0.5 billion of essential services infrastructure.

## 9.2 DETAILED BENEFICIARY ANALYSIS – WEST ISLAND SETTLEMENT

Economic value for property on Home Island has been considered based on the mean GRV within the Shire of CKI. Property benefits for West Island Settlement are described at Table 22.

Table 22 – Property benefits for West Island Settlement that will be impacted by coastal hazards

Type	Total Properties	Per unit value	Total (Annual)	NPV (4% discount rate)
Dwellings	87	\$17,232	\$1,499,184	\$37,479,600
Commercial	39	\$27,044	\$1,054,723	\$26,368,063
Total			\$2,553,907	\$63,847,663

Source: FAR Lane, 2023.

The analysis indicates that NPV of the preserved benefits for properties on West Island Settlement is approximately \$63.8 million.

Community benefits for West Island Settlement are described at Table 23.

Table 23 – Community benefit in West Island Settlement

Item	Units	Total CKI Households	Per unit value	Annual Value	NPV	NPV discount rate
Wages	97	-	\$38,532	\$1,495,042	\$21,357,737	7%
Environmental Amenity	219 ha	202	\$36.80	-	\$1,629,118	4%
Public Sector Revenue	-	87	\$2,001	\$174,055.26	\$2,486,504	7%
Total					\$25,473,359	

Source: FAR Lane, 2023.

The analysis indicates that the NPV of the preserved community benefits on West Island Settlement is approximately \$25.5 million.

### Infrastructure

Cost of replacement for road infrastructure on West Island Settlement is described at Table 24.

Table 24 – Cost of replacement for road infrastructure in West Island Settlement that will be impacted by coastal hazards

Utility Type	Unit quantity	Per unit value (\$)	Total
Road – Sealed (sqm)	7,125	\$2,200	\$15,675,000
Road - Gravel (sqm)	1,181	\$1,406	\$1,660,486
Total			\$17,335,486

Source: FAR Lane, 2023.

The analysis indicates the estimated cost of replacement for road infrastructure for West Island Settlement at approximately \$32.5 million.

Indicative cost of replacement for built form public infrastructure is described at Table 25. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 25 – Cost of replacement for built form public infrastructure on West Island Settlement that will be impacted by coastal hazards

Infrastructure Item	Estimated Value of Built Form
School	\$4,900,000
Medical centre	\$1,577,813
Total	\$6,477,813

Source: FAR Lane, 2023.

The analysis indicates the cost of replacement for built form infrastructure on West Island Settlement is approximately \$6.5 million.

Please also note that values for the following built form infrastructure has been captured in calculations for private commercial properties:

- Golf course.
- Settlement facilities.
- Transmitter station.

Aggregating costs of replacement for service and built form infrastructure gives a total of approximately \$23.8 million.

Summary of all owner and community benefit that will be impacted by coastal hazards at West Island Settlement is at Table 26.

Table 26 - Summary of economic value in West Island Settlement that will be impacted by coastal hazards

Beneficiary	NPV of Benefit	% of Total Benefit
Private Dwellings	\$37,479,600	42%
Private Commercial	\$26,368,063	30%
Environmental Amenity	\$1,629,118	2%
Public Sector Revenue	\$2,486,504	3%
Economic Activity - wages	\$21,357,737	24%
Total	\$89,321,021	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island Settlement by 2068 is approximately \$89.3 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 71.5% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island Settlement, representing indicative costs of relocating the infrastructure, is \$23.8 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island Settlement management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$89.3 million in West Island Settlement is:

- \$23.8 million in non-essential infrastructure in the West Island Settlement management unit.
- \$1 billion of essential services infrastructure across all of West Island.

### 9.3 DETAILED BENEFICIARY ANALYSIS – WEST ISLAND NORTH

West Island North contains no dwellings but one commercial property, the Big Barge art gallery. Economic value for property on West Island North has been considered based on the mean GRV within the Shire of CKI. Property benefits for West Island North are described at Table 27.

Table 27 – Property benefits for West Island North that will be impacted by coastal hazards

Type	Total Properties	Per unit value	Total (Annual)	NPV (4% discount rate)
Commercial	1	\$27,044	\$27,044	\$676,104

Source: FAR Lane, 2023.

The analysis indicates that NPV of the preserved benefits for properties on West Island North is approximately \$676,000.

Community benefits for West Island North are described at Table 28. Wages have been calculated the assumption that Big Barge has two FTE staff.

Table 28 – Community benefit in West Island North

Item	Units	Total CKI Households	Per unit value	Annual Value	NPV	NPV discount rate
Wages	2	-	\$38,532	\$30,825.60	\$440,366	7%
Environmental Amenity –	189 ha	202	\$36.80	\$1,404,989	\$1,404,989	4%
Total					\$1,845,354	

Source: FAR Lane, 2023.

The analysis indicates that the NPV of the preserved community benefits on West Island North is \$1.85 million.

### Infrastructure

Cost of replacement for road infrastructure on West Island North is at Table 29.

Table 29 – Cost of replacement for road infrastructure value in West Island North that will be impacted by coastal hazards

Utility Type	Unit quantity	Per unit value (\$)	Total
Road - Sealed (sqm)	3,330	\$2,200	\$7,326,000

Source: FAR Lane, 2023.

The analysis indicates the estimated cost of replacement for road infrastructure on West Island North at approximately \$7.3 million.

West Island North has no built form public infrastructure, therefore the cost of replacement is zero.

As noted above, values for the following built form infrastructure has been captured in calculations for private commercial properties:

- Big Barge Art Gallery.

Aggregating costs of replacement for service and built form infrastructure gives a total of approximately \$7.3 million.

Summary of all owner and community benefit that will be impacted by coastal hazards at West Island North is at Table 30.

Table 30 – Summary of economic Net Present Value in West Island North that will be impacted by coastal hazards

Beneficiary	NPV of Benefit	% of Total Benefit
Dwellings	-	0.0%
Private Commercial	\$676,104	26.8%
Environmental Amenity	\$1,404,989	55.7%
Public Sector Revenue	-	0.0%
Economic Activity - wages	\$440,366	17.5%
Total	\$2,521,458	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island North by 2068 is approximately \$2.5 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 26.8% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island North, representing indicative costs of relocating the infrastructure, is \$7.3 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island North management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$2.5 million in West Island North is:

- \$7.3 million in non-essential infrastructure in the West Island North management unit.
- \$1 billion of essential services infrastructure across all of West Island.

#### 9.4 DETAILED BENEFICIARY ANALYSIS – WEST ISLAND SOUTH

No dwellings or commercial properties exist within West Island South. Therefore the preserved benefit for property for this management unit is zero.

Community benefits for West Island South are described at Table 31.

Table 31 – Community benefit in West Island South

Item	Units	Total CKI Households	Per unit value	NPV	NPV discount rate
Environmental Amenity –	105	202	\$36.80	\$780,549	4%

Source: FAR Lane, 2023.

The analysis indicates that the NPV of the preserved community benefits on West Island South is approximately \$780,000.

#### Infrastructure

Cost of replacement for road infrastructure on West Island South is at Table 32.

Table 32 – Cost of replacement for road infrastructure in West Island South that will be impacted by coastal hazards

Utility Type	Unit quantity	Per unit value (\$)	Total
Road – Gravel (sqm)	3,470	\$1,406	\$4,878,820

Source: FAR Lane, 2023.

The analysis indicates the estimated cost of replacement for current costed service infrastructure on West Island South at approximately \$4.8 million.

Indicative cost of replacement for built form public infrastructure is described at Table 33. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 33 – Cost of replacement for built form public infrastructure on West Island South that will be impacted by coastal hazards

Infrastructure Item	Estimated Value of Built Form
Yacht club	\$118,264

Source: FAR Lane, 2023.

The analysis indicates the cost of replacement for built form infrastructure on West Island Settlement is approximately \$0.1 million.

Aggregating costs of replacement for service and built form infrastructure gives a total of approximately \$5 million.

Summary of all owner and community benefit that will be impacted by coastal hazards at West Island South is at Table 34.

Table 34 - Summary of economic Net Present Value in West Island South that will be impacted by coastal hazards

Beneficiary	PV of Benefit	% of Total Benefit
Dwellings	-	0%
Private Commercial	-	0%
Environmental Amenity	\$780,549	100%
Public Sector Revenue	-	0%
Economic Activity - wages	-	0%
Total	\$780,549	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island South by 2068 is approximately \$0.78 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, none of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island South, representing indicative costs of relocating the infrastructure, is \$5 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island South management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$0.78 million in West Island South is:

- \$5 million in non-essential infrastructure in the West Island Settlement management unit.

- \$1 billion of essential services infrastructure across all of West Island.

### 9.5 DETAILED BENEFICIARY ANALYSIS – OTHER ISLANDS

This section examines CKI's unpopulated islands are considered for loss of public amenity, as they contain many sites used for by CKI's residents for recreation, including fishing and sightseeing. Islands considered are South Island, Direction Island, and Pulau Laur.

Note that no other benefits are considered as the islands are unpopulated and do not contain infrastructure or properties, with the exception of numerous pondoks (traditional fishing huts) scattered throughout the islands which are assumed to have no determinable value.

Table 35 – Community benefit, all other islands

Item	Total Hectares	Environment Hectares	NPV per Household	Total CKI Households	NPV	NPV discount rate
Environmental Amenity	682	682	\$25,098	202	\$5,069,853	4%

Source: FAR Lane, 2023.

The analysis indicates that the PV of the preserved community benefits on all other islands is approximately \$5 million, none of which would be apportioned to private interests.

## 10 GLOSSARY OF KEY TERMS AND ACRONYMS

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Amenity - an asset, facility or place that is a desirable or useful feature of a given area, which individuals find value in having access to. Includes natural environments such as beaches, waterways or parklands.

Benefit Distribution Analysis – a method of systematically estimating benefits to different parties from an action.

Benefit - the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA.

CHRMAP - Coastal Hazard Risk Management and Adaptation Plan.

Commercial benefit – benefit that sustains a commercial return from an intervention that preserves a business location.

Community amenity – see amenity.

Economic activity – wages generated by workers on CKI.

Erosion - Coastlines composed primarily of loose sediment (such as beaches) recede until a new equilibrium shoreline is found further inland. This report considers predicted erosion levels at 2068.

GRV – Gross Rental Value. The value expected to be gained from renting a property to a tenant/lessee.

Infrastructure – as defined in section 8.5.

Intervention – a deliberate action to avoid coastal hazards to townships that are deemed a risk to a community. Includes consideration of options to ‘avoid’ impact, ‘retreat’, ‘accommodate’ or to ‘protect’. CKI already has experience in this space, with construction of seawalls to mitigate the immediate effects of erosion (protect).

Inundation - Storm surges and increased mean sea levels will create flooding in areas adjacent to shorelines. The risk zone is measured based on 500-year average return interval (ARI) storms, combined with 100 years of sea level rise.

Management unit – a sub-unit of a community which allows for the required level of detail for assessment under the BDA (see section 8.2).

Net Present Value in perpetuity – difference in present value of cash inflows and present value of cash outflows, that will exist in perpetuity.

Private dwelling benefit – benefit value from an intervention that protects a private dwelling.

## 11 APPENDIX A – LIST OF INFRASTRUCTURE

A list of all road infrastructure on CKI by management unit is at Table 36.

Table 36 – Table of all road infrastructure by management unit

Management Unit	Asset	Value (\$2023)
Home Island	Roads - Sealed	\$9,680,000
Home Island	Road - Gravel	\$21,553,980
West Island - North	Roads - Sealed	\$7,326,000
West Island - Settlement	Roads - Sealed	\$15,675,000
West Island - Settlement	Road - Gravel	\$1,660,486
West Island - South	Road - Gravel	\$4,878,820
Total		\$60,774,286

Source: FAR Lane, 2023.

A list of all non-essential infrastructure built form on CKI by management unit is at Table 37.

Table 37 – Table of all public infrastructure built form by management unit

Management Unit	Asset - built form	Value of built form (\$2023)
Home Island	Mosque	\$612,500
Home Island	Doctor's centre	\$1,104,469
Home Island	Museum	\$693,000
Home Island	Police	\$577,500
Home Island	School	\$5,250,000
Home Island	Oval	\$1,732,500
Home Island	Tennis Courts	\$123,420
Home Island	Yacht Club	\$70,455
Home Island	Boat Yard	\$1,398,705
West Island - Settlement	School	\$4,900,000
West Island - Settlement	Medical Centre	\$1,577,813
West Island - South	Yacht Club	\$118,264
Total		\$18,158,625

Source: FAR Lane, 2023.

A list of essential services infrastructure by management unit is at Table 38. Note that values are not included, as aggregated asset values for essential services infrastructure for Home Island and West Island in this report have been provided by the Australian Government based on insurance values. These values indicate the approximate total value of replacement (in 2023 dollars) of essential services infrastructure is:

- \$0.5 billion for Home Island.
- \$1 billion for West Island.

Table 38 – Table of essential services infrastructure by management unit

Management Unit	Asset
Home Island	Desalination Pumps
Home Island	Water Pump
Home Island	Waste Water Treatment
Home Island	Fuel Facilities
Home Island	Power
Home Island	Jetty
Home Island	Cyclone Shelter
Home Island	Water Pipes
Home Island	Sewerage
Home Island	Underground cables
West Island - North	Fuel Station/Depot
West Island - North	Rumah Baru Jetty/Infrastructure
West Island - North	Port Office
West Island - North	Underground cables
West Island - North	Communication cables
West Island - Settlement	Transmitter Station
West Island - Settlement	Waste Water Treatment
West Island - Settlement	Water Storage Tank
West Island - Settlement	BoM facility
West Island - Settlement	Seismic Station
West Island - Settlement	Power Station
West Island - Settlement	Water Pipes
West Island - Settlement	Sewerage
West Island - Settlement	Underground cables
West Island - Settlement	Communication Cables
West Island - Settlement	Airport and Related Infrastructure
West Island - South	Underground cables
West Island - South	Communication cables

Source: FAR Lane, 2023.